Lemongrass *(Cymbopogon Citratus)* Essential Oil: Health Beneficial Perspective

Shymaa Mohamed abdelkader [1], Iman Abdel-Rady Elkhishin [1], Dalia Ibrahim Ahmed Mesallam [1], Mai Abdelwahab [2]

1 Forensic Medicine and Clinical Toxicology Department, Faculty of Medicine, Zagazig University, Zagazig, Egypt

2 Pathology Department, Faculty of Medicine, Zagazig University, Zagazig, Egypt

Email: **shymaaabdelkader112@gmail.com**

Abstract

Background: Essential oils are naturally occurring complex mixtures of volatile odor compounds synthesized as secondary metabolites by plants. They widely used as therapeutic agents owing to their pharmacological and psychological properties. Lemongrass (Cymbopogon citratus) is grown as an ornamental plant and is used as a culinary and medicinal herb, the essential oil extracted from its leaves is widely known. It is recognized for its antioxidant activity and effective scavenging mechanism for free radicals through its potent flavonoid and phenol components, besides, it is available in different countries and extensively used in medicine and industry. The purpose of this review article is to gather the information on Lemongrass regarding chemical composition and its extraction, and some potential health benefits and ameliorative effects on different toxic exposure., it is important to recommend using Lemongrass essential oil as food supplement to decrease the risk of diseases associated with daily toxic environmental exposure.

Keywords: Essential oil, *Lemongrass*, Herb, Extraction,

Introduction

Essential oils are volatile, natural, complex chemicals with a strong odor that are produced as secondary metabolites by aromatic plants. They are mainly obtained using steam or hydro-distillation, which was first pioneered by Arabs in the Middle Ages. They are employed in food preservation, and as antibacterial, analgesic, sedative, anti-inflammatory, spasmolytic, and locally anesthetic treatments because of their antiseptic and therapeutic characteristics, as well as their smell **(Bakkali et al., 2008).**

Lipophilic terpenoids, phenylpropanoids, and short-chain aliphatic hydrocarbon derivatives of low molecular weight make up the majority of essential oil ingredients, with the first being the most common and distinctive. Among these, allylic, mono-, bi-, or tricyclic mono- and sesquiterpenoids of various chemical classes make up the majority of essential oils, such as hydrocarbons, ketones, alcohols, oxides, aldehydes, phenols, or esters **(Turek and Stintzing, 2013).**

Essential oils can be classified severally based on their different methods of extraction, chemical composition, aroma etc.

Classification based on extraction methods: Essential oils can be classified into four different types: Steam-distilled, Expressed, Solvent-extracted and Absolutes or concretes.

Classification based on chemical composition: Like all organic compounds, essential oils, are made up of hydrocarbon molecules and can further be classified as terpenes, alcohols, esters, aldehydes, ketones and phenols etc.

Classification based on aroma: This classification of oils can be categorized into Citrus, Herbaceous, Medicinal/Camphorous, Floral, Resinous oils and Woody, Earthy, Minty and Spicy oils **(Herman et al., 2019).**

Source of Lemongrass essential oil:

Lemongrass essential oil is derived from the *Lemongrass* plant (*Cymbopogon citratus*), which is primarily found in tropical and subtropical climates **(Majewska et al., 2019).**

Lemongrass plant is native to South India, Malaysia and Sri Lanka, although it is now widely farmed on a commercial scale and in gardens throughout Central and South America, Southeast Asia, Africa and the Indian Ocean Islands **(Shah et al., 2011; Majewska et al., 2019).** The name *Lemongrass* is due to its typical lemon-like odour **(Mukarram et al., 2021a).**

Cymbopogon citratus (C. citratus) is an aromatic, clump-forming, evergreen, fast-growing C4 perennial grass from the Poacae family. It has multiple stiff stems that grow up to 1.5 m tall and arise from a short rhizomatous rootstock. Producing flowers by this plant is very rare. Its leaves are long, flat, upright, linear in shape, blue-green in colour, and when crushed**,** they give a distinct lemon flavour **(Ekpenyong et al., 2015; Majewska et al., 2019; Mukarram et al., 2021b).**

Extraction of Lemongrass essential oil:

Lemon grass essential oil (LGEO) is extracted by steam distillation from the dried or fresh leaves of the plant which was found to be the most suitable method as it allows obtaining the oil without altering product quality. Steam distillation produces not only essential oil but also hydrosols or aromatic waters, which are often used against inflammatory diseases and microbial infectious **(Boukhatem et al., 2014; Majewska et al., 2019).**

Physical properties:

The characteristic properties of *Lemongrass* essential oil are a sherry color, pungent taste, and lemon like odor **(Majewska et al., 2019).**

Chemical constituents:

The chemical composition of *Lemongrass* essential oil is affected by multiple factors like the geographical origin, geobotanical conditions of the environment, agricultural practices, photoperiod, harvest time, plant age, genetic factors, and the method of extraction. The chemical constituents of the essential oil which have constantly been detected and determine its biological activity are aldehydes, hydrocarbon terpenes, alcohols, ketones, and esters **(Majewska et al., 2019).**

The *Lemongrass* essential oil (LGEO) has a significant amount of citral (mixture of geranial and neral), isoneral, isogeranial, geraniol, geranyl acetate, citronellal, citronellol, germacrene-D, and elemol in addition to numerous other bioactive compounds. These components confer various medicinal activities to LGEO including antifungal, antibacterial, antiviral, anticancer, and antioxidant properties **(Mukarram et al., 2021b).**

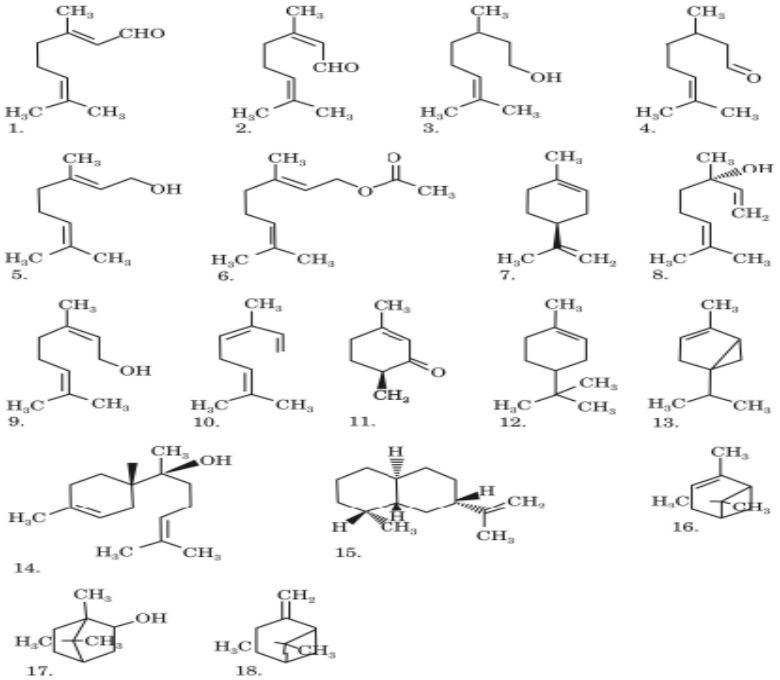

Figure (1): Structures of some chemical constituents of *Lemongrass* essential oil. 1, citral a; 2, citral, b; 3, citronellol; 4, citronellal; 5, geraniol; 6, geranyl acetate; 7, limonene; 8, linalool; 9, nerol; 10, cis-ocimene; 11, piperitone; 12, a-terpineol, 13, thujane; 14, a-bisabolol, 15, isointermedeol; 16, borneol; 17, a-pinene; 18, b-pinene **(Ganjewala and Gupta, 2013).**

Pharmacokinetics:

Essential oils are mixtures of lipophilic, volatile, and compounds (often terpenoids) present in plants. Essential oil components, such as those found in *C. citratus*, have a lot in common in terms of absorption, metabolism, and excretion.They are quickly absorbed following oral, pulmonary, and cutaneous application .Most are metabolized and eliminated by the kidney in the form of glucuronides, or exhaled as CO2 . Because of their fast clearance and short biological half-lives, they are unlikely to accumulate in the body **(Ekpenyong et al., 2015).**

Biological activities and uses of *Lemongrass* oil:

Lemongrass oil is used for a variety of medicinal, herbal, and therapeutic purposes. It has been used in folk medicine to enhance circulation, relieve cough and cold, boost immunity and stabilize menstrual cycles. It is also used to treat rheumatism, bladder and digestive disorders and as mouth wash to relieve toothache and gum sores **(Priya et al., 2015; Majewska et al., 2019; Mirzaei et al., 2020).**

There is a great demand for LGEO all over the world due to its significant commercial value as it is used in production of flavours, cosmetics, perfumes, detergents and pharmaceuticals **(Boukhatem et al., 2014).**

The different chemical compounds in LGEO have antioxidant, anti-inflammatory, antibacterial, antifungal, antiparasitic, and insect-repellent properties besides having analgesic and antipyretic effects **(del Carmen Vázquez-Briones et al., 2015; Do et al., 2021).**

Antioxidant effect:

Essential oils' anti-oxidant qualities may encourage their use as a natural oxidant in nutraceuticals and medicinal products. In recent years, there is an increasing interest in finding antioxidant phytochemical due to their ability to prevent the propagation of free radical reactions, protect the human body from diseases, and delay lipid oxidative rancidity in foods. The anti-oxidative properties of natural sources were attributed primarily to phenolic compounds. The increased phenolic content will result in greater anti-oxidative efficiency. Thus, this explains the high percentage activity of free radical scavenging activity in the essential oil collected from stalk due to its high amount of total phenolic content **(Mirghan et al., 2012).**

Antimicrobial activity:

Lemongrass oil and extract are efficient against a wide range of disease-causing microbes. On numerous times, LGEO has been employed as an antibacterial, antifungal, and antiviral agent. *Lemongrass* extract also suppressed the development of Bacillus cereus, Escherichia coli, Klebsiella pneumoniae, Candida albicans, and Staphylococcus aureus at various susceptibility levels. The antibacterial potential of essential oil components with different functional groups varies, with phenols and aldehydes having the highest activity and esters and hydrocarbons having the lowest. However, the antimicrobial properties of *Lemongrass* is extensively attributed to the citral (aldehyde) present in its oil **(Mukarram et al., 2021b).**

Lemongrass essential oil's antibacterial activities are based on the presence of three primary components: geranial, neral, and myrcene. Individually, geranial and neral have antibacterial activity against Gram-negative and Gram-positive bacteria, although myrcene has no antibacterial activity on its own. When myrcene was combined with either geranial or neral, or both, it was found to have increased bioactivity. *Lemongrass* essential oil's antibacterial activity is due to a reaction between the primary oil ingredients and the bacterial cell membrane. Lipophilic terpenes can alter cell membrane fluidity and permeability, as well as intracellular pH and ATP concentrations, causing cell rupture **(Majewska et al., 2019).**

Food preservative effect:

Lemongrass oil is known to be safe in the food industry and can be used as a substitute for synthetic types of food additives due to its substantial antibacterial and antioxidant properties, fulfilling today's consumer expectations **(Do et al., 2021).**

Anti-gout activity:

Mirghan et al. (2012) had analyzed the anti-gout activity of the *Lemongrass* essential oil by the Xanthine Oxidase Inhibition assay and had concluded that both essential oils extracted from leaves and stalks showed positive results where they possessed an inhibition rate higher than 50% at high sample concentration and the essential oil extracted from the stalk showed higher xanthine oxidase inhibition compared to that extracted from the leaves. with increase concentration of the essential oil, the inhibition activity increase. That inhibition of xanthine oxidase led to decrease production of uric acid, thus decreases the risks of gout.

Anticancer activity:

In the field of cancer, medicinal plants are emerging as promising possibilities, giving scientists hope. Scientists are always searching for natural sources in order to discover new plant-based medicinal compounds with powerful anticancer characteristics. *Lemongrass* essential oil is one of these herbs because of its cytotoxicity on human cancer cells. Geraniol, geranyl acetate, α-bisabolol, and iso-intermedeol, among its active components, have all been shown to have cytotoxic effects on cancer cells. Human mouth epidermal carcinoma (KB) and murine leukaemia cell lines were inhibited by *Lemongrass* essential oil (P388). Citral, the main component of *Lemongrass* oil, has antiproliferative properties against various cancer cell lines, including the two human prostate cancer cell lines, LNCaP and PC-3, HL60, U937 ovarian cancer cells, cervical cancer cell lines, and the breast cancer cell line, MCF-7. Citral does not cause cytotoxicity in normal epithelial cells, but it does cause toxicity in human breast cancer cell lines, indicating that it has cancer-specific effectiveness **(Mukarram et al., 2021b).**

Anti-hyperlipidemic effect:

Kumar et al. (2011) found that *Lemongrass oil* (100 and 200 mg/kg) treatment has showed significant inhibition against dexamethasone induced hyperlipidemia in rats by maintaining the serum levels of cholesterol, triglycerides and atherogenic index near to the normal levels. The possible mechanism may be associated with decrease in lecithin cholesterol acetyl transferase activity.

Hepatoprotective effect:

According to **Saenthaweesuk et al. (2017)**, pre-treatment of animals with *C. citratus* extract ameliorated the liver injury induced by paracetamol. *C.citratus* extract reduced the levels of hepatic markers (AST and ALT) and also significantly reduced oxidative stress induced by Paracetamol as shown by an increase in GSH level and reduction of MDA compared to rats treated with paracetamol alone.

Reproductive effect:

The protective effect of *Lemongrass* leaf extracts against petroleum fume-induced oxidative stress and reproductive dysfunction in male rats was proven by **Edet and NW (2019)** who found a significant decreases in serum levels of testosterone, LH and FSH and a significant increase in MDA in animals exposed to petroleum fume alone compared to levels in the control. Histo-morphological changes observed in the testicular and epididymal structures of animals exposed to petroleum fume alone included degenerative changes in seminiferous tubules, depleted germ cells, congested blood vessels and low luminal sperm volume. Supplementation with different concentrations of *Lemongrass* leaf extracts caused dose dependent changes in the biochemical and histo-morphological indices of male reproductive dysfunction. This protective effect of *Lemongrass* leaf extracts is due to its varied bio-constituents and their activities.

Also, **Setiyowati et al. (2022)** proved that natural antioxidants and flavonoid on *Lemongrass* have a great potential for protecting the male reproductive system. He found that exposure of mice to Lead acetate increased Reactive Oxygen Species, affecting spermatozoa quality. After giving various dosages of *Lemongrass* extract, repair of morphology, concentration, and motility of spermatozoa was found.

Conflicts of Interest: The authors declare no conflict of interest.

References

Bakkali, F.; Averbeck, S.; Averbeck, D. and Idaomar, M. (2008): Biological effects of essential oils–a review. *Food and chemical toxicology*, *46*(2), 446-475.

Boukhatem, M. N.; Ferhat, M. A.; Kameli, A.; Saidi, F. and Kebir, H. T. (2014): Lemon grass (Cymbopogon citratus) essential oil as a potent anti-inflammatory and antifungal drugs. *Libyan Journal of Medicine*, *9*(1), 25431.

del Carmen Vázquez-Briones, M.; Hernández, L. R. and Guerrero-Beltrán, J. Á. (2015): Physicochemical and antioxidant properties of Cymbopogon citratus essential oil. *Journal of food research*, *4*(3), 36.

Do, D. N.; Nguyen, H. T. T.; Huynh, T. H.; Nguyen, N. P. and Luu, X. C. (2021): Chemical composition, antibacterial and antioxidant activities of lemongrass (Cymbopogon citratus) essential oil and its fractions obtained by vacuum distillation. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1166, No. 1, p. 012051). IOP Publishing.

Edet, E. C. and NW, A. A. (2019): Lemongrass diet improves petroleum fume-induced oxidative stress, spermatotoxicity and testicular histomorphological disorders in rats. International Journal of Herbal Medicine, 7(5), 56-64.

Ekpenyong, C. E.; Akpan, E. and Nyoh, A. (2015): Ethnopharmacology, phytochemistry, and biological activities of Cymbopogon citratus (DC.) Stapf extracts. *Chinese journal of natural medicines*, *13*(5), 321-337.

Ganjewala, D. E. E. P. A. K. and Gupta, A. K. (2013): Lemongrass (Cymbopogon flexuosus Steud.) Wats essential oil: overview and biological activities. *Recent Progress in Medicinal Plants*, *37*, 235-271.

Herman, R. A.; Ayepa, E.; Shittu, S.; Fometu, S. S. and Wang, J. (2019): Essential oils and their applications-a mini review. *Adv. Nutr. Food Sci*, *4*(4), 1-13.

Kumar, V. S.; Inamdar, M. N. and Viswanatha, G. L. (2011): Protective effect of lemongrass oil against dexamethasone induced hyperlipidemia in rats: possible role of decreased lecithin cholesterol acetyl transferase activity. *Asian Pacific journal of tropical medicine*, *4*(8), 658-660

Majewska, E.; Kozlowska, M.; Gruszczynska-Sekowska, E.; Kowalska, D. and 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), 327-341.

Mirghani, M. E. S.; Liyana, Y. and Parveen, J. (2012): Bioactivity analysis of lemongrass (Cymbopogan citratus) essential oil. *International Food Research Journal*, *19*(2), 569.

Mirzaei, M.; Ladan Moghadam, A.; Hakimi, L. and Danaee, E. (2020): Plant growth promoting rhizobacteria (PGPR) improve plant growth, antioxidant capacity, and essential oil properties of lemongrass (Cymbopogon citratus) under water stress. *Iranian Journal of Plant Physiology*, *10*(2), 3155-3166.

Mukarram, M.; Choudhary, S.; Khan, M. A.; Poltronieri, P.; Khan, M. M. A.; Ali, J.; Kurjak, D. and Shahid, M. (2021 b): Lemongrass essential oil components with antimicrobial and anticancer activities, 11(1), 1-23.

Mukarram, M.; Khan, M.; Zehra, A.; Choudhary, S.; Naeem, M. and Aftab, T. (2021a): Biosynthesis of lemongrass essential oil and the underlying mechanism for its insecticidal activity. In Aftab T, Hakeem K R (eds), *Medicinal and Aromatic Plants,* Springer, Cham, pp. 429-443.

Priya, E. S.; Selvan, P. S. and Yavanarajan, A. (2015): Chemotypic variation in clove oil and lemongrass oil obtained from three different geographical locations of India. *Journal of Pharmacognosy and Natural Products*, *1*(102), 2472-0992.

Saenthaweesuk, S.; Munkong, N.; Parklak, W.; Thaeomor, A.; Chaisakul, J. and Somparn, N. (2017): Hepatoprotective and antioxidant effects of Cymbopogon citratus Stapf (Lemon grass) extract in paracetamolinduced hepatotoxicity in rats. *Tropical Journal of Pharmaceutical Research*, *16*(1), 101-107.

Setiyowati, P. A. I.; Solekha, R.; Irawan, D. D.; Rosalina, R.; Rachmadani, K. A. and Saputra, A. A. (2022): Protective Effect of Lemongrass Extract (Cymbopogon nardus) on Spermatozoa Cells of Lead Acetate Induced Mice. Biomolecular And Health Science Journal, *5*(1), 29-32.

Shah, G.; Shri, R.; Panchal, V.; Sharma, N.; Singh, B. and Mann, A. S. (2011): Scientific basis for the therapeutic use of Cymbopogon citratus, stapf (Lemon grass). *Journal of advanced pharmaceutical technology & research*, *2*(1), 3-8.

Turek, C. and Stintzing, F. C. (2013): Stability of essential oils: a review. *Comprehensive reviews in food science and food safety*, *12*(1), 40-53.