



ORIGINAL REVIEW PAPER

Ayurveda

A REVIEW PAPER BASED UPON AYURVEDIC AND MODERN USES OF LEMONGRASS (CYMBOPOGEN CITRATUS)

KEY WORDS: Citratus, Lemongrass, Rasayana, Antiplatelet, Geraniol.

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ABSTRACT

The custom of using plants for therapeutic and dietary practices is as old as the origin of humanity on the earth. One of the most ancient plant is the Cymbopogon citratus which belongs to the Poaceae family. The plant has a very rich ethnic history of its utilization around the world. The plant was utilized to treat several ailments by folks. It is a well-considered plant remedy used in the treatment of many diseases in a traditional system like Ayurveda and Folk system of medicine. In Ayurveda, it is used as a Rasayana in many Ayurvedic polyherbal formulations for curing many diseases. The plant consists of numerous phytochemical constituents in it such as citral, cellulose, hemicellulose, lignin, nerol geraniol, citronellal, terpinolene, geranyl acetate, myrecene and terpinol methylheptenone, etc. Each phytochemical constituent is associated with important therapeutic properties like anti-microbial, hepatoprotective, cardioprotective, antidiabetic, anticancer, antihypertensive, antidiuretic, etc. The present review aims to provide information related to phytochemistry, traditional uses in ayurveda and folk medicinal system and therapeutic properties of Cymbopogon citratus.

INTRODUCTION:

Lemongrass is obtained from rhizomes of the plant *Cymbopogon citratus*, a member of the Poaceae family. *Cymbopogon* is a genus of about 55 species of grasses and different *Cymbopogon* viz, *C. bombycinus*, *C. ambiguus*, *C. oblectus*, *C. refractus*, *C. citratus*, *C. nardus*, *C. schoenanthus*, *C. flexuosus*, *C. winterianus*, etc. which are found in different countries like Australia, China, Africa, India, Java and others. The name *Cymbopogon* is derived from the Greek words "Kymbe" (boat) and "pogon" (beard), referring to the flower spike arrangement. *Cymbopogon citratus* is a tufted perennial grass growing to a height of 2.5 meters with numerous stiff leafy stems arising from short rhizomatous roots [1]. It is an aromatic grass that gives essential oil upon steam distillation. The compounds identified in *Cymbopogon citratus* plant are mainly terpenes, alcohols, ketones, aldehyde and esters. Some of the reported phytoconstituents are essential oils that contain citral □, citral □, nerol geraniol, citronellal, terpinolene, geranyl acetate, myrecene and terpinol methylheptenone [2]. Lemongrass is so named for its distinctive citrus aroma of the green leaves [3]. It is also known as 'Squinant' or 'Citronella' in English, as well as other names around the world [4]. Initially, lemongrass was used to flavor foods in Thai and Vietnamese cooking. It has beneficial use in African and South American regions for flavoring tea and also popular in alcoholic and non-alcoholic drinks. Additionally, it has conventional uses in Ayurveda as a tranquilizer, diuretic, antipyretic and anti-inflammatory medicine [5]. The cultivation of lemongrass offers a profitable source of earning, as each hectare of land produces a net profit of approximately 300 USD per annum to the growers [6]. The pleasant lemon fragrance of this grass has long been used in perfumery and food industries [7]. In addition, several pharmacological activities of lemongrass were reported over the years, including antibacterial, antifungal, antiprotozoal, anti-inflammatory, antioxidant, antitussive, antiseptic, anti-carcinogenic, cardio-protective and anti-rheumatic, etc. [8]. In this review, the pharmacological properties and applications of lemongrass in various medication systems like folk, ayurvedic and modern with recent reported studies are summarized. The taxonomical classification and vernacular names of lemongrass are shown in table no. 1 and table no. 2 respectively.

Table 1: Taxonomical classification of *Cymbopogon citratus*

Taxonomical Rank	Taxon
Kingdom	Plantae
Division	Magnoliophyta
Class	Liliopsida
Order	Poales

Family	Poaceae
Genus	Cymbopogon Spreng
Species	Citratus

Table 2: Vernacular names of *Cymbopogon citratus*

Brazil	Capim-cidrao, Capim-santo
Egypt	Lemon grass
English	Lemongrass, Citronella, Squinant
Ethiopia	Tej-sar
Hindi	Sera, Verveine
Indonesian	Sereh
Italian	Cimbopogone
Malaysia	Sakumau
Mexico	Zacate limon
Swedish	Citrongrass
Thailand	Ta-khrai
Turkish	Limon out
USA	Citronella

BOTANICAL DESCRIPTION OF CYMBOPOGON CITRATUS

Lemongrass is equally versatile in the garden. This tropical grass grows in dense clumps that can grow to 6 ft. (1.8 m) in height and about 4 ft. (1.2 m) in width, with a short rhizome and leaves, appear from the soil directly without any stem. The leaves (Figure 1) are 1.3-2.5 cm in width and around 1 m in length. Leaves are not basally aggregated; non-articulate. The leaf blade is linear, tapered at both ends and can grow to a length of 50 cm and width of 1.5cm. The leaf-sheath is tubular in shape and acts as a pseudostem. Leaves are long glaucous, green, linear tapering upwards and along the margins. This plant produces flowers at matured stages of growth which are bisexual in nature. Lemongrass plants do not typically produce flowers, or flowering panicles are rarely formed [9].



Figure 1: *Cymbopogon citratus* (Lemongrass)

GEOGRAPHICAL DISTRIBUTION OF CYMBOPOGON CITRATUS

Cymbopogon citratus plant is widely found in tropical and subtropical areas of the Indian subcontinent, South America, North America, Africa, Australia and Europe [10]. Lemongrass is cultivated over an area of 16000 ha throughout the world which generates around 1000 t of essential oil per year. The plant is cultivated mostly on infertile and wastelands [11].

PHYTOCHEMICAL CONSTITUENTS OF CYMBOPOGON CITRATUS

The chemical constituents of the lemongrass plant are cellulose, hemicellulose, lignin, ash, and moisture. Structurally, lemongrass is a hydrocarbon mainly composed of carbon and oxygen [12-13]. Cellulose is a three-dimensional linear molecule structure, which includes both crystalline and amorphous regions, whereas hemicellulose consists of a mainly amorphous region with several crystalline regions. Another basic difference between cellulose and hemicellulose is the degree of polymerization, which can be 100-10000 for cellulose and less than 200 for hemicellulose [14]. Lignin is an amorphous heterogeneous three-dimensional nonlinear polymer which binds cellulosic components together [15]. Cellulose is made up of 1,4 β -glucopyranose units, hemicellulose comprises xylose, galactose, arabinose and mannose sub units and lignin consists mainly guaiacyl, syringyl and p-hydroxyphenyl units [16]. Furthermore, there is a variety of oil content found in lemongrass depending upon the genetics, area of growth, culture and agronomic treatment. Generally, the essential oil is collected around 1-2% of the total dry weight [17]. However, the method of drying can influence the composition. Oven drying of the leaves can produce a greater amount of essential oil than sun-drying or shade-drying methods, although the oil collected from the shade drying has a higher citral content. Citral is comprised of mainly two stereoisomeric mono-terpene aldehydes i.e. geranial and neral, transcitral and cis-citral. In general, lemongrass oil contains 45% of citral, but the amount can vary widely among species. The East India Lemongrass commonly possesses around 30-94% of citral [18-20]. Many hydrocarbons such as terpenes, alcohols, ketones and esters were reported in the composition of essential oil [21-22]. The phytochemical composition of *C. citratus* also includes tannins, saponins, anthraquinones, phenols, flavonoids and alkaloids. In addition, myrcene, geraniol, borneol, citronellol, limonene, α -terpineol, elemicin, nerol, catechol, luteolin, apigenin, quercetin, Kaempferol, glycosides, chlorogenic acid, caffeic acid, geranyl acetate as well as methylheptanone, isovaleric aldehyde, fumesol, L- linalool, furfural, isopulegol, n-decyclic aldehyde, p-coumaric acid, terpinene are also evident in trace amount in several studies [23-25]. Different minerals are also present including potassium (54.02%), calcium (25.87%), silica (9.02%), phosphorus (1.57%). It also possesses vitamins A, C and E and folate, niacin, pyridoxine, riboflavin as well as protein, carbohydrates and fat [26-27]. The structure of some major phytochemicals of *Cymbopogon citratus* are shown in fig.2.

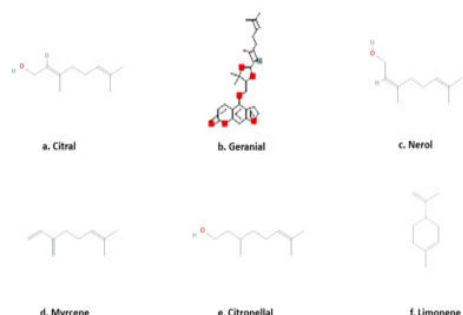


Figure 2: The structure of major phytochemicals of *Cymbopogon Citratus*

TRADITIONAL AND MODERN VIEW

a. FOLK VIEW: Traditional applications of *Cymbopogon citratus* in different countries shows high applicability as a common tea, medicinal supplement, insect repellent, insecticide, in flu control and as anti-inflammatory and analgesic. It is utilized in Nigeria for stomachache, malaria therapy, insect repellent and as an antioxidant [28]. *Cymbopogon* species are the prevailing species in Eastern and Western India and have been used locally in cosmetics, insecticides and for the treatment of digestive disorders and fevers [29-30]. The species was utilized as antiseptics, antimalarial condiments, diuretics and also to cure rheumatism by the folks of the Middle East [31-33]. The high amounts of volatile compounds from these species are responsible for their diverse uses. Table no. 3 shows *Cymbopogon citratus* folk uses, their relevance and how they applied. Though there are limited scientific data on the medical claims of lemongrass, it has been used in traditional medicine for the treatment of several ailments [34]. The infusion or decoction of aerial parts of lemongrass has widespread used in folk medicine [35].

Table 3: Ethanomedicinal Uses of *Cymbopogon citratus*

Region	Used Part	Ethanomedicinal Uses	References
India	Aerial	Fever, Digestive Disorder	[29]
Nigeria	Leaves	Diabetes, inflammation and nerve disorders	[28]
Argentina	Leaves	Against cold and flu, and digestive complaints stomach upsets and as decoction with other plant for malaria	[36]
Cuba	Leaves	Upsets and as decoction with other plants for malaria	[37]
Costa Rica	Leaves	To relieve cough, carminative, expectorant and depurative	[38]
Colombia	Rhizome	It is chewed and used as toothbrush and for pest control	[39-40]
Brazil	Leaves	Anxiolytic and anti-hypertensive	[41]
Trinidad and Tobago	Grass and Rhizomes	Utilized to treat cold, flu, fever and diabetes	[41]

b. AYURVEDIC VIEW: Lemongrass is an aromatic ayurvedic herb which is utilized to treat gastrointestinal problem, vomiting, ringworm, fever, worm infestation, asthma, cough, rheumatic pain, fungal infection, etc. It is also considered an anaphrodisiac and nerve tonic. The oil content of lemongrass is used to improve digestion, relieve nausea, menstruation problems, headaches. Its external application relieves muscle cramps, spasms, rheumatic pains, athlete's foot, ringworm, lice, scabies [42-43]. In Ayurveda, sage Charka has mentioned Lemongrass under 'Haritakyadi varga' (Haritaki subdivision) and Sushrut has mentioned it under 'Shak Varga' (Vegetable subdivision) and called as jambir. In old times, lemongrass was given to stop vomiting in diseases like Cholera and patient feels rejuvenation in the body after taking lemongrass tea. The ayurvedic qualities of Lemongrass are mentioned in table no. 4 below:

Table 4: Rasa Panchak (physiochemical properties/ qualities) of Lemongrass

Sanskrit/English	Sanskrit/English
Rasa/Taste	Katu, Tikta/ Pungent, Bitter
Virya/Potency	Ushana/Hot
Guna/Qualities	Tikshna, Laghu, Ruksha/ Sharp, Light, Dry

Karma (therapeutic actions) of Lemongrass (Sharban): It has three main actions i.e. Vidahi (causes burning sensation), Anetram (not good for eyes), and Avrishya (Anaphrodisiac). There are many therapeutic uses of lemongrass mentioned in ayurveda.

Rochana- it helps to improve the taste.
 Mukhashodanam: cleansing the oral cavity.
 Bahuvitkancha: detoxifying the body.
 Krimi: Kill worms and bacteria's.
 Shwasa: Helpful in respiratory disorders.
 Santapanashana: Mentioned the hemostasis in body.
 Bhutagrahavasha- Useful in psychiatric disorders.

c. Modern View: There are many applications of lemongrass in different fields. Herbal medicines are primarily known for their negligible adverse impacts and least toxicity than allopathic medicine. But over the past years, some deliberate practices have been noticed which are majorly responsible for the gradual fall in the quality of herbal products for example adulteration, contamination, etc. [44]. Hence, lemongrass is also used in many modern formulations. The antimicrobial activity of essential oil of lemongrass was utilized for food preservation. From a reported study it was found that essential oil induces cytoplasmic coagulation which includes spheroplast formation as well as preventing septum formation [45]. It was also found effective in preserving processed foods like yogurt [46]. Although lemongrass has a potential feature to become a bio preservative for food storage, lemongrass is a natural flavor complex (NFC). The essential oil of lemongrass is also used commercially, in palmarosa oil, perfume material and aroma soaps [47-48]. There are several lemongrass products available in the cosmetic field with patented formulas in combination with lemon balm oil and glycerol [49].

REPORTED THERAPEUTIC USES AND PHARMACOLOGICAL ACTIVITIES OF *C. CITRATUS* (LEMONGRASS)

C. citratus (Lemongrass) is associated with many important therapeutic properties. Numerous applications of lemongrass and its essential oil are evident all over the world. Lemongrass tea extracts were reported to be taken as an antipyretic, antispasmodic, sedative, diuretic, anti-inflammatory and analgesic compound [50]. It is also used to treat sore throats and nausea to increase the menstrual flow [51-52]. Some of the reported studies on therapeutic properties are discussed below:

Antifungal Activity: Wannissorn et al., reported antifungal activity of *C. citrate* an experiment on Minimum Inhibitory Concentration (MIC) and Minimum Lethal Concentration (MLC) test strains. The highest MIC and MLC was showed by *microsporum gypseum*, which was followed by *Trychophyton rubrum* and *Epidermophyton floccosum*, respectively. This study revealed that citral act as fungicidal agent and possesses antifungal activity [53].

Antidiabetic Activity: Andrade et al., reported the antidiabetic effect of water and butanolic extracts of leaves of *C. citratus* in streptozotocin induced diabetic rats. The finding revealed that isoorientin and chlorogenic acid component present in the extract of *C. citratus* have hypoglycemic effects in diabetic rats [54].

Anticancer Activity: Puatanachokchai et al., reported anticancer activity of the lemongrass extract (LGE) in male Fischer 344 rats. Diethylnitrosamine (DEN) was administered intraperitoneally for 3 weeks at the doses of 100mg/kg body weight and partially hepatectomized at the end of the 5 week. After that, Lemongrass extract (LGE) was given at dietary concentrations of 0, 0.2, 0.6 or 1.8% for 6 weeks. The finding revealed inhibitory effects of LGE on the early phase hepatocarcinogenesis in rats [55].

Antioxidant Activity: Patel et al., evaluated the antioxidant property of dry *C. citratus*(lemongrass) which contains more phenol and flavonoids than the fresh one [56]. Lu et al., reported antioxidant activity of chloroform extract of *Cymbopogon citratus*. Three different methods were used to test the antioxidant activity, including FRAP assay (Ferric reducing antioxidant potential), DPPH radical scavenging assay (1,1-diphenyl-2-picryl hydrazyl radical reducing power methods), and β -carotene bleaching assay. *Cymbopogon citratus* showed low radical scavenging activities compared to ascorbic acid, gallic acid and quercetin. The results obtained suggest that *Cymbopogon citratus* is a source of antioxidants [57].

Antimicrobial Activity: Nkambule et al., reported the antimicrobial activity of acetone and hexane extract of stem of *C. citratus* against *Staphylococcus aureus* strains. The result showed that oven-dried extract of lemongrass stem has a greater antimicrobial effect than that of freeze-dried extracts [58]. Jafari et al., reported the antibacterial activity of methanol extract of the plant leaf essential oil of *C. citratus* against *staphylococcus aureus*, *Bacillus cereus* and *E. coli*. The study revealed that there was no inhibitory effect on the growth of *pseudomonas aeruginosa* [59].

Antihypertensive Activity: The reported clinical study was conducted by Ray et al., in the 31 hypertensive individuals in Barangay Situbo for 16 weeks to evaluate the effect of lemongrass decoction. Average arterial pressure was improved with the consumption of decoction of lemon grass two times a day. A significant effect was found on the mean arterial pressure of the patient with hypertension [60].

Cardioprotective Activity: Gayathri et al., reported the cardioprotective effect of *C. citratus* in isoproterenol-induced male wistar albino rats. It was found that administration of lemongrass decreased the toxic level of lipid peroxidation (TBARS) in both heart tissue and serum, by increasing the level of enzymatic antioxidants and non-enzymatic antioxidants in the rats [61]. Seth et al., reported the cardioprotective activity of essential oil of *C. citratus* in the rat model. A significant effect of essential oil of lemongrass was found on pain sensitivity, behavior, hormone releases and neurotransmitter signaling [62-63].

Antiplatelet Activity: Tognolini et al., reported antiplatelet activity of the essential oil extract of different plants (*Anthemis nobilis* L, *Artemisia dracunculus* L., *Cannabis sativa* L., *Cupressus sempervirens* L., *Curcuma longa* L., *Foeniculum vulgare* L., *Hypericum perforatum* L., *Hyssopus officinalis* L., *Mentha spicata* L., *Monarda didyma* L., *Ocimum basilicum* L., *Ocotea quixos* Kosterm., *Origanum vulgare* L., *P. nigra* J.F. Arnold, *Pinus silvestris* L., *Piper crassinervium* Kunth., *Rosmarinus officinalis* L., *Salvia officinalis* L., *Salvia sclarea* L., *Santolina chamaecyparissus* L., *Thymus vulgaris* L., *Zingiber officinale* L) including *C. citratus* in guinea pigs and rats. The finding revealed significant antiplatelet activity of the oil extract of different plants in the animal model [64].

CONCLUSION: The present study is an attempt to provide detailed information about the ancient medicinal and commercial plant, *Cymbopogon citratus*. The reported pharmacological studies indicated that this plant has extraordinary biological potential. It is strongly believed that the present review on the phytochemical value of *Cymbopogon citratus*, might draw the attention of researchers to use this plant in modern medicines. The plant has various functions in various fields. *Cymbopogon* oil obtained from the leaves, stems and roots, which is extensively used in perfumery industries. This plant has greater medicinal value. From the present review, it can be concluded that plants are a promising source of anti-microbial and antioxidant compounds.

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