The Pharma Innovation Journal 2018; 7(3): 300-304

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(3): 300-304

www.thepharmajournal.com
Received: 26-01-2018
Accepted: 27-02-2018

Promila
Medicinal, Aromatic and Potential Crops Section, CCS Haryana Agricultural University, Hisar, Haryana, India

VK Madan
Medicinal, Aromatic and Potential Crops Section, CCS Haryana Agricultural University, Hisar, Haryana, India

Correspondence
Promila
Medicinal, Aromatic and Potential Crops Section, CCS Haryana Agricultural University, Hisar, Haryana, India

A Review on the Phytochemistry and Pharmacology of *Cymbopogon citratus* Stapf. (Lemongrass)

Promila and VK Madan

Abstract
Cymbopogon citratus Stapf. (Lemon grass) has become a cynosure of modern medicinal system due to presence of wide range of biologically active chemicals and therapeutic functions associated with them. Lemon grass is reported to exhibit immunomodulatory, anti-inflammatory, antiviral, anticarcinogenic, antihyperglycaemic, antioxidant, antimalarial, antimutagenic, antimicrobial and antiglycation properties. This review aims to summarize the information concerning the chemicals present in lemon grass and various kinds of pharmacological properties attached with them.

Keywords: *Cymbopogon citratus* Stapf., Lemon grass, pharmacological profiling, phytochemicals

Introduction
Aromatic and medicinal plants form the backbone of healthcare system for curing various ailments in developing countries including India. Various herbal therapies used in traditional system of medicine possess the benefit of negligible side effects usually associated with allopathic system of medicine [1]. Plants are natural factories that manufacture various phytochemicals having certain physiological action on living beings. Studying the phytochemical and pharmacological properties of medicinal plant extracts is a rational approach in our quest for new drugs [2]. The problem with the use of single isolated compound as a drug is that it may cause various side effects but plant extract possess combination of chemicals that counterbalance side effects of each others. Therefore, now-a-days current impetus of research is directed towards the detailed study of medicinal and aromatic plants so that novel drugs may be synthesized with enhanced physiological actions and minimal side-effects [3]. New, robust and less cumbersome extraction techniques assisted by recent developments in biotechnology have accelerated the investigation of natural compounds faster with more precision than before leading to isolation of bioactive compounds with intense health benefits [4]. This review article covers previous research work and information regarding the phytochemical and pharmacological aspects of lemongrass.
Cymbopogon citratus Stapf. (Lemon grass) is an important medicinal and aromatic perennial tall grass having rhizomes and densely tufted fibrous root. It belongs to the Poaceae family which is renowned as oil rich family. Green slightly leathery leaves appears in dense clusters on short underground stems [5]. The plant is a native herb from India and is cultivated in other tropical and subtropical countries [6].

Fig 1: Lemon grass

Lemongrass can tolerate a wide range of soils and climatic conditions. However, vigorous growth is obtained on well-drained sandy loam soil with high fertility and exposed to sunlight [7]. It is reported to possess antibacterial [8], antifungal [5]. antiprotozoal, anti-carcinogenic, anti-inflammatory, antioxidant, cardioprotective, antitussive, antiseptic, and anti-rheumatic activities [9]. It has also been used to inhibit platelet aggregation [10], treat diabetes [11], dyslipidemia, gastrointestinal disturbances [5], anxiety [12], malaria [13], flu, fever, and pneumonia [9], as well as in aromatherapy. In addition to its therapeutic uses, *C. citratus* is also consumed as a tea, added to non-alcoholic beverages and baked food, and used as a flavoring and preservative in confections and cuisines. In cosmetics, its essential oils are used as fragrance in the manufacture of perfumes, soaps, detergents, and creams.

Phytochemistry of lemon grass

Citral, geranial and neral form nearly 75 % of the aldehydes present in the oil extracted from lemongrass. These chemicals provide aroma to the plant and helps its usage in aromatherapy. Citral α, citral β, nerol, geraniol, citronellal, terpinolene, geranyl acetate, myrecene and terpinol methylheptenone are some of the chemicals that have been extracted from lemongrass parts by various researchers. Two triterpenoids, cymbopogone and cymbopogonol and flavones identified as luteolin and its 6-C-glucoside have also been isolated from leaves of *C. Citratus* [14, 15, 16].

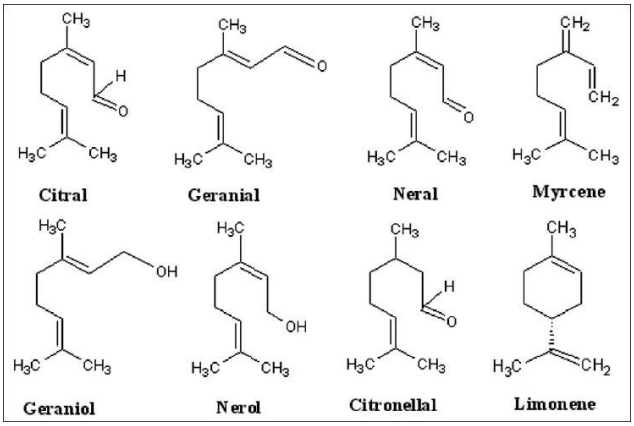

Fig 2: Chemical structure of major constituents of essential oil from lemon grass

Table 1: [17]

Chemical	Pharmacological action
Myrcene	Antibacterial activity
Citral	Antibacterial activity
α-citral	Antinociceptive activities
β-citral(neral)	Not available
Heptenone	Not available
Dipentene	Not available
Limonene	Not available
Linalool	Not available
Borneol	Not available
Geraniol	Antiviral activity
Limonene	Anti-oxidant activity
β-myrcene	Anti-gout activity
Citronello	Anti-fungal activity

Traditional uses of lemon grass

- 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 relieves 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 [18].
- Alves *et al.* reported its use for cure of gastrointestinal problems [19].
- Decoction of lemongrass leaves is used as diaphoretic in fever [20].
- 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 [21].
- Lemon grass tea is commonly used to combat flu, fever, pneumonia [21].

Pharmacological potential of lemon grass

Antioxidant activity

Latest research investigations have proved that antioxidant potential of plants is attributed to the presence of polyphenols, flavonoids, lignins, alkaloids, terpenoids, carotenoids, vitamins etc. They help in maintaining the nutritional quality and shelf life of foods by inhibiting lipid oxidation, minimizing rancidity, and removing toxic oxidative products [22, 23, 24, 25]. Similarly, phenolic compounds play important role in antioxidant activity and resistance against pests and other species dissemination. Phenolic compounds helps in scavenging of reactive oxygen species (ROSs) which include hydrogen peroxide (H_2O_2), superoxide anion (O^{2-}) and free radicals [26], generated during metabolism in body, hence helps in combating oxidative stress. Due to its reactivity, ROSs damage biochemical components like cell membrane, cellular lipids, proteins and DNA [27]. ROSs are main culprit of atherosclerosis, rheumatoid arthritis and muscle destruction, cataracts, certain neurological disorders, cancer and ageing. Antioxidants have to be present in the body to offer protective mechanism against damaging effects of oxidation process caused by these radicals. Lawrence *et al.* determined the antioxidant activity of lemon grass essential oil grown in northern Indian plains by using DPPH assay, Nitrogen Oxide assay, reducing power assay and β-carotene bleaching assay. They observed that IC_{50} values observed for DPPH and NO scavenging method was 0.5 mg/ml and 2 mg/ml respectively. The reducing activity gave positive results of increase in absorbance with increase in the concentration of oil. In β-carotene bleaching method also there is 84.1% bleaching in first one hour and it went to 46.8% by the completion of second hour. In all the methods BHT and Gallic acid were kept as standards [28]. The results clearly indicated that lemon grass essential oil is effective in scavenging free radical and has the potential to be powerful antioxidant.

Hypoglycemic activity

Onabanjo *et al*. reported that aqueous extract of lemon grass possess hypoglycemic properties [29]. These properties are due

to presence of flavonoids and alkaloids in essential oil of lemon grass. Similarly, lemon grass extracts were efficient in reducing cholesterol levels in the blood stream. Investigators opined that this could be due to the presence of an endogenous ligand of central-type benzodiazepine receptors known as endozepine octadecaneuropeptide (ODN), which are inhibitors of food intake in small animals [30]. β-glucosidase inhibition assay was carried out using an *in-vitro* model for anti diabetic test and lemongrass stalk essential oil and it showed highest degree of inhibitory activity (89.63%) [28].

Table 2: Pharmacological profiling of lemon grass [31]

Property	Pharmacological action
Cytotoxicity	Shows high toxicity against Chinese Hamster Ovary (CHO) cells (IC50 = 10.63 µg/mL) and moderately toxic against human fibroblast cell line 138 (W138) cells (IC50 = 39.77 µg/mL).
Insecticidal	LC50 of 48.6 µL/L against housefly larvae
Neurobehavioral effects	Ability to be active as sedative, anxiolytic and anticonvulsant agent
Antitrypanosomal	Modest activity against *Trypanasoma brucei* IC50 = 1.837 ±0.13 µg/mL
Anti-diabetic	Shows activity against poloxamer-407 induced type 2 diabetic (T2D) in Wistar rats
HIV/AIDS	As a highly effective control for oral thrush in HIV/AIDS victims in South Africa
Chemopreventive activity	Inhibits the early phase of hepatocarcinogenesis in rat
Anti-inflammations	Hexane extract inhibited iNOS (inducible nitric oxide synthase)expression, NO (nitric oxide) production and various LPS (lipopolysaccharide)- induced pathways
Larvicidal activity	It shows high inhibition and mortality rate against larva of *A. aegypti*

Antimicrobial activity

Umar *et al.* studies the antibacterial activity of the extracts of *Cymbopogon citratus* against *Escherichia coli*, *Salmonella typhi* and *Staphylococcus aureus.* Results of this study showed that ethanol leaf extract was active against all the test organisms at the concentration of 100 mg/ml, 50 mg/ml and 25 mg/ml. Antimicrobial activity of ethanolic leaf extract was higher than that of acetone and chloroform leaf extracts. This may be due to variable polarity as well as due to the ability of ethanol to extract more of the plant active components. The highest mean zone of inhibition (23 mm) of *Escherichia coli* by the ethanolic extract was recorded at 100 mg/ml while the lowest (06 mm) was at 25 mg/ml [32]. This agrees with the work of Kolodziej and Kormas and Komiya *et al.* who reported that phytochemicals such as tannins have antibacterial and antileshmanial activity due to their immune modulatory effects on the microbial antigenic receptors [33, 34]. Other phytochemicals were analyzed by phenolic extraction, which includes diverse group of chemical compounds, such as flavonoids, lignins, tannins, phenolic acids, coumarins, phenols, phenylpropanoids, quinines, stilbenoids and xanthones [vermeres]. LGEO exhibited promising antifungal effect against *Candida albicans*, *C. tropicalis*, and *Aspergillus niger*, with different inhibition zone diameters (IZDs) (35-90 mm). IZD increased with increasing oil volume [35]. Lemongrass has demonstrated antimicrobial properties which could be harnessed for the control of pathogens tested.

Anti-inflammatory activity

Boukhatem *et al.* studied the anti-inflammatory and antifungal potential of lemon grass. They found out that LGEO (10 mg/kg, administered orally) significantly reduced carrageenan-induced paw edema with a similar effect to that observed for oral diclofenac (50 mg/kg), which was used as the positive control. Oral administration of LGEO showed dose-dependent anti-inflammatory activity. In addition, topical application of LGEO *in vivo* resulted in a potent anti-inflammatory effect, as demonstrated by using the mouse model of croton oil-induced ear edema. The topical application of LGEO at doses of 5 and 10 mL/ear significantly reduced acute ear edema induced by croton oil in 62.5 and 75% of the mice, respectively. In addition, histological analysis clearly confirmed that LGEO inhibits the skin inflammatory response in animal models [35].

Anti gout test was examined by xanthine oxidase inhibition (XOI) assay with the maximum percentage of xanthine oxi xanthine oxidase inhibition of 81.34% obtained from lemon grass stalk essential oil [28].

Antiglycation activity

Glycation stress is defined as the modification of cell proteins by non-enzymatic/irreversible reactions with reducing sugars [36, 37]. Glycation is a non-enzymatic reaction between free amino groups of proteins and reducing sugars. This reaction is known as Maillard reaction [38]. The reaction occurs when the amino group of amino acid reacts with a carbonyl group of reducing sugar. Accumulation of glycation products is associated with various diseases including, first of all, diabetes and diabetic nephropathy, microangiopathy and atherosclerosis [39]. The anti-glycation ability of ascorbic acid and ethanol extracts of *C. Citratus* on hydrogen peroxide was studied by Sari *et al.* The ethanol extract showed a same potential of anti-glycation activity as ascorbic acid. The results shows that the presence of *C. Citratus* leaves extract could inhibit the glycation reaction [40].

Conclusion

This review has emphasized on the various kinds of phytochemicals founds in the *C. Citratus* parts and pharmacological activities associated with them. These properties and chemicals in lemon grass make it a very important medicinal plant for curing and prevention of various ailments.

References

1. Edris AE. Pharmaceutical and therapeutic potentials of essential oils and their individual volatile constituents: a review. Phytother Res. 2007; 21:308-323.
2. Yuan G, Wahlqvist ML, He G, Yang M, Li D. Natural products and anti-inflammatory activity. Asian Pac J Clin Nutr. 2006; 15:143.
3. Patil AS. Exploring *Passiflora incarnata* (L.): A medicinal plants secondary metabolites as antibacterial agent. Journal of Medicinal Plants Research. 2010; 4:1496-1501.
4. Wang L, Weller CL. Recent advances in extraction of nutraceuticals from plants. Trends in Food Science and Technology. 2006; 17:300-312.

5. Carlini EA, De-Contar JP, Siloai-Filho AR, De-Silreiral-Filho NG, Fronchtengarten ML. Bveno Of Pharmacology of Lemon Grass (*Cymbopogon citrates* Stapf). J Ethnoparmacol. 1986; 17(1):37-64.
6. Figueirinha A, Paranhos A, Perez-Alonso JJ, Santos-Buelga C, Batista MT. Cymbopogon citratus leaves. Characterisation of flavonoids by HPLC-PDA-ESI/MS and an approach to their potential as a source of bioactive polyphenols. Fd. Chem, 2008; 110:718-728.
7. Sugumaran M, Joseph S, Lee KLW, Wong KW. Herbs of Malaysia. Shah Alam: Federal Publication, 2005.
8. Wannissorn B, Jarikasem S, Siriwangchai T, Thubthimthed S. Anti-Bacterial Properties of Essential Oils From Thai Medicinal Plants. Fitoterapia. 2005; 76:233-236.
9. Negrelle RR, Gomes EC. *Cymbopogon citratus* (DC) Stapf: Chemical Composition and Biological Activities. Revista Brasileira De Plantas Medicinais, Botucatu. 2007; 9(1):80-92.
10. Tognolini M, Barocelli E, Ballabeni V, Bruni R, Biandi M, Impicciatore M. Comperative Screening of Plants Essential Oils, Phenylpropanoid as Basic Core for Antiplatelet Activity. Life Science. 2006; 78(13):1419-1432.
11. Mansour HA, Newairy AS, Youset MI, Sheweita MI. Biochemical Study on the Effects of Some Egyptian Herbs in Alloxan-Induced Diabetic Rats. Toxicology. 2002; 170(3):221-228.
12. Peigen X. Recent Developments on Medicinal Plants in China. J Ethnopharmacol. 1983; 7:95-109.
13. Tchoumbougnang F, Zollo PH, Dagne E, Mekonnen Y. *In vivo* Anti malaria Activity of Essential Oils from *Cymbopogon Citratus* and *Ocimum Gratissimum* on Mice Injected with Plasmodium Berghei. Planta Medica, 2005; 71:20-23.
14. Vazquez-Briones, Hernandez IR, Guerrero-Beltran JA. J Food Res. 2015; 4(3):36-45.
15. Shah G, Shri R, Panchal V, Sharma N, Singh B, Mann AS. Scientific basis for the therapeutic use of *Cymbopogon Citratus* (Lemon grass) J Adv. Pharm. Technol. Res. 2011; 2(1):3-8.
16. Becker EM, Nissen LR, Skibsted LH. European Food Res. and Tech. 2004; 219:561-571.
17. Olorunnisola SK, Asiyanbi HT, Hammed AM, Simsek S. Biological properties of lemongrass: An overview. International Food Research Journal. 2014; 21(2):455-462.
18. Joseph Mercola. Benefit of lemongrass oil. Edmon Agron Lemongrass as mosquito repellent word, 2005.
19. Alves AC, Souza AF. Nota prévia sobre o estudo fitoquímico de Cymbopogon citratus (D.C.) Stapf. Garcia de Orta, 1960; 8:629-638.
20. Chopra RN, Chopra IH, Kapur LD. Indigenous drugs of India U.N. Dhur and Sons. Private Ltd. Calcutta. 1958; 67:502.
21. Nambiar VS, Matela H. Potential Functions of Lemon Grass *(Cymbopogon citratus)* in Health and Disease. International Journal of Pharmaceutical & Biological Archives. 2012; 3(5):1035-1043.
22. Fukumoto LR, Mazza G. Assessing antioxidant and prooxidant activities of phenolic compounds. Journal of Agricultural and Food Chemistry. 2000; 48(8):3597-3604.
23. 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.
24. Sies H. Oxidative stress: oxidants and antioxidants. Experimental Physiology, 1997; 82(2):291-295.
25. Prakash D, Gupta KR. The antioxidant phytochemicals of nutraceutical importance. The Open Nutraceuticals Journal. 2009; 2:20-35.
26. Heo SJ, Lee KW, Song CB, Jeon YJ. Antioxidant activity of enzymatic extracts from brown seaweeds. Algae. 2003; 18:71-81.
27. 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.
28. 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.
29. Onabanjo AO, Agbaje EO, Odusote OO. Effects of Aqueous Extracts of *Cymbopogon citratus* in Malaria. Journal of Protozoological Research. 1993; 3:40-45.
30. Do Rego JC, Orta MH, Leprince J, Tonon MC, Vaudry H, Costentin J. Pharmacological characterization of the receptor mediating the anorexigenic action of the octadecaneuropeptide: evidence for an endozepinergic tone regulating food intake. *Neuropsychopharmacology*. 2007; 32:1641-1648.
31. Opeyemi A, Opeoluwa O, Pamela R, Nkeh-Chungag B, Oyedeji A. *Cymbopogon* Species; Ethnopharmacology, Phytochemistry and the Pharmacological Importance. Molecules. 2015; 20:7438-7453.
32. Umar M, Mohammed IB, Oko JO, Tafinta IY, Alika AA, Jobbi DY. Phytochemical Analysis and Antimicrobial Effect of Lemon Grass (*Cymbopogon citratus*) Obtained From Zaria, Kaduna State, Nigeria. Journal of Complementary and Alternative Medical Research. 2016; 1(2):1-8.
33. Komiya M, Takeuchi T, Harada E. Lemon oil vapor causes an anti-stress effect-via modulating the 5-HT and DA activities in micr. Behav Brain Res. 2006; 172(2):240-249.
34. Kolodziej H, Kormas CM. Antileshmanial activity and immune modulatory effects of tannins and related compounds on Leishmania parasitized RAWA 264.7 cell. Phytochemistry. 2005; 66(17):2056-71.
35. Boukhatem MN, Ferhat MA, Kameli A, Saidi F, Kebir HT. Lemon grass (Cymbopogon citratus) essential oil as a potent anti-inflammatory and antifungal drug. Libyan Journal of Medicine. 2014; 9:25431-41.
36. Gasparovic AC, Lovakovic T, Zarkovic N. Oxidative stress and antioxidants: Biological response modifiers of oxidative homeostasis in cancer. Periodicum Biologorum. 2010; 112(4):433-439.
37. Nomoto K, Yagi M, Arita S, Ogura M, Yonei Y. Skin Accumulation of Advanced Glycation End Products and Lifestyle Behaviors in Japanese. Anti-Aging Medicine. 2012; 9(6):165-173.
38. Biworo A, Tanjung E, Iskandar, Khairina, Suhartono E. Antidiabetic and Antioxidant Activity of Jackfruit (*Artocarpus heterophyllus*) Extract. Journal of Medical and Bioengineering. 2015; 4(4):318-323.
39. Sadowska-Bartosz I, Bartosz G. Prevention of protein

glycation by natural compounds. Molecules. 2015; 20(2):3309-3334.
40. Sari DM, Lestarisa T, Alexandra FD, Jelita H, Thalib I. Antioxidant and Anti-Glycation Activity of Ethanol Lemongrass (*Cymbopogon citratus*) Leaves Extract. International Journal of Pharmacognosy and Phytochemical Research. 2017; 9(5):710-715.