



## International Journal of Innovative Pharmaceutical Sciences and Research

www.ijipsr.com

### *Cymbopogon Citratus*: A MIRACLE HERB AND BOON TO MEDICAL SCIENCE

<sup>1</sup>Pranali Wasate\*, <sup>2</sup>NavnathKashid, <sup>3</sup>Rohini Kulkarni Pandhare

<sup>1</sup>Research student, Baburaoji Adaskar Mahavidyalaya Kaij, Beed (MS) 431123, INDIA

<sup>2</sup>Associate Professor, Baburaoji Adaskar Mahavidyalaya Kaij, Beed (MS) 431123, INDIA

<sup>3</sup>Principal, Government College of Arts and Science Aurangabad (MS) 431001, INDIA

#### Abstract

*Cymbopogon citratus* is an aromatic plant of Gramineae family wellknown as lemon grass. It is profusely cultivated for its fragrant leaves that are used in cooking and brewing tea. The heart of the young shoots is cooked and eaten as a vegetable. The leaves and the essential oil are used in traditional medicine to relieve spasms and increase perspiration. It is also used to treat digestive ailments, arthritis pains, and various skin conditions. The essential oil can also be used in perfumery and making cosmetics and soaps. The chemical composition of *Cymbopogon citratus* contains phytochemical compounds as hydrocarbon terpenes, alcohols, ketones, esters and mainly aldehyde. The plant extract shows antifungal activity against such *Trichophyton mentagrophytes*, *T. rubrum*, *Epidermophyton floccosum* and *Microsporungypseum*. It shows antidiabetic, anti inflammatory, antibacterial, neurobehavioral activities.

**Keywords:** *Cymbopogon citratus*, Phytochemical, Antimicrobial, Herbal medicine.

#### Corresponding Author:

Pranali Wasate

Baburaoji Adaskar Mahavidyalaya Kaij,

Beed (MS) 431123, INDIA

E.mail: pranaliwasate@gmail.com

Phone: +91-7276131110



*Pranali Wasate*

Available online: [www.ijipsr.com](http://www.ijipsr.com)

October Issue

37

PRINCIPAL  
Govt. College of Arts & Science  
Aurangabad

## INTRODUCTION

More than half of the world population use plants for their basic health needs. They are bestowed for humanity. From the millennia they have been used as a potent medicinal treatment against various kinds of diseases and ailment. Plant resides wide range of bioactive components/secondary metabolites viz Phenols, Tannins, Saponin, Steroids, Alkaloids, Flavanoids, Carbohydrates and Glycosides which are responsible for antimicrobial activity (Nascimento *et al.*, 2000; Ewansihaet *et al.*, 2012; Chaudhary *et al.*, 2017; Elishet *et al.*, 2017) therefore the discovery of extraction of bioactive components from plants have proved to be one of the important research for human kind.

Due to the negative impact of chemically designed antimicrobial drugs as compared to natural drugs on human health and environment; treatment with natural constituents has increased potentially these days (Wu *et al.*, 2013).

*Cymbopogon* originated from the Greek word “kymbe - pogon” meaning boat-beard (due to its flower spike configuration) and *citratius* (Latin) means lemon-scented leaves (G. Shah *et al.*, 2011).

*Cymbopogon citratius* is an aromatic, perennial and economically valuable plant. Studies indicate that this plant have a strong lemon like aroma due to the presence of citral, which is a potent bioactive constituent having antimicrobial activity (Korenblumet *et al.*, 2013) and therefore in common language, *C. citratius* called by lemongrass. The component present in plant is conventionally used in variety of human therapy (Han and Parker, 2017).

Traditionally aqueous extract of its dried leaves use to treat digestive disorders, diabetes, nervous disorders and cancer (Francisco *et al.*, 2011).

According Thangamet *et al.*, 2014 findings *C. citratius* polysaccharides has important role in turning off the genes that suppresses the tumour growth and act as a potent novel anti-cancer drugs. *C. Citratius* is widely applicable in field of medicine, cosmetic (Perfumes, soap etc) and brewing (non-alcoholic like tea) (Ekpenyonget *et al.*, 2014). Because of the immense benefit to human kind, *C. citratius* has been used to conduct several of studies for investigation of its valuable potential. *Cymbopogon citratius* is a perennial herb with tiny long and needle-like leaves. The strap-like leaves are about 1.3–2.5 cm in width, 0.9 cm long with loose tips and glossy bluish-green colouration with a citrus aroma when grounded due to the presence of citral and high content of neral and aldehyde geranial (N.E. Tajidinet *et al.*, 2012).

The leaf blade is about 18–36 cm with parallel venation and showy fall characteristics. They do not produce flowers or panicles (cultivars). The inflorescence is approximately 30–60 cm



with paired racemes of spike-lets for partial inflorescence. The plant grows in fertile clumps and can reach about 1.8 m and 1.2 m in height and width, respectively (S.P. Chanthalet. al, 2012).

The dry leaf contains about 1–2% of essential oil with bioactive chemical constituents varying depending on their habitat, genetic differences and agrarian treatment (L. Paviani, et al, 2006).

### Phytochemical constituents

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 aldehyde have constantly been registered. (Abegaz B et al,1983, Trease GE et al, 1996).

The essential oil (0.2–0.5%, West Indian lemon grass oil) consists of, mainly, citral. Citral is a mixture of two stereo isomericmonterpene aldehydes; the trans isomer geranial (40–62%) dominates over the cis isomer neral (25–38%),(Ming L et al 1996 , SarerEet al,1983 , Rauber Set al, 2005).

### Mineral content

*Cymbopogon citratus* contains important mineral constituents such as potassium (K), sodium (Na), magnesium (Mg), manganese (Mg), iron (Fe), zinc (Zn), phytate and phosphorus (P) (Table 4). The phytate concentration has been estimated as 11860 mg/100 g and reported to have sufficient amount of zinc due to the molar concentration of Phytate: zinc of 10 (recommended limit) to 15 (unsafe due to excess amount), Calcium to Phytate (0.05), Phytate to Zinc (9.6) and Calcium to Phytate (6:1) (M.N. Boukhatemet al, 2013 , P.A. Tarkanget al, 2012).

**Triterpenoids:** Isolated and identified new triterpenoids from leaf wax are Cymbopogon and cymbopogonol (Hanson SW et al, 1976).

**Flavenoid and Phenolic Compounds:** Lemongrass consists of luteolin and its 6-C and 7-O–glycosides, iso-orientin 2'-O-rhamnoside and isolation of the flavonoids quercetin, kaempferol and apigenin from the aerial parts. The phenolic compounds elimicin, catecol, chlorogenic acid and hydroquinone are also isolated from the plant.(Guanasingh CB et al 1981 ,Matouschek BK et al 1991,Miean KH et al 2001 , Faruq MO et al 1994).

**Anti-amebic Effect:** The essential oil in broth culture was active on *Entamoeba histolytica*, (Blasi DV et al, 1990).

**Antibacterial Activity:** The chromatographic fraction of the essential oil in agar plate was active on *Bacillus subtilis*, *Escherichia coli*, *Staphylococcus aureus* (Onawunmiaet al,1984 ,



Melo SF *et al*, 2001 ) and Salmonella paratyphi and Shigella flexneri. (Syed M *et al*, 1990) These activities are shown in two of the three main components of the oil identified through chromatographic and mass spectrometric methods. While the  $\alpha$ -citral (geranial) and  $\beta$ -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.(Onawunmia *et al* 1984). The extract was also active when the volatile oil extract was oxidized via the active oxygen method, (Orafidiva *et al* 1993 , Wannissorn B *et al* 2005).

**Antidiabetic activity:** Diabetes is one of the lethal diseases of the twentieth century. It inhibits the pancreas from production of adequate insulin and could prevent the regulation of blood sugar. The in-vivo antidiabetic potency of *C. citratus* was investigated via molecular docking at dosage rate of 400 and 800 mg. The extracts show pronounced reduction in the level of insulin ( $p < 0.001$ ), glucose ( $p < 0.001$ ) and triglycerides ( $p < 0.001$ ) The in-vitro antidiabetic potential of *C. citratus* was investigated against Type II diabetes via  $\alpha$ -amylase and  $\alpha$ -glucosidase inhibitory assays. The inhibition of 99.9% (1 mg/mL) and EC<sub>50</sub> (0.31 mg/mL) was identified for  $\alpha$ -glucosidase and  $\alpha$ -amylase, respectively (N.K. Boaduo *et al* 2014 , S.K. Bharti *et al* 2013).

**Antidiarrheal Activity:** *Cymbopogon citratus* stalk decoction reduced the fecal output in a dose-dependent manner,(Tangpu V *et al* 2006).

**Antifungal Activity:** Lemon grass oil is active against such dermatophytes such as *Trichophyton mentagrophytes*, *T. rubrum*, *Epidermophyton floccosum* and *Microsporum gypseum*, and is among the most active agents against human dermatophytes,(Wannissorn B *et al* 1996). Other studies reported that lemon grass oil is active against keratinophilic fungi, 32 ringworm fungi and food storage fungi (Kishore N *et al* 1993, Abe S *et al* 2003).

**Anti-HIV activity:** Citronella oil isolated from *C. citratus* leaf was reported to effectively cure mouth thrush caused by *Candida albicans* in HIV/AIDS patients within 1–5 days (S.C. Wright *et al* 2009).

**Anti-inflammatory Activity:** The hot water extract of the dried leaves administered intragastrically to rats was active when compared with carrageen in-induced pedal edema,(Carbajal D *et al* 1989).

**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%),(Tchoumboungnan F *et al* 2005 )

**Antimutagenicity:** The ethanolic extract of lemon grass extract exhibits an antimutagenic activity in various models and retards the growth of fibro sarcoma cells transplanted in mice in association with the prevention of lung metastasis, (Meevateet *al*,1993, Vinitketkumnuenet *al* 1994,Puatanachokchai R.*et al* 1994). The plant extract is known to show inhibition on the formation of azoxymethane-induced DNA adducts and aberrant crypt foci in the rat colon,(Suaeyun R, *et al* 1997).

Inhibitory effects of the plant extract on the early phase of hepatocarcinogenesis after initiation with diethylnitrosamine were seen in 344 male Fischer rats,(Puatanachokchai R *et al* 2002).

**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.

**Anti-obesity and antihypertensive activities:** Lemon grass has been incorporated in hypolipidemic and hypoglycemic drugs. In folk and Ayurvedic medicine, it has been used to regulate glucose, lipid and fat level in the blood serum which could prevent obesity and hypertension, usually taken as tea (G. Shah *et al*, 2011).

The plant has been used to maintain blood glucose through secretion of insulin (hyperinsulinemia). It reduces blood pressure which could lead to hypertension (K. Shimonoe *et al*,2010).

Citral isolated from *C. citratus* has function as endothelium-independent vaso-relaxation through the blockage of Ca<sup>2+</sup> influx and prostacyclins (PGI<sub>2</sub>) channel (R. Devi *et al* 2012), acts both at the peripheral and at the central levels, (Viana GS *et al*, 2000).

**Antioxidant activity:** *Cymbopogon citratus* contain natural antioxidants, such as caffeoylquinic acid, flavonoids, chlorogenic acids, phenolic acids, swertiajaponin and isoorientin. These compounds could be responsible for the diminishing low-density lipoprotein (LDL) oxidation induced by Cu<sup>2+</sup> reducing capability of plasma (FRAP), β-carotene and 1,1-diphenyl-2-picryl-hydrazyl (DPPH) assays [ Lu Y., F. Shipton *et al* 2014]. It also help suppress oxidative stress in Wistar rats investigated for diabetic conditions (A. Ademuyiwa *et al* 2015, A.S. ,Adesegun *et al* 2013 , Blanco MM *et al* 2007).

**Antiprotozoan Activity:** A dose-dependent antiprotozoan effect of the essential oil of *Cymbopogon citratus* could be observed on two strains of *Crithidia deanei*, (Pedroso RB *et al*



**Dermatotoxicity activity:** *Cymbopogon citratus* has been incorporated in herbal soap to treat rashes, itchy and swollen skin, Herbal soap produced from *C. citratus* leaf, tea tree oil and orange peel was investigated for their derma toxicity potency using clinical samples. Significant activity of 60% ( $p < 0.05$ ) was observed after 40 days of treatment with the soap (E.S. Carmoet *al*, 2013).

Similar investigation reported significant inhibition of 85.35% against *Microsporumcanis* when treated with *C. citratus* oil (1  $\mu\text{L}/\text{mL}$ ). Shampoo incorporated with citral was effective against fungus (*Malassezia furfur*) inherent in dandruff (M.Wulthi-Udomlert *et al* 2011, K.E. Elkhair *et al*, 2014).

**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. (Cheel J *et al*, 2005).

**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 hypocholestecolemic potential. (Agbafor KN *et al*, 2007).

**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. (Adeneye *et al*, 2007).

**Larvicidal and Insecticidal activity:** The fresh leaf essential oil has a larvicidal activity (Cavalcanti ES, 2004). Essential oils from *C. citratus* have been applied in the control of pathogens and insects (P Sessouet *al* 2012).

It has been reported to be effective against *Aedes aegypti*, *Phemacoccussolenopsis*, *Musca domestica* and *Dermatophagoides sp.* (Vera *et al* 2014, Adeneye *et al* 2007 A.K. Banu *et al* 2013, M. Soonwera *et al* 2015, B. Bagora *et al* 2018).

**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.(Blanco MM *et al*, 2007).

**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.

### Traditional importance

Leaves of lemongrass are reported to have good quantity of oil and this oil is reported to have antimicrobial, carminative, fungicidal, analgesic, antiseptic, astringent, bactericidal and antidepressant properties. It can be used for curing of ringworm and athlete's foot disease due to its ability to act as antibiotic as well as antiseptic properties. Lemongrass possesses good inhibitory activity against methicillin-resistant *Staphylococcus aureus* (MRSA) infection. It can be used for colitis indigestion and gastro-enteritis ailments. It helps relieve the symptoms of headache, body ache, nervous exhaustion and stress-related condition. Its infusions are often made useful in infections such as sore-throats, laryngitis, bronchitis etc (Joseph Mercola *et al*, 2005).

Studies on lemongrass by researchers have indicated that it revitalizes the body and enhances good health. It stimulates digestion and inhibits chemical induced carcinogenesis by modulating xenobiotic metabolizing enzymes in the liver and intestine. Lemon grass tea is commonly used to combat flu, fever, pneumonia (Nambiar VS *et al*, 2012).

### Economic importance

Essential oils such as citral, geraniol,  $\alpha$ -oxobisabolene and myrcene isolated from *C. citratus* are important raw materials in soap and detergent, food, beverage, perfume, cosmetic and confectionaries industries (Avosehet *al* 2015, R. Usha *et al* 2012).

An essential oil obtained from the plant is used in perfumery, scenting soaps, hair oils, cosmetics and as an insect repellent. It is also used in the synthesis of vitamin A (Bown. D *et al* 1995, Chevallier *et al*, 1996).

The oil consists mainly of citral and is an important starting material in the perfumery industry for the production of 'ALPHA'- and 'BETA'-ionones, which in low concentrations



have the odour of violets. The fresh leaves, crushed in water, are used as a hair wash and toilet water. The plant is used for cellulose and paper production.

**Garden Uses:** Rapid-growing ornamental grass for herb gardens, borders, along walkways or for tubs/containers. Harvest bulbous lower leaf sections for cooking. Though tough and inedible, sections of the mature leaf blades may be used fresh or dried for flavouring teas, soups or stews.

**Agro forestry Uses:** A good soil conditioner in worn out land. The plants quickly produce a bulk of organic material which soon rots down, attracting worms and other beneficial creatures and quickly enriching the soil

A row of lemongrass plants can be used as a divider in the garden - it can help to contain more invasive plants such as sweet potato, and also as a barrier to prevent weeds growing into the garden. The grass is useful for soil improvement and erosion control. (Norrington. L. Publication, 2001).

## CONCLUSION

*C. citratus* leaf, stem, and roots are commonly used in herbal medicine. Its essential oils are considered safe for human consumption and are commonly used in aromatherapy. More empirical studies evaluating the effect of *C. citratus* on humans are needed to substantiate its use in therapeutics. Most of the available studies are animal-based and may not be informative for the assessment of its therapeutic potential in humans.

## REFERENCES

1. Abegaz B, Yohanne PG, Diете KR(1983). Constituents of the essential oil of Ethiopian *Cymbopogon citratus* Stapf. J Nat Prod. 146:423–426.
2. Abe S, Sato Y, Inoue S, Ishibashi H, Maruyama N, Takizawa T,(2003). Anti-Candida albicans activity of essential oils including Lemongrass (*Cymbopogon citratus*) oil and its component, citral” Nippon Ishinkin Gakkai Zasshi.; 44:285–291.
3. Adeneye AA, Agbaje EO,(2007). Hypoglycemic and hypolipidemic effects of fresh leaf aqueous extract of *Cymbopogon citratus* Stapf in rats. J Ethnopharmacol. 112:440–444.
4. Agbafor KN, Akubugwo EI.(2007). Hypocholesterolaemic effect of ethanolic extract of fresh leaves of *Cymbopogon citratus* (lemon grass) African J Biotechnol.;6:596–598.
5. A.K. Banu, A. Bewaraji (2013). A novel herbal pesticide to control adult scale insects, J.Pharmacol. Sci. Innov.,2,pp. 22-25.





6. **Alves AC, Souza AF. (1960).**Nota prévia sobre o estudo fitoquímico de *Cymbopogon citratus* (D.C.) Stapf. Garcia de Orta, 8:629-638.
7. **A. Ademuyiwa, K. Grace, (2015).**The effects of *Cymbopogon citratus* (Lemon grass) on the antioxidant profiles wistar albino rats Merit. Res. J., 3 pp. 51-58.
8. **A.S. Adesegun, F. Samuel, R.G. Olawale, S.A,(2013).**Funmilola Antioxidant activity of the volatile oil of *Cymbopogon citratus* and its inhibition of the partially purified and characterized extracellular protease of *Shigella sonnei*Am. J. Res. Commun., 1 pp. 31-45.
9. **B. Bagora, H.N. Imael, M. Salwan, B. Silvere, S. Jacques, A. Jean-Marc,(2018).** *Cymbopogon citratus* and *Cymbopogon giganteus* essential oils have cytotoxic effects on tumour cell cultures. Identification of citral as a new putative anti-proliferative molecule Biochimie, 153 pp. 162-170.
10. **Blanco MM, Costa CA, Freire AO, Santos JG, Costa IM.(2007).**Neurobehavioral effect of essential oil of *Cymbopogon citratus* in mice. Phytomedicine.;16:265–70.
11. **Blasi DV, Debrot S, Menound PA, Gendre L, Schowing J.(1990)**Amoebicidal effect of essential oils in vitro. J Toxicol Clin Exp;10:361–73.
12. **Bown. D. (1995)** Publisher Dorling Kindersley, London ISBN 0-7513-020-31
13. **Carbajal D, Casaco A, Arruzazabala L, Gonzalez R, Tolon Z. (1989)** Pharmacological study of *Cymbopogon citratus* leaves.J Ethnopharmacol. ;25:103–7.
14. **Cavalcanti ES, Morais SM, Lima MA.(2004)**Larvicidal activity of essential oils from Brazilian plants against *Aedes aegypti*L. Mem Inst OswaldoCruz.;99:541–4.
15. **Chaudhary, S., Chandrashekar, K. S., Pai, K. S. R., Setty, M. M., Devkar, R. A., Reddy, N. D., et al. (2017).** Screening of anticancer activity of selected medicinal plants indigenous to western ghats: *Argyrea nervosa*, *Memecylon malabaricum* and *Memecylon umbellatum*, Adv. Sci. Lett. 23:784.
16. **Cheel J, Theoduloz C, Rodriáquez J, Hirschmann SG.(2005)**Free Radical Scavengers and Antioxidants from Lemongrass (*Cymbopogon citratus*Stapf) J Agric Food Chem. ;53:2511–7.
17. **Chevallier(1996)**The Encyclopedia of Medicinal PlantsPublication. A. Publish Dorling Kindersley. London ISBN 9-780751-303148.
18. **Chopra RN, Chopra IH, Kapur LD. (1958)** Indigenous drugs of India U.N. Dhur and Sons. Private Ltd. Calcutta.; 67:502
19. **Chungsamarnvart N, Jiwajinda. S. (1992)** A acaricidal activity of volatile oil from lemon and citronella grasses on tropical cattle ticks.Kasetsart J Nat Sci.;26:46–51.



20. Ekpenyong, C. E., Akpan, E. E., and Daniel, N. E. (2014). Phytochemical Constituents, therapeutic applications and toxicological profile of *Cymbopogon citratus* Stapf (DC) leaf extract. *J. Pharmacogn. Phytochem.* 1, 133–141.
21. Elish, I. L., Botha, F. S., McGaw, L. J., and Eloff, J. N. (2017). The antibacterial activity of extracts of nine plant species with good activity against *Escherichia coli* against five other bacteria and cytotoxicity of extracts. 17:133.
22. Ewansiha, J. U., Garba, S. A., Mawak, J. D., and Oyewole, O. A. (2012). Antimicrobial activity of *Cymbopogon Citrus* (Lemon Grass) and its phytochemical properties. *Front. Sci.* 2, 214–220.
23. E.S. Carmo, F. Pereira, N.M. Cavalcante, C.W. Gayoso, E. Lima (2013), Treatment of Pityriasis versicolor with topical application of essential oil of *Cymbopogon citratus* (DC) Stapf therapeutic pilot study *An. Bras. Dermatol.*, 88 (2013), pp. 381-385
24. Francisco, V., Figueirinha, A., Neves, B. M., Rodríguez, C. G., Lopes, M. C., Cruz, M. T., et al. (2011). *Cymbopogon citratus* as source of new and safe anti-inflammatory drugs: bio-guided assay using lipopolysaccharide-stimulated macrophages. *J. Ethnopharmacol.* 133, 818–827.
25. Faruq MO. (1994) TLC technique in the component characterization and quality determination of Bangladeshi lemongrass oil (*Cymbopogon citratus* (DC) Stapf.). *Bangladesh J Sci Ind Res* ;29:27-38 Tropical Food Gardens
26. Guanasingh CB, Nagarajan S. (1981) Flavonoids of *Cymbopogon citratus*. *Indian J Pharma Sci.* 43:115.
27. G. Shah, R. Shri, V. Panchal, N. Sharma, B. Singh, A Mann (2011) Scientific basis for the therapeutic use of *Cymbopogon citratus*, staff (Lemongrass) *J. Adv. Pharmaceut. Techn. Res.*, 2 (1), pp. 3-8
28. Hanson SW, Crawford M, Koker M.E.S, Menezes F.A. (1976) Cymbopogonol a new triterpenoid from *Cymbopogon citratus*. *Phytochemistry* ;15:1074-5
29. Han, X., and Parker, T. L. (2017). Lemongrass (*Cymbopogon flexuosus*) essential oil demonstrated anti-inflammatory effect in pre-inflamed human dermal fibroblasts. *Biochimie Open* 4, 107–111.
30. Joseph Mercola. (2005) Benefit of lemongrass oil. *Edmon Agron Lemongrass as mosquito repellent word* .
31. Kishore N, Mishra AK, Chansouria JP. (1993) Fungitoxicity of essential oils against dermatophytes. *Mycoses.* ;36:211–5.



32. Korenblum, E., Goulart, F. R. D. V., Rodrigues, I. D. A., Abreu, F., Lins, U., Alves, P. B., et al. (2013). Antimicrobial action and anti-corrosion effect against sulfate reducing bacteria by lemongrass (*Cymbopogon citratus*) essential oil and its major component, the citral. *AMB Exp.* 3:44.
33. K. Shimono, O. Hiroaki, S. Masato, S. Kanae, K. Shoji ((2010) Aromatic antihypertensive agent, and method for lowering blood pressure in mammals, US Patent 20 (100) 891
34. K.E. Elkhair (2014) About Anti-dermatophytic activity of essential oils against locally isolated *Microsporium canis* Gaza Strip Nat. Sci., 6 (2014), pp. 676-684
35. L. Paviani, S.B. Pergher, C. Dariva (2006), Application of molecular sieves in the fractionation of lemongrass oil from high-pressure carbon dioxide extraction *Br. J. Chemical Engin.*, 23, pp. 219-222
36. Lemos TL, Matos FJ, Alencar JW, Craveiro AA, Clark AM, Chesney JD. 1990 Antibacterial activity of essential oils of Brazilian plants. *Phytother Res.*; 4:82-4.
37. Matouschek BK, Stahl BE. (1991) Phytochemical study of nonvolatile substances from *Cymbopogon citratus* (DC.) Stapf (Poaceae) *Pharmaceutica Acta Helvetiae*; 66:242-5.
38. M.N. Boukhatem, M.A. Ferhat, A. Kameli, F. Saidi, H. Kebir ((2013) Lemon grass (*Cymbopogon citratus*) essential oil as a potent anti-inflammatory and antifungal drugs *Libyan J. Med.*, 8 (2013), p. 25431
39. Meevatee U, Boontim S, Keereeta O, Vinitketkumnuen U, O-ariyakul N. (1993) Antimutagenic activity of lemon grass. In: Boot-in S, editor. *Man and Environment*. Thailand: Chiang Mai University Press.
40. Melo SF, Soares SF, Costa DR, Silva DC, Oliveira DM, Bezerra RJ, et al. (2001) Effect of the *Cymbopogon citratus*, *Maytenus ilicifolia* and *Baccharis genistelloides* extracts against the stannous chloride oxidative damage in *Escherichia coli*. *Mutat Res.*; 496:33-8.
41. Mian KH, Mohamed S. (2001) Flavonoid (Myricetin, Quercetin, Kaempferol, Luteolin, and Apigenin) Content of Edible Tropical Plants. *J Agric Food Chem.* 2001; 49:3106-12.
42. Ming L, Figueiredo R, Machado S, Andrade R. (1996) In: *Proceedings of the International Symposium on Medicinal and Aromatic Plants*. Mexico: Acta



- Horticulturae Leiden; .Yield of essential oil of and citral content in different parts of lemongrass leaves (*Cymbopogon citratus* (DC.) Stapf.) Poaceae; pp. 555–9.
43. **Misrha AK, Dubey NK.(1994)**Evaluation of some essential oils for their toxicity against fungi causing deterioration of stored food commodities.Appl Environ Microbiol. ;160:1101–5.
44. **M. Soonwera(2015)**Larvicidal and oviposition deterrent activities of essential oils against house fly (*Musca domestica* L.; Diptera: muscidae) J. Agric. Technol., 11, pp. 657-667.
45. **M. Wuthi-Udomlert, P. Chotipatoomwan, S. Panyadee, W. Gritsanapan (2011),** Inhibitory effect of formulated lemon grass shampoo on *Malassezia furfur*: a yeast associated with dandruff Southeast Asian J. Trop. Med. Publ. Health, 42, pp. 363-369
46. **Nambiar VS, Matela H.(2012)** Potential Functions of Lemon Grass (*Cymbopogon citratus*) in Health and Disease.International Journal of Pharmaceutical & Biological Archives. 2; 3(5):1035-1043.
47. **Nascimento, G. G. F., Locatelli, J., Freitas, P. C., and Silva, G. L. (2000).** Antibacterial activity of plant extracts and phytochemicals on antibiotic resistant bacteria. Braz. J. Microbiol. 31:256.
48. **N.E. Tajidin, S.H. Ahmad, A.B. Rosenani, H. Azimah, M. Munirah (2012)**Chemical composition and citral content in lemongrass (*Cymbopogon citratus*) essential oil at three maturity stages Afr. J. Biotechn., 11 (11) (2012), pp. 2685-2693
49. **Norrington. L.(2001)**Tropical Food Gardens Publication Publisher Bloomings Books (Melbourne) ISBN 1-876473-41-x
50. **N.K. Boaduo, D. Katerere, J. Eloff, V. Naidoo (2014)**Evaluation of six plant species used traditionally in the treatment and control of diabetes mellitus in South Africa using in vitro methods Pharm. Biol., 52, pp. 756-761
51. **Onawunmia GO, Yisak WA, Ogunlana EO.(1984)** Antibacterial constituents in the essential oil of *Cymbopogon citratus* (DC.) Stapf. J Ethnopharmacol. ;12:279–86.
52. **Orafidiva LO. (1993)**The effect of autoxidation of lemon-grass oil on its antibacterial activity. PhytotherRes;7:269–71.
53. **O.Avoseh, O. Oyedeji, P. Rungqu, B. Nkeh-Chungag, A. Oyedeji (2015)***Cymbopogon* species; ethnopharmacology, phytochemistry and the pharmacological importance Molecules, 20 , pp. 7438-7453



54. **Pedroso RB, Ueda-Nakamura T, Prado B, Filho D, Cortez DA, Cortez LE, et al.(2006)**Biological Activities of Essential Oil Obtained from *Cymbopogon citratus* on *Crithidiadeanei*. Acta Protozoologica. ;45:231–40.
55. **P.A. Tarkang, G.A. Agbor, N. Tsabang, L.R. Tchokouaha, D.A. Tchamgoue, D. Kemeta, F. Weyepe (2012)**Effect of long-term oral administration of the aqueous and ethanol leaf extracts of *Cymbopogon citratus* (DC. ex Nees) Stapf Ann. Biol. Res., 3, pp. 5561-5570
56. **Puatanachokchai R.(1994)**Antimutagenicity, cytotoxicity and antitumor activity from lemon grass (*Cymbopogon citratus*, Stapf) extract, Master's thesis, Faculty of Medicine. Thailand: Chiang Mai University
57. **Kishida H, Denda A, Murata N, Konishi Y, Vinitketkumnuen U. (2002)** Inhibitory effects of lemon grass (*Cymbopogon citratus*, Stapf) extract on the early phase of hepatocarcinogenesis after initiation with ethylnitrosamine in male Fischer344 rats. Cancer Lett. ;183:9–15.
58. **Purnajyoti Deka Bhuyan(2015)**In-Vitro Efficacy of Certain Essential Oils and Plant Extracts against Three Major Pathogens of *Jatropha curcas* L. Publication American Journal of Plant Sciences, 6, 362-365
59. **P. Sessou, S. Farougou, S. Kaneho, S. Djenontin, G. Alitonou, P. Azokpota, D.(2012)**Sohounhloué Bioefficacy of *Cymbopogon citratus* essential oil against food borne pathogens in culture medium and in traditional cheese wagashi produced in Benin Int. Res. J.Microbiol., 3 , pp. 406-415
60. **Rauber S, Guterres SS, Schapoval EE. (2005)**LC determination of citral in *Cymbopogon citratus* volatile oil. J Pharm Biomed Anal. ;37:597–601.
61. **R. Devi, Sim S., R. Ismail (2012)**Effect of *Cymbopogon citratus* and citral on vascular smooth muscle of the isolated thoracic rat aorta Evidence-Based Complement. Alternat. Med. pp. 1-8
62. **R. Usha (2012)**Fumigant and contact toxic potential of essential oils from plant extracts against stored product pests J. Biopesticides, 5, pp. 120-128
63. **Sarer E, Scheffer JJ, Baerheim SA.(1983)** Composition of the essential oil of *Cymbopogon citratus* (DC.) Stapf cultivated in Turkey. Scientia Pharmaceutica. ;51:58–63.
64. **Suaeyun R, Kinouchi T, Arimochi H, Vinitketkumnuen U, Ohnishi Y. (1997)** Inhibitory effects of lemon grass (*Cymbopogon citratus*Stapf) on formation of



- azoxymethane-induced DNA adducts and aberrant crypt foci in the rat colon. Carcinogenesis. ;18:949–55.
65. Suresh M, Rai RK. Cardol(1990):The antifilarial principle from *Anacardium occidentale*. Curr Sci.;59:477–9.
  66. Syed M, Khalid MR, Chaudhary FM.(1990)Essential oils of Graminae family having antibacterial activity Part 1. (*Cymbopogon citrates*, *C.martinii* and *C.jawarancusa* oils. Pak J Sci Ind Res.;33:529–31.
  67. S.C. Wright, J.E. Maree, M. Sibanyoni(2009)Treatment of oral thrush in hiv/aids patients with lemon juice and lemon grass (*Cymbopogon citratus*) and gentian violet Phytomedicine, 16, pp. 118-124
  68. S.K. Bharti, A. Kumar, O. Prakash, S. Krishnan, A.K. Gupta(2013),Essential oil of *Cymbopogon citratus* against diabetes: validation by in-vivo experiments and computational studies J. Bioanal. Biomed., 5pp. 194-203
  69. S.P. Chanthal, C. Ruangviriyachai(2012), Influence of extraction methodologies on the analysis of five major volatile aromatic compounds of citronella grass and lemongrass grown in Thailand J. AOAC Int., 9,pp. 763-772
  70. S.S. Vera, D.F. Zambrano, S.C. Méndez-Sanchez, F. Rodríguez-Sanabria, E. Stashenko, J.E. Duque Luna(2014) Essential oils with insecticidal activity againstlarvae of *Aedes aegypti* (Diptera: Culicidae) Parasitol. Res., 113, pp. 2647-2654
  71. Tangpu V, Yadav TA. (2006)Some Important Folklore Medicinal Plants Used by TangkhulNagas of Ukhrul District, Manipur. TX, USA: Recent Progress in Medicinal Plants.
  72. Tchoumboungang F, Zollo PH, Dagne E, Mekonnen Y.(2005)In Vivo Antimalarial Activity of Essential Oils from *Cymbopogon citratus* and *Ocimumgratissimum* on Mice Infected with *Plasmodium berghei*. Planta Medica.;71:20–3.
  73. Trease GE. (1996)A textbook of Pharmacognosy. 9th ed. London: W.B Saunders; p. 201.
  74. Wu, T., He, M., Zang, X., Zhou, Y., Qiu, T., Pan, S., et al. (2013).A structure-activity relationship study of flavonoids as inhibitors of *E.coli* by membrane interaction effect.Biochim. Biophys. Acta 1828, 2751–2756.
  75. Viana GS, Vale TG, Pinho RS, Matos FJ.(2000)Antinociceptive effect of the essential oil from *Cymbopogon citratus* in mice. J Ethnopharmacol.;70:323–7.



76. Vinitketkumnuen U, Puatanachokchai R, Kongtawelert P, Lertprasertsuke N, Matsushima T.(1994)Antimutagenicity of lemon grass (*Cymbopogon citratus*, Stapf) to various known mutagens in Salmonella mutation assay. Mutant Res;341:71–5.
77. Wannissorn B, Jarikasem S, Soontorntanasart T. (1996)Antifungal activity of lemon grass and lemon grass oil cream.Phytother Res;10:551–4.
78. Wannissorn B, Jarikasem S, Siriwangchai T.(2005)Antibacterial properties of essential oils fromThai medicinal plants. Fitoterapia.;76:233–6.



*(Handwritten signature)*