A Review of Antimicrobial Activity of Cymbopogan Citratus

P.Kathirvel[1], M.Jeeva.[2]
[1, 2] Dept of Pharmacognosy
[1, 2] Pallavan Pharmacy College,
Kolivakkam, Iyyengarkulam, Kanchipuram-631502.

Abstract- *Antibiotic resistance has grown to be a significant issue globally, affecting patients' finances and emotional well-being.Alternative treatment agents should be looked into to solve this issue. The pharmacological properties of Cymbopogon citratus include antibacterial activity, which is helpful in the treatment of bacterial infections that are multidrug resistant. Because the plant contains chemicals that change resistance, it has antibacterial properties. The multidrug resistant bacterial isolates that were taken from healthy Nilai residents were recognised and confirmed in this study. To ascertain the effectiveness of C. citratus in treating multidrug resistant bacterial infections, agar diffusion experiments were conducted using aqueous and methanolic extracts of the plant. infections. Additionally, different C. citratus sections were employed to assess the variations in antibacterial activity.The inhibition zones of the various extracts and C. citratus essential oil, which served as the positive control, were measured and compared. Additionally, the extracts and regularly used antibiotics were treat bacterial infections with multiple medication resistance. Because the methanolic extract in this experiment was insufficiently concentrated and the boiling extract lacked any antibacterial action, C. citratus essential oil had stronger antibacterial activity than the methanolic extract. With the exception of P. aeruginosa, which had a significant susceptibility to the methanolic extracts, the C. citratus extract similarly demonstrated superior antibacterial activity against gramme positive bacteria than against gramme negative bacteria. Thus, C. citratus could have the potentiall use in the treatment of biofilm development related infections.*

Keywords- Cymbopogan citrates, antimicrobial activity, phytochemistry, citral , medicinal plants.

I. INTRODUCTION

Popular names for Cymbopogon citrates staff include citronella grass and lemongrass. This species is a member of the Gramineae family, which consists over 8,000 plant species and 500 genera [1]. Lemon grass is a tufted perennial grass that can reach heights of one metre.stalks with stiff leaves that grow from short rhizomatous roots. It has a five-year economic lifespan [2].

The linear, tapered leaf blade can reach a maximum length of 50 cm and a maximum width of 1.5 cm. The leaf-sheath serves as a pseudostem and has a tubular form. Long, glaucous, green, and linear with a tapering upwards and along the margins are the leaves. In its mature stages of growth, this plant produces blooms. However, flowering has never been noticed during cultivation as a result ofto a quick harvesting period. A 1-meter-long spike makes up the inflorescence.
Flowers are produced on decompound spatheate panicles that can be 30 to 60 cm long. New suckers are produced by the rhizome and grow vertically as tillers to form thick clusters [3, 4].Since the dawn of time and for thousands of years prior to that, nature has served as a source of therapeutic compounds. Nearly all plants in Nigeria have therapeutic properties, and the use of medicinal plants, particularly in traditional medicine, is today recognised and recognised as a viable profession[1]. Plants accumulate secondary metabolites, which are created as a byproduct and are not immediately helpful to them, in addition to producing food, fuel, and shelter for the animal kingdom. In addition to alkaloids, tannins, saponins, flavonoids, antraquinones, glycosides, volatile oils, terpenes, essential oils, and resins, these secondary metabolites are what give plants their therapeutic value[2].

Therefore, a medicinal plant is one that has compounds that can be employed for therapeutic purposes in one or more of its organs[19]. It may take the form of organised (material with a cellular structure, such as leaf, bark, petal, flower, stem, root, etc.) or unorganised (a cellular structural medicinal agent, such as gums, balsams, and latex) vegetable drugs.

Such plant materials may be used in the form of decoctions in cold or warm water, concoctions, preparations of soups, drinks, etc. made entirely from various ingredients. They can also be prepared as infusions by adding water to a particular plant material and letting it sit for around 15 minutes[18].

The examination of various extracts obtained from traditional medicinal plants as possible sources of novel antimicrobial agents has drawn more attention during the past 20 years[1]. Even though it has been estimated that about 7,000 different medications and one in four prescription pharmaceuticals contain substances of plant origin or their derivatives, their economic value is estimated to be around $40 billion a year[5]. shown that 33% of medications made in industrialised nations come from plants[6].

Tropical Asia is the natural habitat of Cymbopogon citratus, a tall, monocotyledonous, scented perennial plant with thin, sharply-edged green leaves and a pointy apex. In West Indies, C. citratus is referred as as Madagascar lemongrass or Guatemala lemongrass[9]. The plant C. citratus is grown Africa, the West Indies, Central and South America, and tropical regions. The linear leaves can grow up to 90 cm in height and 5 mm and in width.

Lemongrass (Poaceae) is a perennial grass that grows in South and Central America, the tropics, and other parts of the world. It is valued for its flavour and medicinal benefits. Although it is frequently referred to as lemongrass or citronella, its dispersion has given rise to a number of names for it (Table 1). The name Cymbopogon derives from the Greek words "kymbe - pogon" and "citratus," which indicate lemon-scented leaves and "boat-beard," respectively (owing to the flower spike structure). It belongs to the family Gramineae. There have been more than 55 species found (Table 2). There are a few species that are widely dispersed, including Cymbopogon citratus (West Indian grass), Cymbopogon flexuosus (East Indian or Malabar grass), and Cymbopogon pendulus (Jammu grass) [5, 16-18].

In both traditional and Ayurvedic medicine, C. citratus' pharmacological effects have a stellar track record [19, 20]. The antifungal, antibacterial, antiprotozoal, anti-inflammatory, anti-carcinogenic, antioxidant, anti-rheumatic, and cardio-protective properties of C. citratus have been documented by scientific studies [21–25]. Additionally, it has been reported to treat malaria, pneumonia, diabetes, gastrointestinal infections, anxiety, and depressive disorders [26–28**.**

FIGURE 1. LEMONGRASS PLANT

II. TAXONOMY

- Kingdom: Plantae,
- Division: Magnoliophyta,
- Class: Liliopsida,
- Order: Poales,
- Family: Poaceae,
- Genus: Cymbopogon Spreng,
- Species: citrates
- Plants Subkingdom :Tracheobionta
- (Vascularplants)
- Superdivision: Spermatophyta (Seed plants)
- Division: Magnoliophyta (Flowering plants)

III. SYNONYMS: (CATALOGUE, 2003)

- Andropogon ceriferus Hack
- Andropogon citratus DC
- Andropogon citratus DC ex Nees
- Andropogon citriodorum Hort x Desf.
- Andropogon nardus subsp. ceriferus (Hack)
- Hack
- Andropodon roxburghii Nees ex Steud.
- Andropogon schoenanthus L.
- Cymbopogon nardus subvar. citratus (DC.)
- Roberty

IV.COMMON NAMES:

(SEMINÁRIO TRAMIL, 1991;GERNOT, 2003)

- Burma: Zabalin, Sabalin
- China: Cang-Mao, Xiang Mao Cao, Heung
- Mao Tsu, Ching Tong
- Costa Rica: Zacate, Limón, Té De Limón,
- Zacate Té
- Croatia: Vlaska

- Cuba: Caña Santa
- Czech Republic: Citrónová Tráva
- Denmark: Citrongræs
- Dominican Republic & Venezuela: Limoncillo
- England & Usa: Lemon Grass, Citronella
- Estonia: Harilik Sidrunhein
- France: Citronnelle, Verveine Des Indes
- Germany: Zitronengras, Citronella,
- Lemongras
- Greece: Ëåìïíü÷Ïñôï, Êéôñïíýëëá
- (Cymbopogon Nardus) Lemonochorto; Kitronella
- (Cymbopogon Nardus)
- Guatemala: Zacate, Limón, Té De Limón, Zacate Té
- Israel:
- Eshb Limon, Limon Gras, Limonit Rihnit
- India: Sera, Verveine

V. BOTANCIAL CLASSIFICATION

A perennial herb called Cymbopogon citratus has minuscule, long, needle-like leaves. The strap-like leaves have loose tips, a glossy bluish-green coloration, and a width of 1.3 to 2.5 cm. They have a citrus aroma when crushed due to the presence of citral and a high quantity of neral and aldehyde geranial [30, 31]. The 18–36 cm-long leaf blade has parallel veining and beautiful autumn features. They don't make panicles or blooms (cultivars). About 30–60 cm of spike-let paired racemes make up the inflorescence, which is only partially inflorescent. The plant forms fruitful clumps and can grow as tall as 1.8 metres and as wide as 1.2 metres [32].

VI. MORPHOLOGY

Lemon grass is a large, perennial sedge with dense leaf clusters and a compact rhizome. It is an upright cliff that rises to a height of 1.8 metres.The leaves are long, glaucous, green, and tapered upward and along the margins; the ligule, which is a portion of the leaf that is found where the blade and sheath meet, is very short; the barren shoots have cylindrical sheaths, some of which are wide at the base and tightly clasp at the bottom while others are narrow and separating. It is a short-day plant that blooms profusely in South India.

The inflorescence measures about 1 metre in length. The Gramineae family includes the aromatic plant known as lemongrass [12]. It has cheaper production costs and essential oils of greater grade. This tall, clumped perennial grass can reach a height of 1 m. The linear, conical-shaped leaf blades can expand to a length of 50 cm and a width of 1.5 cm [24]. The leaf sheath's tubular form serves as a phoney stem. In its mature growth phases, this plant produces blooms [24].

VII. ETHNOBOTANY

Due to its commercially valuable essential oils and widespread application in both traditional medicine and food technology, Cymbopogon citratus is of great interest. Due to the introduction of new diseases, people are increasingly more conscious of health issues. using plant-based remediesDue to the negative consequences of using synthetic medications, medicine seems to be an alternate strategy [5]. Coughs, elephantiasis, the flu, gingivitis, headaches, leprosy, malaria, ophthalmology, pneumonia, and vascular problems can all be treated with lemongrass.

Lemon grass has been demonstrated in studies to have antibacterial and antifungal effects. It works as a home remedy for nausea and menstruation problems when combined with pepper. The liver, pancreas, kidney, bladder, and digestive tract can all be detoxified with the help of lemon grass, which is an effective cleaner.

In addition to promoting digestion, blood circulation, and lactation, it reduces uric acid, cholesterol, excess lipids, and other toxins in the body and relieves gastroenteritis and indigestion. The rumour is that lemon in addition to acting as a muscle and tissue toner, grass reduces acne and pimples on the skin. Additionally, it can lower blood pressure. Lemon grass can help prevent cancer, according to a recent study by the Food and Nutrition Research Institute of the Department of Science and Technology (DOES) [6, 7].

IX. LOCATION

Tropical climates that are bright, warm, and humid are ideal for the Cymbopogon citratus. Over 30 °C in Kerala has little overall impact on plants, but the oil content is significantly decreased. Different types of soils are used to cultivate lemon grass [22]. From rich loam to terrible lateritis, lemongrass grows in a variety of Sanskrit. 300-350 t/year of calcareous and water-logged ranges.

Citratus is a tropical perennial plant that produces commercial Cochin oil. Sand-based lemon grass has a higher

yield of leaf oil and a higher citral concentration. Greater oil yields are produced when lemongrass is grown in extremely salty soils [23].

X. CHEMISTRY

Cymbopogon citratus, sometimes known as lemon grass, belongs to the poaceae family. It is a medicinal plant that contains chemicals that can inhibit the growth of pathogens and boost the body's natural defences against infectious disorders. This fragrant plant is grown to yield essential oils for commercial usage and is utilised in the manufacturing of perfume. It is utilised in several pharmaceutical industries to prepare colognes, deodorants, and soaps because of its pleasant scent [25]. Citral monoterpenes, an isomeric mixture of neral and geranial, and myrcene, both of which have medicinal and antibacterial properties, make up its main constituents.

Due to the intricacy of the essential oil components, modern techniques like high performance liquid chromatography in conjunction with gas chromatography (HPLC-GC) are the recommended analysis method. A sample can be placed into a GC for further, greater separation using HPLC, which is more effective for a broad class separation of a sampl

XI. PHYTOCHEMISTRY & PHARMACOLOGY

The presence of phytochemicals or secondary metabolites may contribute to the medicinal potential of a herb. The distribution of these chemicals is uniform in medicinal plants. Important chemicals from C. citratus have been isolated and characterised, including phytosterols, anthocyanins, amino acids, organic acids, phenolic compounds, volatile components, fatty acids, fumesol, flavonoids, isovaleranic aldehyde, methylheptenone, valeric esters, L-linanool, furfurol, isopulegol, and p-coumaric acid [41–43].

The usage of medicinal plants is a component of a competitive market that also includes the food, cosmetics, perfume, and pharmaceutical industries [8]. The essential oil of number six is chemically composed.

According to its geographical origin, Cymbopogon citratus differs. Compounds such hydrocarbon terpenes, alcohols, ketones, esters, and primarily aldehydes have continuously been recorded. Myrcene, an antibiotic and analgesic, as well as citronellal, citronellol, and geraniol are among the active components found in lemon grass.

The major component of the essential oil is citral, a volatile oil with a powerful lemon scent. Citral is a blend of two monoterpenes with stereoisomers.Aldehydes are utilised in the production of perfumes, coloured soaps, and the synthesis of vitamin A; the trans isomer geranial (40–62%) predominates over the cis isomer neral (25–38%) [9, 10].

XII. CHEMICAL COMPOSITION

Because it contains more citral than other plants, lemongrass (Cymbopogon citratus) is well known. Early or late lemongrass harvesting has an impact on the essential oils and citral concentration. Temperature, light output, soil moisture, fertiliser, and maturity all had an impact on the essential oils and citral components. The plant transitions from the vegetative to the reproductive stage as it ages. Overall, there is a strong correlation between the production of plant biomass and the yield of essential oils. The ratio of young to older leaves determines whether essential oils are of higher quality and contain more citral (75%) when harvested at a particular time. Different processes, such as solvent, rapid solvent dense CO2 and the Soxhlet, solidphase matrix, and super-critical fluid extraction techniques, are typically used to get lemongrass essential oils.

XIII. POST HARVESTATION TECHNOLOGY

Winter is often when lemongrass blooms. Harvests after that take place every 60–70 days. In the first year, three harvests are possible under normal circumstances, and three to four harvests are possible the following years, depending on the management techniques used. Before being carried to the distilling plant and allowed to wilt in the grown fields, the crops are picked using sickles and cut to a height of 10 cm above the ground. Depending on the soil and weather, a plantation lasts for three to four years on average. The age of the plant has an impact on the essential oil yield. The yield of essential oil is lower in the first year, increases in the second

year, peaks in the third year, and then declines the following year.

80 kg of oil are produced from an average of 25 to 30 tonnes of fresh herbage gathered annually from 4 to 6 cuts per hectare. An oil yield of 100-150 kg/ha is obtained from newly developed cultivars under irrigated circumstances. Average oil content for lemon grass is 0.3%, and thick stems are cut off before distillation. Oil is absent from thick stems [26].

XV. PROPAGATION

The plant is multiplied by clump division [35] or by creating genetic clones through vegetative techniques. Genetic reproduction may cause differences, degradation, and a decrease in oil supply and quantity [35]. The soil must be fertile, sandy-loam, pH 2-12, and consistently moist for the plant to thrive [36].

XVI. TRADITIONAL IMPORTANCE

The leaves have long been consumed as tea or decoction throughout Asia, South America, and Africa. The plant's analgesic, analgesic, antipyretic, tranquillizer, anti-hermetic, and diuretic qualities are all controlled by the leaf's essential bioactive components, which also have anti-inflammatory, antiseptic, anti-dyspeptic, and anti-fever effects [37, 38]. They act as deodorants in a variety of goods, including candles, local soaps, perfume, and insect repellents [38, 39]. In some parts of Asia and several African nations, it has been employed as a snake and reptile deterrent.

XVII. ECONOMIC IMPORTANCE

Essential oils from C. citratus, including citral, genariol, -oxobisabolene, and myrcene, are vital raw materials for the soap and detergent, food, beverage, perfume, cosmetic, and candy industries [24, 40]

.

XVIII. USES

It works well as a deodorizer and antiseptic as well. It is employed in the creation of foot baths and foot talc for sweaty feet. For any fungal treatments of the feet, it can be used to treat ringworm and tinea. It occasionally causes other types of inflammation in addition to skin irritation. Therefore, it is best to avoid application when pregnant [31]. Over the years, people have used the amazing herb lemon grass for both culinary and medical purposes. Globally, hot tropical temperatures support the growth of the green and white plant known as lemon grass [20].

Lemongrass is also used as a diuretic for fever and as an insect repellant. Its pepper mixture was used to treat nausea and ease menstruation cramps. Other essential oils including coriander, basil, jasmine, cedar wood, and geranium blend beautifully with lemon grass oil.

XIX. PHARMACOLOGICAL ACTIVITIES PRESENT IN C. CITRATUS

Anti-microbial activity: Lemon grass leaf ethanolic extracts demonstrated promising antibacterial activity against Staphylococcus aureus. Tannins and Flavonoids discovered in theThe activity is caused by extract [11].

Anti-fungal activity: Additionally, other species may be linked to various infections. Candida albicans is a significant pathogen of human infections. The capability of against fungiStudying the effects of lemongrass and citral against Candida species revealed that these two substances have strong in vitro anti-Candida spp. action. [12].

Antiprotozoan Activity: Protozoans that cause serious infections in people, animals, and plants are found in the Trypanosomatidae family of parasites. In this family, there are someThe trypanosomatids, which are monoxenous protozoans typically found in insect hosts and include Crithidia, Blastocrithidia, and Herpetomonas. Crithidia deanei was

resistant to the anti-protozoan effects of the Cymbopogon citrate essential oil [13].

Antioxidant activity: Due to their pharmacological action, phenolic acid and flavonoids have attracted attention for their potential as natural antioxidants and free radical scavengers. Acids phenolicsThe anti-oxidant profile was present in the plant [14].

Anti Diarrhoeal Activity : In actuality, the entire lemongrass stem and leaf are boiled, and the resulting decoction is ingested to treat diarrhoea. Due to its widespread usage in conventional medicineThe effectiveness of the C. citrates stalk decoction and its primary chemical component, citral, as an anti-diarrheal was investigated [15].

Anti Mutagenic Activity: Salmonella typhimurium strains TA98 and TA99 were discovered to have anti-mutagenic characteristics when exposed to an ethanolic extract of lemongrass.TA100 [16].

Anti inflammatory activity: Dendritic cells that have been activated by lip polysaccharide were examined for their anti-inflammatory properties and used to treatinflammation-related conditions, particularly those affecting the digestive system [17].

Anti-malarial activity: On mice infected with Plasmodium berghei, ogon citratus was investigated [18].

Anti-nociceptive properties: Citrates essential oil has these properties.a substantial antinociceptive effect. Essential oil operates both at the peripheral and central levels, according to results obtained with three different experimental models of nociception, including the hot-plate, mice writhing in acetic acid, and the formalin test [19].

XX. ANTIMICROBIAL ACTIVITY OF C,CITRATUS

Staphylococcus aureus, Streptococcus pyogenes, Bacillus cereus, Escherichia coli, and other bacteria were tested for their susceptibility to the produced extracts of lemon grass (Cymbopogon citratus) stem.Using the Agar well diffusion and disc diffusion methods, Acinetobacter baumanni and Neisseria gonorrhoeae were used to measure the zone of inhibition.Using the well diffusion and disc diffusion procedures, the produced extracts of lemon grass (Cymbopogon citratus) stem were assessed for their antibacterial activity against diverse bacterial strains.

Numerous varieties of lemon grass have been used for their therapeutic benefits and positive impacts on health, such as their ability to stimulate digestion and their antioxidant, antibacterial, anti-inflammatory, hypolidemic, anti-carcinogenic, and antimutagenic capabilities [20]. Essential oils react quite differently to different sources. Plants of many kinds, including flowers, trees, grasses, shrubs, fruits, and herbs, can be used to produce essential oils. Different portions of the plant contain concentrated amounts of the gathered oils. Although several essential oils are well known for their antibacterial properties [27–28], the mechanism of action is frequently not entirely understood.

Infusions made from Cymbopogon citrates leaves have medicinal value and are frequently taken as drinks to alleviate inflammatory diseases. Nuclear magnetic resonance is used to distinguish between and identify the luteolin-C, luteolin-O, and C,O-glycosides, which are entirely detailed in the lemongrass for the first moment. Luteolin and its glycosides were tested for their anti-inflammatory effects in lipopolysaccharide-stimulated macrophages. Luteoline glycosides have a lower cytotoxicity than luteoline itself. Although glycosylation, which is higher than C-glycosylation, reduces luteolin's anti-inflammatory characteristics, the cytotoxic effects of the 7-O-glucopyranoside luteolin were examined for an inhibitory effect on the synthesis of inflammatory mediators (nitric oxide and IL-1).

The luteolin glycosides in lemongrass infusion have less harmful effects when compared to the anti-inflammatory medications currently used in the food and pharmaceutical industries. Additionally, structure-activity connections were discovered, which provides important knowledge for the development of cytoxicity-free anti-inflammatory luteolin glycosides [30].

There are numerous known uses for lemongrass in medicine. Beyond being utilised as a flavouring agent, lemongrass oil has a variety of health benefits.Due to its anti-depressant, analgesic, antipyretic, bactericidal, anti-septic, carminative, and astringent qualities, lemon grass is significant in several pharmaceutical sectors.

Citral contains a lot of essential oils, which are very the essential lemon grass oil contains geranial and neral compounds, which have favourable antimicrobian effects, according to Onawunmi et al. (1984). When myrcene is combined with one of these compounds, the impact is strengthened.

A number of Cymbopogon species are thought to be antifungal when it comes to rice diseases, particularly when it comes to Rhizoctonia solani and Sclerotium oryzae (Naidu & John, 1981; Shimoni et al., 1993).

When tested against 42 microorganisms (20 bacteria, 7 yeasts, and 15 fungi), the oil extracted from C. citratus leaves displayed antimicrobian action. Compared to the fungi, the isolated bacteria showed a higher susceptibility (Ibrahim, 1992).Similar studies were conducted by Syed et al. (1991), Baratta et al (2002a, 2002b)

CONCLUSION

Humans rely heavily on medicinal plants to maintain their health. The pharmacological analysis of several plants utilised in India's traditional medical system is becoming more and more popular.medicine. Due to its highly valuable essential oils and widespread application in both traditional medicine and culinary technology, lemongrass is of significant interest. Due to the growing interest in the natural products made from lemon grass, a thorough phytochemical and pharmaceutical investigation is needed. This will open up new pharmacological possibilities for this lovely plant that will aid in both the creation of new medications and clinical research.

Cymbopogon citratus, sometimes known as lemon grass, belongs to the poaceae family. It is a medicinal plant that contains chemicals that can inhibit the growth of pathogens and boost the body's natural defences against infectious disorders. Lemongrass is frequently used in baked goods, confections, herbal teas, and other non-alcoholic beverages. Lemongrass essential oil is frequently used as a scent in perfumes and beauty products like creams and soaps.

The creation of beta carotene, vitamin A, and other nutrients is derived from citral, which is present in high concentrations in lemon grass essential oil. Lemon grass oil is therefore used in several pharmaceutical sectors for its anti-depressant, analgesic, antipyretic, bactericidal, anti-septic, and carminative properties due to the presence of diverse chemical elements.

REFERENCES

[1] Barbosa LCA, Pereira UA, Martinazzo AP, Maltha CRA,Teixeira RR, Melo EC. Evaluation of the Chemical Compositionof Brazilian Commercial *Cymbopogon citratus* (D.C.) StaffSamples. Molecules 2008; 13:1864-1874.

[2] Carianne de Boer. Organic lemongrass, a guide for smallholders. EPOPA (Export Promotion of Organic Products fromAfrica) 2005:1-27.

[3] Tajidin NE, Ahmad SH, Rosenani AB, Azimah H, Munirah M.Chemical composition and citral content in lemongrass(*Cymbopogon citratus*) essential oil at three maturity stages.African Journal of Biotechnology 2012; 11(11):2685-2693.

[4] Lemongrass. Available from Available from:http://nhb.gov.in/Horticulture%20Crops%5CLemongrass%5CLemongrass1.htm. 17 Feb, 2014.

[5] Bonjar, G.,H.,S & Farrokhi, P.,R. (2004). Antibacillusactivity of some plant used in traditional medicine of Iran.Nigerian Journal on National Prod. Med. (8): 34-39.

[6] Robinson, N. (2006). Integrated traditional Chinese medicine.COMPLEMENTAEY

[7] Carter, A.P., Clemons, WM., Brodersen, D.E., Morgan-Warren, R.I., Wimberly, B.T & Ramakrishnan, V.(2000). "Functional insights from the structure of the 30Sribosomal subunit and its interactions with antibiotics".Nature 407 (6802): 340-8.

[8] CDC. (2007). "Escherichia coli 0157:R7". CDC Division ofBacterial and Mycotic Diseases. http://www.cdc.govlncidodldbmdldisease infolesch erich iaco I_g.htm.

[9] Ernst, E. (2008). "Chiropractic: a critical evaluation". Journalon Pain Symptom Management 35 (5): 544-62

[10] Plant Database. (2008). National Plant Daabase CeterStapf.USDA, NRCS.The plant Database. http://plants.usda.gov, 70874-4490. LA, USA.

[11] Rios, J.L & Recio, M.,c. (2005). Medicinal plants andantimicrobial activity. Journal Of Ethnopharmacology 100:80-84.

[12] V. Francisco , A. Figueirinha , B. Neves , C. García-Rodríguez , M. Lopes , M. Cruz , M. Batista , *Cymbopogon citratus* as source of new and safe anti-inflam- matory drugs: bio-guided assay using lipopolysaccharide-stimulated macrophages, J. Ethnopharmacol. 133 (2011) 818–827 .

[13] T.S. Filgueiras, Cymbopogon in Lista de Espécies da Flora do Brazil. Jardim Botânicodo Rio de Janeiro (2014). Available at: _ http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB24285 _ .

[14] M. Coelho , C. Rocha , L.M. Cunha , L. Cardoso , L. Alves , R.C. Lima , M. Pintado , Influence of harvesting factors on sensory attributes and phenolic and aroma compounds composition of *Cymbopogon citratus* leaves infusions, Food Res. Int. 89 (2016) 1029–1037 .

[15] G. Shah , R. Shri , V. Panchal , N. Sharma , B. Singh , A. Mann , Scientific basis for the therapeutic use of *Cymbopogon citratus* , staff(Lemongrass), J. Adv. Pharmaceut. Techn. Res. 2 (1) (2011) 3–8

[16] M.I. Chowdury , M. Debnath , M. Ahmad , M. Alam , A. Saleh , S. Chowdhury , A.H. Kama , Potential phytochemical, analgesic and anticancerous activities of

Cymbopogon citratus leaf, Am. J. Biomed. Res. 3 (2015) 66–70 .

[17] N.M. Kouame , M. Kamagate , C. Koffi, H. Die-Kakou , N.A. Yao , A. Kakou , *Cymbopogon citratus* (DC.) Stapf: ethnopharmacology, phytochemical, pharma- cological activities and toxicology, Phytothérapie 13 (2015) 1–9 .

[18] Y.N. Clement , Y.S. Baksh-Comeau , C.E. Seaforth , An ethnobotanical survey of medicinal plants in Trinidad, J. Ethnobiol. Ethnomed. 11 (2015) 67 .

[19] Mirghani MES, Liyana Y, Parveen J. Bioactivity analysis oflemongrass (*Cymbopogon citratus*) essential oil. InternationalFood Research Journal 2012; 19(2):569-575.

[20] Ojo OO, Kabutu FR, Bello M. Babayo Inhibition ofparacetamol-induced oxidative stress in rats by extracts oflemongrass (*Cymbropogon citratus*) and green tea (*Camelliasinensis*) in rats. African Journal of Biotechnology 2006;5(12):1227-1232.

[21] Lemongrass. Available from: www. dehydrate2store.com, 2013.

[22] Rocha RP, Evandro DCM, Demuner AJ, Radunz LL, CorbinJJB. Influence of drying air velocity on the chemicalcomposition of essential oil from lemon grass. African Journal ofFood Science and Technology 2011; 2(6):132-139.

[23] Shah G, Shri R, Panchal V, Sharma N, Singh B, Mann AS.Scientific basis for the therapeutic use of *Cymbopogon citratus*,staff (Lemongrass). Journal of advanced pharmaceuticaltechnology and research 2011; 2(1):3-8.

[24] Antihypertensive Properties of Lemon Grass Leaf BiologyEssay. www.ukessays.com. 14 Feb, 2014.

[25] Danlami U, Rebecca A, Machan DB, Asuquo TS. Comparativestudy on the Antimicrobial activities of the Ethanolic extracts ofLemon grass and *Polyalthia longifolia*. Journal of AppliedPharmaceutical Science 2011; 01(09):174-176.

[26] Silva CdeB, Guterres SS, Weisheimer V, Schapoval EE.Antifungal activity of the lemongrass oil and citralagainst *Candida* spp. Braz J Infect Dis 2008; 12(1).

[27] Pedroso RB, Nakamura TU, Filho BPD, Cortez DAG, CortezLER, Morgado-diaz JA, Nakamura CV. Biological Activities of~ 7 ~International Journal of Herbal MedicineEssential Oil Obtained from *Cymbopogon citrates* on *Crithidiadeanei.* Acta Protozool 2006; 45:231-240.

[28] Garg D, Muley A, Khare N, Marar T. Comparative Analysis of

[29] Phytochemical Profile and Antioxidant Activity of Some IndianCulinary Herbs. Research Journal of Pharmaceutical, Biologicaland Chemical Sciences 2012; 3(3):845-854.

[30] Tangpu V, Yadav AK. Antidiarrhoeal activity of *Cymbopogoncitrates* and its main constituent, citral. Pharmacologyonline2006; 2:290-298.

[31] Vinitketkumnuen U, Puatanachokchai R, Kongtawelert P,Lertprasertsuke N, Matsushima T. Antimutagenicity of lemongrass (*Cymbopogon citratus*, Stapf) to various known mutagensin salmonella mutation assay. Mutat Res 1994; 341(1):71-5.

[32] Figueirinha A, Cruz MT, Francisco V, Lopes MC, and BatistaMT. Anti-Inflammatory Activity of *Cymbopogon citratus* Leafinfusion in Lipopoly saccharide-Stimulated Dendritic Cells:Contribution of the Polyphenols. Journal of Medicinal Food2010; 13(3):681-690.

[33] Tchoumbougnang F, Zollo PH, Dagne E, Mekonnen Y. *In vivo*antimalarial activity of essential oils from *Cymbopogon citratus*and *Ocimum gratissimum* on mice infected witPlasmodiumberghei. Planta Medica 2005; 71(1):20-3.

[34] Viana GSB, Vale TG, Pinho RSN, Matos FJA. Antinociceptiveeffect of the essential oil from *Cymbopogon citratus* in mice.Journal of Ethnopharmacol 2000; 70(3):323-327.

[35] Arhoghro EM, Kpomah DE, Uwakwe AA. Curative Potential ofAqueous Extract of Lemon Grass (*Cymbopogon citratus*) onCisplatin Induced Hepatotoxicity in Albino Wistar Rats. J Phys Pharm Adv 2012; 2(2):282-294.

[36] Seenivasan, P., Manickkam, J & Savarimuthu, I. (2006). "Invitro antibacterial activity of some plant essential oils". BMCComplement journal of Alternative Medicine. 6: 39.

[37] Sofowora, E.A. (1984). Medicinal Plants and TraditionalMedicine in Africa. John WHey and Sons Inc. New York,pp256-257.

[38] Trease, G.E., Evans, W.C. (1983). Pharmacognosy. 12thedition Bailliere Tindall, London. Pp. 343-383.

[39] Tyler, V.E., Brandy R.H., Robert, J.E. (1981).Pharmacognosy. Tea and Farbiger, Philadephia Pp; 4-8.

[40] Vandepette, J.,Engback, K.,Piot, P & Hark, C.(1991). BasicLaboratory procedures in clinical Bacteriology, World HealthOrganisation.Geneva, pp. 31-36.

[41] World Health Organization (1998). WHO monographs on theselected medicinal plants. WHO Geneva.