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Ethnobotany, traditional use, phytochemistry and pharmacology of *Cymbopogon citratus*: Review article

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Abstract

Today, scores of people around the world consume plant based medicines as a part of traditional medicine for a variety of medical disorders. *Cymbopogon citratus* (DC) Stapf is an herbal plant belonging to Poaceae family, which is usually referred to as lemongrass. It is one of the important oil bearing plants of everywhere around the globe. Based on the literature reviewed, citral is said as active natural agent presented in *Cymbopogon citratus* and it's accountable for most of *Cymbopogon citratus* pharmacological activities. This plant is sometimes prepared from the fresh herbs within the kind of infusions and decoctions also, the dried leaves is given mostly within the sort of tea in most of the continents for a good range of indications. Thus, further investigations should be carried out to boost the knowledge of its efficacy and toxicological studies in validating these traditional uses.

Keywords: *Cymbopogon citratus*, ethnobotany, traditional use, phytochemistry, pharmacology

1. Introduction

Today, innumerable people around the world consume plant based medicines as a part of traditional medicine for the spread of medical disorders. The utilization of traditional medicine in developing countries contributes to the socio-economic status and well-being of the agricultural communities. About 80% of the populations in developing countries where largely rely upon herbal medicine for their primary health care needs. The use of medicinal plants especially in primary health care becomes prominent [1]. The search for plants with medicinal value has led to undergo some studies that have documented traditional medicinal plant species, the mode of preparation and use by local communities in some parts of the country. It's thus reasonable for decision-makers to spot locally available plants or plant extracts that might usefully be added to the national list of medication, or that might even replace some pharmaceutical preparations that require to be purchased and imported [2]. *Cymbopogon citratus* (DC) Stapf is herbal plant belonging to Poaceae family. Commonly known as lemongrass and it is one of oil bearing plant. This plant is used in traditional and modern medicine to cure different disease conditions. Essential oils, aqueous extracts, phenolic compounds, and other extracts from this plant are industrially and economically important. They are used in perfumery, cosmetics and pharmaceuticals. The plant is a native herb from southern India and Sri Lanka, but nowadays grows spontaneously all over the world, especially in other tropical, subtropical and Savannah regions [3]. *Cymbopogon citratus*, a perennial plant with long, thin leaves, is one amongst the largely cultivated medicinal plants for its essential oils in numerous parts of the world. It contains 1-2% of oil on a dry basis and also the chemical composition of *Cymbopogon citratus* essential oil is varying widely upon genetic diversity, habitat, and agronomic treatment of the culture. The leaves of *Cymbopogon citratus* present lemony characteristic flavor because of its main content, citral which present great importance to the industry [4]. The predominant feature of *Cymbopogon citratus* within the pharmaceuticals, perfumery in addition to food industries is because of the high citral content of its oil and for its strong lemon fragrance. *Cymbopogon citratus* contains several bioactive compounds that impart medicinal value to that. In keeping with the WHO, herbal medicine is taken into account a vital part of the healthcare system by quite two-thirds of the population in developing countries [5]. *Cymbopogon citratus* (lemon grass) is geneses of about 55 species are indigenous in tropical and semi-tropical areas of Asia. The oil of *Cymbopogon citratus* contains Citral and other secondary metabolites and everyone are important stuff employed in the pharmaceutical, perfumery and cosmetics industries, furthermore as for the synthesis of vitamin A.

Citral has been reported to exhibit various biological activities like, larvicidal activity, hypoglycemic and hypolipidemic effects, anti-inflammatory, antimalarial, free radical scavengers, antioxidants effect, ascaricidal activity, anti-nociceptive effect, anti-inflammatory, antifungal, anti-diarrheal, and anti-bacterial activities [6]. Therefore, this review has emphasized to summarize the various varieties of phytochemicals found within the *Cymbopogon citratus* parts, pharmacological activities claimed in several studies previously, Traditional use in several areas and Ethnobotanical aspects related to *Cymbopogon citratus*.

2. Materials and Methods

Data for this review were obtained from previous research findings regarding Ethnobotanical, phytochemical and pharmacological aspects of *Cymbopogon citratus* from available literatures published in scientific journals. Literature was searched in numerous electronic databases (Science Direct, PubMed, Research gate, Web of Science and Google Scholar) with inclusion criteria of full length published articles on *Cymbopogon citratus* conducted in numerous countries and with exclusion criteria of information from non-open access journals or partially accessed (Abstract only) articles by using primary search terms like, Ethnobotanical/Ethnobotany, phytochemistry, pharmacology of *Cymbopogon citratus*". We reviewed a complete of 33 publications. 'Citation style APA.

3. Ethnobotany of *Cymbopogon citratus*

Cymbopogon citratus may be a great interest because of its commercially valuable essential oils and widely utilized in food technology yet as in traditional medicine. People nowadays are more aware of health issue because of the emergence of recent diseases and the resistance of commercially available conventional medicines. Traditionally treatment using plant-based medicine appears to be an alternate approach thanks to the adverse effects related to the utilization of synthetic drugs. For many rural communities, *Cymbopogon citratus* could be a folk remedy for coughs, elephantiasis, flu, gingivitis, headache, leprosy, malaria, ophthalmic, pneumonia, and vascular disorders. It also used as an honest cleanser that helps to detoxify the liver, pancreas, kidney, bladder and also the digestive tract. It cuts down uric acid, cholesterol, reduces blood pressure, excess fats, and other toxins within the body while stimulating digestion, blood circulation, and lactation [7]. *Cymbopogon citratus* is propagated by means of root divisions and grows in the tropical climate. The clump of a mature plant is split into variety of slips and, the highest and fibrous roots of every slip are trimmed off before planting. The soil must be loosened thoroughly by plowing before planting. It grows on poor soil and is proof against drought. However, it flourishes on a wide variety of soils starting from rich loam to poor laterite and a warm and humid climate with much sunshine. Prefers annual rainfall. In regions of abundant rainfall, the plant is also harvested more regularly during the year. However, with prolonged rainfall, planting on ridges could also be suggested. *Cymbopogon citratus* could be a commercially viable plant accounting for top interchange earnings for countries, like Brazil, Indonesia, India, and China. Although commercial activities on *Cymbopogon citratus* in the geographic area of West Africa are low, its subsistence cultivation is numerous and scattered all across the region for foods, ornamental, and medicinal purpose [8].

4. Morphology and botanical description of *Cymbopogon citratus*

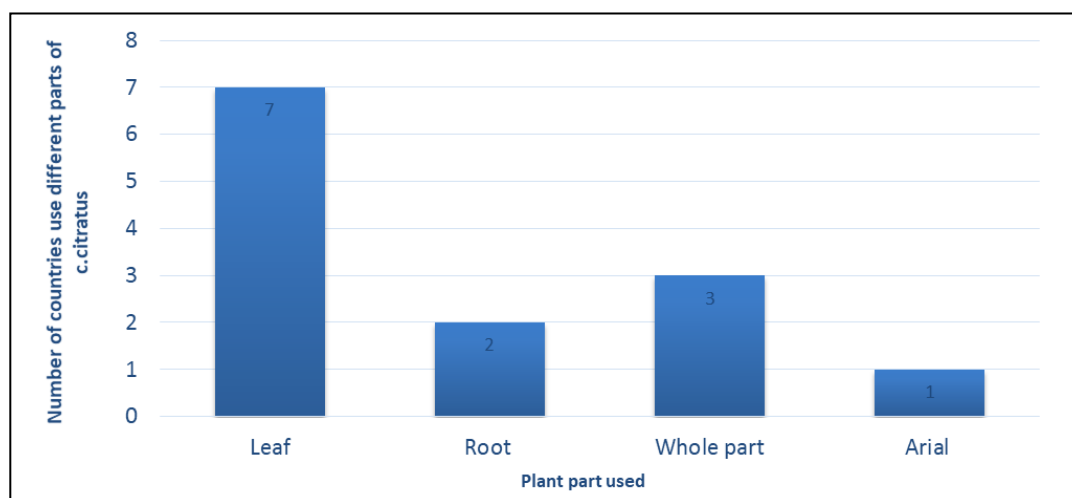
It is a perennial, tufted, aromatic grass with numerous erect culms arising from a short oblique, ring-shaped, sparingly branched rhizome. The culms (stem) become old to 2-3m tall, smooth and glabrous. Leaves sheathing, coriaceous, terete, embracing the culm, glabrous, striate; blade linear, 50-100cm x 0.5-2cm, long attenuate at both ends, apex acuminate, drooping, glabrous, glaucous-green, midrib prominent below and white above, top part and margins often scabrid because the membranes of epidermal cells accumulate silica. The plant is basically non-blooming and flourishes in well-drained sandy soil. An annual rainfall of 80-100 in and a mean temperature of 75-80°F are reported to be favorable for its growth [9].

5. Traditional use of *Cymbopogon citratus*

Cymbopogon citratus is employed as ancient folk drugs within the treatment of the nervous condition, gastrointestinal disturbances, fever and cardiovascular disease. *Cymbopogon citratus* is additionally a folk remedy for coughs, hypertrophy, flu, gingivitis, headache, leprosy, malaria, ophthalmic, respiratory disease, and vascular disorders. It's mainly taken within the variety of "tea" as a remedy for biological process issues, looseness of the bowels and abdomen ache. As a healthful plant, *Cymbopogon citratus* has been thought-about a carminative and bug repellent. *Cymbopogon citratus* oil was claimed to possess anthelmintic activity. Historically, lemon grass is typically ready from the contemporary herbs within the variety of infusions and decoctions. Additionally, the dried leaves of *Cymbopogon citratus* can be given in a variety of tea [10]. The tea or infusion ready with recent or dry leaves of lemon grass is incredibly utilized in the favored drugs in most the continents and it includes a large verity of indications. In India, it's used for channel issues and, in China, as anxiolytic, in Central American nation to alleviate cough, carminative, medicament and depurative. within the Mauricio islands and within the peninsula, it's common to use the lemon grass tea against contagion, fever, pneumonia, and to resolve internal organ, in Brazil popularly used as spasmolytic, analgesic, opposing -inflammatory, antipyretic, drug and sedative, In Nigeria, it's used as antipyretic, and for its stimulating effects. In Republic of Indonesia, the plant is indicated to assist diuresis and sweating. In Argentina decoction of leaf is taken orally for inflammatory disease, empacho and as an emetic. Hot water extract of entire plant is employed externally for healing wounds and bone fractures in USA and in Thailand taken orally for diabetes. Hot water extract of dried leaves is taken orally as a hypotensive, for catarrh and rheumatism in Cuba and as renal antispasmodic and diuretic in Egypt. In Pakistan Aerial part is employed as Pyretic, vomit, diuretic, rheumatism, and as anti-malaria condiment. In Colombia Rhizome (root) it's chewed and used as toothbrush and for pest control. Still in Africa and Asia, it's considered as antitussive, antiseptic, stomachic, anti-rheumatic and to treat backache [6, 11]. [Table1] shows the summary of various studies regarding *Cymbopogon citratus* parts used traditionally in various countries and their preparation for various disease conditions. Traditional applications of *Cymbopogon citratus* in several countries shows high applicability as a standard tea, medicinal supplement, insect repellent, insecticide, in flu control, and as anti-inflammatory and analgesics [12].

Table 1: *Cymbopogon citratus* parts utilized in various countries for various disease conditions and customary names utilized in different countries

Country	Common names	Plant part used	use	Root of administration	Reference
Brazil	apim-limão, Capim-santo, Capim-cidreira	Leaf decoction	antispasmodic, analgesic, anti-inflammatory, antipyretic, diuretic and sedative, Treatment of epilepsy and anxiety	Oral	[6, 11]
Argentina	Limonaria	Decoction of leaf	for sore throat, empacho, and as an emetic	Oral	[6]
India	Sera, Vereine	Leaf infusion	used for gastrointestinal problems	Oral	[6, 11]
Costa Rica	Grass tea	Leaves	To relieve cough, carminative, expectorant and depurativ	Oral	[12]
Colombia	Limonaria	Rhizome /Root	It is chewed and used as tooth brush and for pest control	Oral	[12]
Ethiopia	Tej-sar	Root	Stomachache	Oral	[23]
Pakistan	Lemon grass	Aerial	Antiseptic and stomachic treatment diuretic, rheumatism, and as anti-malaria condiment.	Oral	[12]
Indonesia:	Sere,	Hot water extract of the entire plant	For an emmenagogue	Oral	[6, 11]
Cuba	Cana Santa	Hot water extract of dried leaves	For rheumatism, hypotensive,	Oral	[6]
Egypt	Halfabar	Hot water extract of dried leaves	As Antispasmodic and Diuretics	Oral	[6]
USA	Citronella	Hot water extract of entire plant	for wound healing and bone fractures	Topical	[6]
Thailand	Ta-khrai	Hot water extract of dried entire plant	Taken orally as anti-diabetics	Oral	[6]
China		Dry leaf infusion	As anxiolytic agent	Oral	[6, 11]



Note; as shown within the above figure most of the countries use leaf part of *Cymbopogon citratus* while few are use Root, Whole plant and Aerial to satisfy their primary health care needs as indicated in previous study findings during this review

Fig 1: Graphical representation of plant parts used from *Cymbopogon citratus* in numerous countries summarized in table 1

6. Phytochemistry of *Cymbopogon citratus*

Most of the biological effects described to *Cymbopogon citratus* extracts are attributed to its primary bioactive constituents, derived from its leaves, stem, roots, and their secondary metabolites. Today, an oversized number of empirical studies are administrated planning to expand our understanding of *Cymbopogon citratus* phytochemistry including variety of recently conducted studies. The finding of this studies have shown that the chemical composition of *Cymbopogon citratus* extracts varies consistent with the geographical origin, genetic differences, a part of the plant used, method of extraction (extracting solvents), age/stage of maturity, and season of harvest. Despite these differences, variety of classes of compounds were found, including myrcene, geraniol, limonene, citronellol and nerol within the essential oil of *Cymbopogon citratus*, [Figure 2]: shows the chemical structures of this compound within the essential of *Cymbopogon citratus*. Species differences arise from genetic variations which will directly or indirectly

influence the chemical composition^[13]. In one of the previous study conducted by Soares, M *et al* (2013), several phytochemical materials have been evaluated qualitatively and quantitatively. The discovering of this phytochemical analysis suggests that the presence of tannins, flavonoids and terpenoids in three specific extracts (water, ethanol and methanol), while alkaloids and steroids had been absent in aqueous and ethanolic extracts. This variant of result may also be due to these different extracting solvents. The results of this study support that the edaphic and climatic prerequisites may additionally promote variations in the synthesis of secondary metabolites which may additionally make contributions to the medicinal value as well as physiological activity of the plant section evaluated^[14]. While other study report by Chowdury, M.I.A *et al* (2015) on phytochemical screening test revealed that, methanolic leaf extract of three unique concentrations in opposition to sheep ked and the end result confirmed that promising effect on a number days of post therapy comprise alkaloids, steroids, flavonoids, tannins,

saponins and carbohydrates had been identified. According to this study file methanolic leaf extracts of this plant possess average analgesic activity ^[15]. Other study finding by Promila and VK Madan. (2018) reports that, Citral, geranial and neral form nearly seventy five percent of the aldehydes present in the oil extracted from *Cymbopogon citratus*. These supply aroma to the plant and help its usage in aromatherapy. Chemical structures of citral, geranial and neral are represented in [Figure 2] ^[16]. It has been reported that the phytochemical screening with the help of ethanol extract leaf of *Cymbopogon citratus* indicate that the presence of alkaloids, tannins, carbohydrates and flavonoids while sterols,

cardiac glycoside and saponins were absent. These metabolites were answerable for antimicrobial activity of the leaf extract. For instance, many classes of alkaloids had been shown to possessed antimicrobial properties against *Methicillin resistance Staph. aureus* by denaturing their transposons making the bacterium susceptible to antibiotics. It has additionally been proven that saponins are energetic antifungal agents while tannins have been mentioned to prevent the development of microorganisms with the aid of precipitating microbial proteins and making nutritional proteins unavailable for them ^[17].

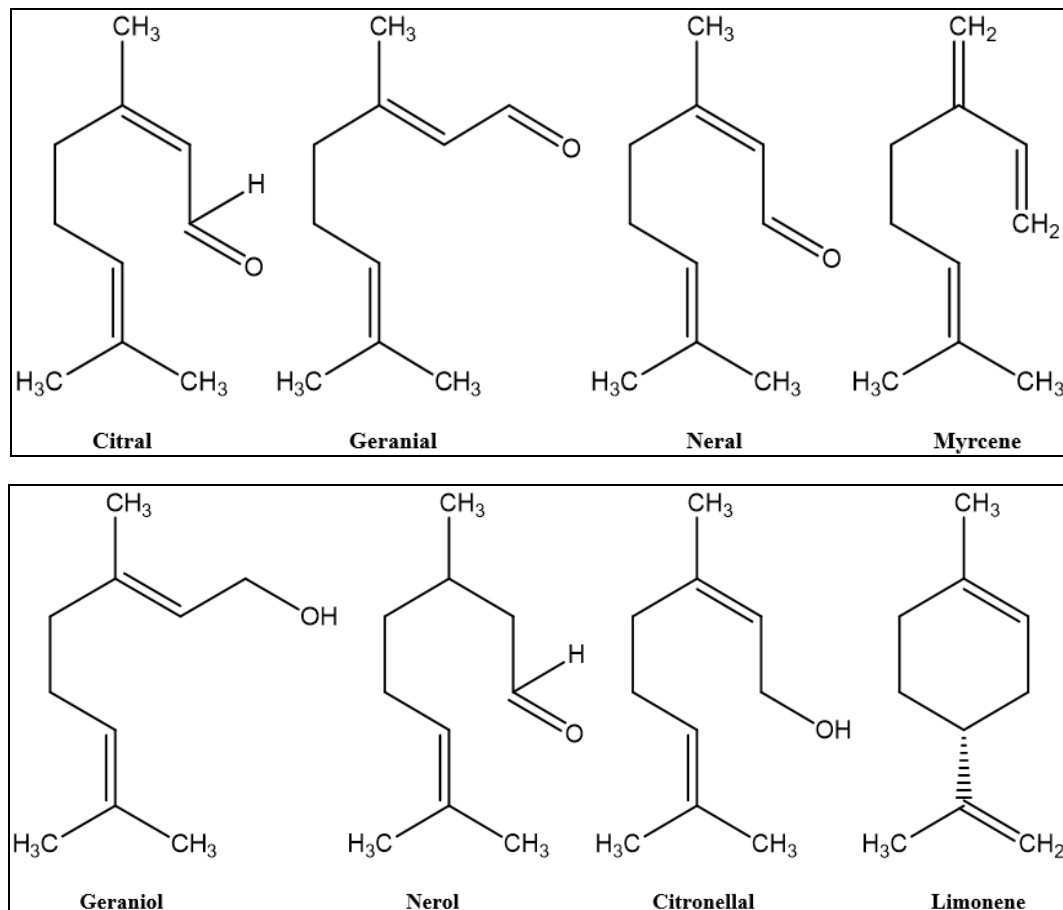


Fig 2: Chemical structures of the major constituents of *Cymbopogon citratus* essential oils

7. Pharmacology of *Cymbopogon citratus*

The medicinal application of *Cymbopogon citratus* follows different treatment mediums, such as topical, infusion, and as tea preparations. Several reports had been published on the pharmacological potential of *Cymbopogon citratus* and its clinical applications. A summary of the findings regarding their pharmacological activities of these studies is presented below.

7.1. In-vitro Antimicrobial Activity

The anti-microbial activity of *Cymbopogon citratus* was studied by Naik, M *et al* (2010). The results obtained from the Agar diffusion assay and broth dilution method support that general indication that Gram positive organisms (*S. aureus*, *B. cereus* and *B. subtilis*) were found more susceptible for *Cymbopogon citratus* than gram negative organisms (*E. coli*, *K. pneumonia*, *P. aeruginosa*). *Cymbopogon citratus* oil was found effective against all the test organisms. As reported in this study antibacterial activity was found progressively increasing with the rise in oil concentration and also the

maximum effect was found at 30% concentration of oil and minimum effect was observed at 5% concentration of oil ^[18]. A study carried out by Lovet. T. Kigigha *et al* (2018) to evaluate the antimicrobial effect of hot water and ethanolic leaf extracts of *Cymbopogon citratus* against *Staphylococcus aureus*, *Bacillus subtilis*, *E. coli*, and *Pseudomonas aeruginosa*. The result of this study showed that zone of inhibition for *E. coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Bacillus subtilis* was 9.33 mm, 9.33 mm, 11.33mm and 9.67 mm respectively for 100% concentration of hot water leaf extract of *Cymbopogon citratus*, and 12.00 mm, 11.33 mm, 12.33 mm and 10.67 mm respectively for 100% concentration of ethanolic leaf extract of *Cymbopogon citratus*. As the finding of this study indicates that both extracts were active against the test organisms. However, the ethanolic extract has superior effects against the test organism ^[19].

7.2. In-vivo and In-vitro repellent and insecticidal activity

An *in-vitro* study conducted in Ethiopian public health

institute by Negero Gameda *et al* 2014 to evaluate insecticidal activity of some traditionally used Ethiopian medicinal plants against sheep Ked *Melophagus ovinus* on naturally infected sheeps. From investigated different medicinal plants for their insecticidal activity against *M. ovinus* in this study is *Cymbopogon citratus*. The result showed that *Cymbopogon citratus* essential oil has pronounced insecticidal activity. As reported in this study, 100% mortalities were recorded by *Cymbopogon citratus* against *M. ovinus* within three hours of exposure at a concentration of 3.13 μ L/mL, as indicated during this study sheep ked mortality increased as concentration and exposure time to the essential oil increased [20]. Consequently, an *in-vivo* insecticidal activity of *Cymbopogon citratus* were evaluated at three different concentrations against sheep ked and the result showed that promising effect on various days of post treatment. The essential oil of *Cymbopogon citratus* at three different concentrations tested against sheep ked and therefore the result showed that promising Insecticidal activity against *M. ovinus* at lowest concentration on various days of post treatment. Different concentration of *Cymbopogon citratus* essential oils has a comparable effect of reducing *M. ovinus* parasite with standard Diazinon after 7, 14, 28 and 49 days post treatment of sheep. Compared to straightforward drug employed in this study, *Cymbopogon citratus* essential oil at a concentration of 0.3125% has lower toxic effects on *M. ovinus* parasite in sheep on 7, 21, 35, 42 and 56 days of post treatment [21]. An *in-vivo* study was conducted to see the repellent activity of essential oils of the *Cymbopogon citratus*, the result shows that the essential oil of this plant was highly repellent to adult sand flies, *P. duboscqi*. Thus, the essential oil was candidate natural repellent which will be used against *P. duboscqi* because of its high efficacy at very low dose. In general, the result of this study shows that the essential oils of *Cymbopogon citratus* at physiological doses have strong repellency against adult sandflies, *P. duboscqi* [22]. An *In-vivo* study finding from human trial on repellent and insecticidal activities of *Cymbopogon citratus* reports that, the test volunteers experienced a bite with 6ml of *Cymbopogon citratus* oil that's 4 hours and half-hour from start of experiment. Of 30 mosquito landing attempts/bites experienced during the study, 21(70%) were on the control subject; 8 (27%) on the volunteer with 2ml of oil and 1(3%) on the volunteer with 6ml of oil. As this study indicate that *Cymbopogon citratus* oil can repel mosquito for about 4 hours and 30minutes at high concentration [23].

7.3. *In-vivo* anti-inflammatory activity

An *in-vivo* approach study was conducted by Costa, G. F. F. D *et al.* (2016) to assess the anti-inflammatory effect of *Cymbopogon citratus* by carrageenan-induced rat paw edema assay. This experimental model is employed for determining the acute phase of the inflammation and its related to neutrophil infiltration, prostaglandins, and cytokines production. The result of this study reveals that *Cymbopogon citratus* essential oil and its flavonoids and tannins are able to reduce paw edema induced by carrageenan and the peripheral mechanism of pain. This indicates that the anti-inflammatory and analgesic effects of *Cymbopogon citratus* could also be associated with inhibition of the synthesis and release of various inflammatory mediators, as well as to its antioxidant activity. These all results from this study indicate that *Cymbopogon citratus* acts as an anti-inflammatory and peripheral analgesic agent, but doesn't exhibit intrinsic central analgesic activity. Therefore, it will be inferred that the observed analgesic effect of *Cymbopogon citratus* in this

study was likely associated with the inflammatory process, flavonoids and tannins having a significant contribution to these activities [24]. Consequently, Figueirinha, A *et al.* (2010) demonstrated that Nitrous oxide (NO), produced in large quantities by activated inflammatory cells, has been to be involved in the pathogenesis of acute and chronic inflammations. This study also has seen that effects of the infusion of dried leaves from three different concentrations against sheep ked and the result showed that promising effect on various days of post-treatment, moreover as its polyphenolic fractions on the NO production induced by lipopolysaccharide (LPS) in a skin-derived dendritic cell line (FSDC). *Cymbopogon citratus* infusion and its polyphenolic fractions significantly inhibited the LPS-induced NO production and inducible NO synthase (iNOS) protein expression [25]. Study results from Costa, G, *et al* (2016) suggest that *Cymbopogon citratus* and its polyphenols, contribute to the topical anti-inflammatory effect. These polyphenols may well be active constituents to integrate with a new anti-inflammatory agent, effective for the treatment of skin inflammatory-related pathologies [26].

7.4 Anticancer activity

The anticancer properties of *Cymbopogon citratus* have also been studied. Its particular oil may provide a solid defense against various cancers. Animal trials showed that direct injection of *Cymbopogon citratus* oil inhibit cancer tumors in a dose dependent way, meaning the upper the dose of the oil, the higher the end result. The results of this trial indicate that the oil has a promising anticancer activity and causes loss in tumor cell viability by activating the apoptotic process as identified by microscopy. As different studies found that *Cymbopogon citratus* have ability to prevent cervical cancer cells and for other various types of cancer cells from spreading, and also initiate cancer cell apoptosis, also called programmed cell death. As the authors concluded that all the results suggest *Cymbopogon citratus* oil and citral emulsion may be considered as potent candidates as anticancer agents [27].

7.5. An *in-vivo* antioxidant and cytoprotective properties

An *in-vivo* study reports from EL-Garawani, I.M. (2015) shows that *Cymbopogon citratus* leaves aqueous extract have cytoprotective and antioxidant properties. Hepatic oxidative stress and toxicity induced by cisplatin in albino rats can be alleviated by three different concentrations against sheep ked and the result showed that promising effect on various days of post treatment aqueous extract. A substantial attention is currently focuses on preventing genotoxic effects of anticancer drugs by using the antioxidants of natural origin. The results obtained from this study revealed that the powerful protection of *Cymbopogon citratus* extract against the whole DNA damage which has been induced by Cisplatin treatment high dose more than Cisplatin low dose due to its cytoprotective and antioxidant effect. Cisplatin exerts genotoxic effect by its ability to induce oxidative stress inside the cells. Beside this its cytotoxicity is believed due to its ability to bind DNA to form cisplatin–DNA adducts [28].

7.6. *In-vivo* gastrointestinal activity

An *in-vivo* experimental study administrated to assess the gastro-protective activity of an essential oil free infusion from *Cymbopogon citratus* dry leaves in acute gastric lesions experimentally induced by ethanol in rats, As the results of this study suggests that the polyphenol chemical composition

of the extract may contribute, a minimum of in part to the gastro-protective effects. Polyphenols have antiulcer activity probably due to their antioxidant properties, which could prevent the formation of free radicals within the body and also minimize injuries by oxidative reactions [29].

7.7. An *in-vivo* anti-diabetic activity

An experimental study was conducted by Abbas, AL *et al* 2018 on anti-diabetic activity of *Cymbopogon citratus* aqueous extract of roots, flowers and Glibenclamide on albino mice glucosein Dexamethasone induced hyperglycemia. It's been reported that the root extract of this plant has better anti-diabetic than flower extract. As this experimental study concluded that administration of root extract and flower of *Cymbopogon citratus* reduced the fasting and postprandial glucose levels, bringing them down towards normal, in dexamethasone induced hyperglycemia in albino mice. This reduction within the fasting and also the postprandial blood glucose levels with root and flower of *Cymbopogon citratus* was comparable to that of obtained with Glibenclamide [30].

7.8. Anti-fungal activity

A study report by Shah, G *et al* (2011) indicate that *Cymbopogon citratus* oil is active against dermatophytes like *Trichophyton mentagrophytes*, *T. rubrum*, *Epidermophyton floccosum* and *Microsporium gypseum* and is among the most active agents against human dermatophytes. As reported in this study *Cymbopogon citratus* oil is active against keratinophilic fungi, 32 ringworm fungi and food storage fungi. *Cymbopogon citratus* oil is additionally effective as an herbicide and as an insecticide because of these naturally occurring antimicrobial effects [31].

7.9. Effect of *Cymbopogon citratus* on blood glucose level and lipid profile

An *in-vivo* experimental study result from Adegbeji, J *et al* (2015) shows that administration of ethanolic and aqueous extracts of *Cymbopogon citratus* at a dose of 200 mg/kg body weight for a period of 30 days to the wistar albino rats caused a steady decrease in their blood glucose level. Consequently lipid Profile of rats for both ethanolic and aqueous extracts of *Cymbopogon citratus* was conducted in this study. The total cholesterol, Triglycerides, High density lipoprotein (HDL) and low density lipoprotein (LDL) levels of the ethanolic extracts were observed to be significantly lowered when compared to with the aqueous extract and the normal rats the results of this study also showed that the level of the LDL-Cholesterols in both ethanolic and aqueous extracts were significantly lowered when compared with the control group and the level of the HDL-Cholesterol in the treated groups. Thus, blood serum cholesterol level was found to be down regulated in this study. Generally this study concludes that cardiac glycosides from *Cymbopogon citratus* serve as defense mechanisms against cardiovascular disease and digestive problem [32].

8. Safety and toxicity

An experimental study was conducted by Ermias Lulekal *et al*, 2019 to assess acute and sub-acute toxicity of *Cymbopogon citratus* oil in mice. The finding of this study indicates that no acute and sub-acute toxicity attributable to *Cymbopogon citratus* essential oil oral administration at the dose of 2000 mg/k. Oral LD50 of *Cymbopogon citratus* essential oil was greater than 2000mg/kg [33].

9. Result

Based on the literature reviewed, citral is said as active natural agent presented in *Cymbopogon citratus* and it is responsible for most of its pharmacological activities as obtained from an *in-vitro* and *in-vivo* experimental study reports. It has been reported that the chemical composition of *Cymbopogon citratus* extracts varies according to the geographical origin, a part of the plant used, method of extraction (extracting solvents), age/stage of maturity, and season of harvest. As indicated in several studies, extraction may be a fundamental step within the medicinal plant's analysis, since it is essential to obtain and purify the required chemical constituents from the plant material for further characterization. Phytochemical screening tests are useful within the detection of pharmacological bioactive principles, and which may lead to in new drug discovery and designing. It has already found applications in the cosmetic and perfumery industries because of its strong fragrance. As observed in several studies *Cymbopogon citratus* popularly employed in folk medicine and is typically prepared from the fresh herbs within the method of infusions and decoctions, also the dried leaves of *Cymbopogon citratus* could be given mostly in a variety of tea in the majority of the continents for a large range of indications.

10. Conclusions and recommendations

In conclusion, medicinal plants are very important to human beings in preserving health. The utilization of plants for medicine can be dated back to the history of man. A major number of world populations still depend on herbs for their primary health care need; about 80% of the populations in rural areas in many developing countries rely on traditional medicine. There is a growing interest within the pharmacological evaluation of varied plants utilized in different countries in their traditional system of drugs. *Cymbopogon citratus* is one of the important oil bearing plants of everywhere in the globe and it's an excellent interest because of its commercially valuable essential oils and widely employed in food technology likewise as in traditional medicine. The chemical composition of the essential oils, showed the key compounds which are responsible for its antifungal, antimicrobial, antioxidant, anti-diabetic, anticancer and lots of other pharmacological activities of *Cymbopogon citratus*. According to several study findings, citral is related as active natural agent presented in *Cymbopogon citratus* and accountable for most of its pharmacological activities. Various information detailed in this review on the traditional use, phytochemistry and pharmacology of *Cymbopogon citratus* make it a good candidate for further scientific experiments in other fields like agronomy, food industries, cosmetics industries, and pharmaceuticals. Owing to the new attraction for natural products obtained from *Cymbopogon citratus* extensive phytochemical and Pharmacological study is required, which are helpful for clinical experimentation and also in the discovery of novel drugs. Thus, further investigations should be carried out to boost the knowledge of its efficacy and toxicological studies in validating this traditional use.

11. Conflict of Interest

There is no conflict of interest's regarding the publication of this paper

12. References

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