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Lemongrass a Wonder Herb of Poaceae Family: An Overview

Spriha, Rattandeep Singh and Anupam Kumar*
Department of Biotechnology, School of Bioengineering and Bio Sciences,
Lovely Professional University, Phagwara, Punjab, India.

(Corresponding author: Anupam Kumar)*
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ABSTRACT: Lemongrass is a native high-flowering aromatic plant of a family: Poaceae, grown in many tropical and subsoil regions of south-eastern Asia and Africa. In India, many lemongrass species are grown and cultivated in the warm, mild, wettest conditions at elevations altitude under 750 m. With average annual temperatures of between 23°C to 30°C and average annual precipitation between 2500 and 3000 mm *Cymbopogon citratus* produces the best. Lemongrass is an herb, it's leaves and oil are used for the treatment of bowel spasms, chest pain, higher blood pressure, epilepsy, dysentery, cough, knee achy (rheumatism), flu, common cold, and tiredness. The chemical composition of essential oils (EOs) as a signature properties of a plant and it's physiological conditions. Various environmental factors also play a critical role in the standardization of EOs. The cultivation of medicinal and aromatic vegetation (MAP) using bio-elicitors has been recommended as a real device to sustainably guarantee a higher amount and reasonable amount of EOs. The present review highlights the overall properties and applications of Lemongrass. The strong lemon fragrance in its oil is a dominant characteristic of this herb. The refining of the oil is suitable for use in soap, detergents, and fragrances. It also has various pharmaceutical applications. Whereas there is a wide range of ethno pharmacological uses for lemongrass also reported. In addition to nutrients such as fats, protein, fiber, and mineral products, there are several bioactive compounds in lemongrass, grouped into terpenoids, tannins, saponins, flavonoids, phenols.

Keywords: Lemongrass, Micropropagation, Anti cancerous, Anti-rheumatism.

INTRODUCTION

Lemongrass is a tropical and sub-tropical aromatic high sedge that is grown in Southeast Asia and Africa. It is grown in the West Ghats (Maharashtra, Kerala), Karnataka, and Tamil Nadu, as well as the foothills of Arunachal Pradesh and Sikkim, in India. It was first introduced in India over a century ago and is now widely used in the region. Lemongrass is high and enduring sedge which throws a short rhizome into dense fascicles. The top is upright and stout, up to 1.8 m long. Blades are long, grass green, flat, up and around the edges; ligule is very short; sheaths are terete; sheaths are wider and clasp closely at the base, sheaths of the barren shoots are thick and separating. It is a large flowering plant for short days in the South of India. The inflorescence is about a meter-long spike. Flowers are borne on decompound spathulate; 30 to more than 60 cm long panicles (Haque *et al.*, 2018).

Table 1: Botanical classification of lemongrass (Nambiar *et al.*, 2012).

Kingdom	Plantae
Order	Poales
Family	Poaceae
Subfamily	Panicoideae
Tribe	Andropogoneae
Subtribe	Andropogoninae
Genus	*Cymbopogon*

Fig. 1. Lemongrass plant (Inflorescence, leaf, stem, and root).

The genus *Cymbopogon*, also known as lemongrass, contains more than 50 native grass species from tropical Asia and Southern India. The best-known cultivated variety is ornamental lemongrass (*Cymbopogon citratus*), which is widely used in Cambodian, Vietnamese, and Thai cuisines. This lemon-scented plant adds flavor to soups, curries, teas, and other beverages (Majewska *et al.*, 2019). Other than cooking, Lemongrass oil is also used in Ayurvedic, Aromatherapy, cosmetic, and perfume industries. The dominant feature of this grass is its high citrus content in its oil, which gives it a heavy lemon scent. The oil's redolence allows it to be used in soaps, detergents, and other products. The raw material used to make ionone, which is used to make vitamin A is also used (Viabhav *et al.*, 2013). Lemongrass includes multiple bioactive compounds which give it medicinal value. For its ethnopharmacological applications considerable evidence is available. Herbal medicine is regarded as an important part of the healthcare industry by more than two-thirds of the population in developing countries, according to the WHO (Okemy *et al.*, 2015). It is a persistent inflammatory circumstance, characterized via airway hyperresponsiveness to a variety of stimuli in large part of allergic origin with reversible airflow downside. The maximum crucial medical capabilities of asthma are wheezing, shortness of breath, and cough; Symptoms arise or get worse at night, awakening the affected person (Sisay *et al*., 2020).

Botanical description

In the garden, lemongrass is just a versatile grass. It grows in dense clumps with short rhizomes, up to 6 ft (1.8 m), 4 ft (1.2 m) widened. In Table 1 description family details have shown and fig 1 various parts of plants are mentioned.

Leaves

Bands like leaves are about 3 ft wide and have a good drop of tips. The leaves are 0.5-1 inchlong. Bluish-green and evergreen leaves emit a citrus aroma when crushed (Alzawqari, M. H., *et al*., 2016).

Leaf arrangement: The majority of the leaves emerge from the soil without a stem.
Leaf type: simple
Leaf margin: entire
Leaf shape: linear
Leaf venation: parallel
Leaf type and persistence: fragrant
Leaf blade length: 18 to 36 inches
Leaf color: green
Fall characteristic: showy

Flowers

Lemongrass is a cultivar and typically doesn't produce flowers or flowering panicles (Ross, 1999).

Inflorescence

The inflorescence reaches a length of 30 to 60 cm. Partially inflorescences are paired with spikes that have been subdued by spates.

Microscopy of leaf

In cross-sections of lemongrass blades and sheaths, only isolated single cells stain with a ship's reagent. These cells are richly red-stained, indicating the presence of the main components of essential oil lemongrass, most probably geranial and neral, aldehydes. The oil cells are parenchymatic cells that occur often adjacent to non-photosynthetic tissue and are embedded between the vascular bundles of that C4 grass on the adaxial side of the Mesophyll leaf. Sheaths of leaves also contain oil cells similarly stained. The oil cells are morphically inseparable from their nearby parenchymal cells both in sheaths and blades, with the exception that they contain the material secreted. Furthermore, the walls of the oil cells show that phloroglucinol-HCl is extremely fluorescent, with high levels of lignification (Ross, 1999).

SPECIES AND VARIETIES

Various species of lemongrass have been reported around the world, some important species are dealt with in this review and some are shown in Fig. 2.

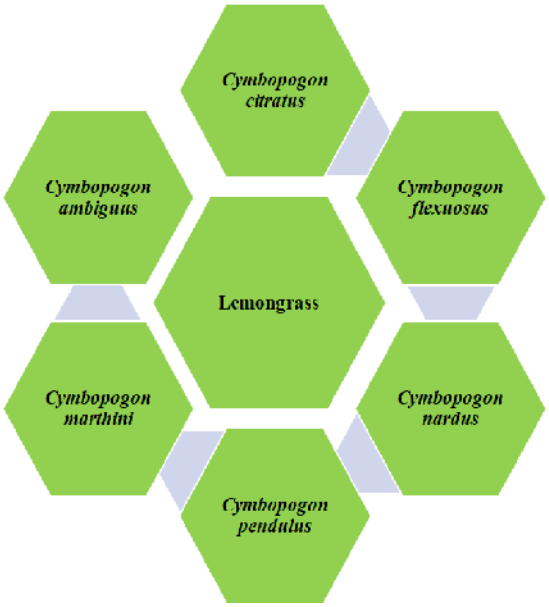

Fig. 2. Common species of Lemongrass.

Flexuous cymbopogon

It is called East Indian grass, Cochin, or Malabar grass. The *Flexuous* is an approximately 2 m high tufted firm, perennial grass, linear and lanceolate are the leaves,it blossoms easily. The inflorescence is wide and trendy at the end, with panicles paired with spikes on tertiary branches. Spikes in pairs, one sessile and the other pedicellate, are mounted on the tops. Like the pedicellate, the sessile spikelet is a bisexual floret with a consistent flora.Two species or styles are determined by the color of the stem according to this species (Battaglia *et al*., 2019).

Cymbopogon. flexuous

The sheath is reddish or purple, with stem and leaves and it is considered as red grass. It's known as the real lemongrass and is grown commercially. More than 75 to 80 percent of the essentials are citrus, which highly soluble in alcohol and thus are superior inconsistency (Patra *et al.*, 2018). Limonin fragrance and taste with

warm, gingery tones are presented in the Eastern Indian lemongrass, also known as Malabar grass. This species, which is permanent in USDA zones 9 to 11, is well-drained by full sun, heat, high organic loam. East Indian lemongrass needs more space in the garden, but in colder weather, it can also be planted every year in large containers. This type makes a very attractive hedge or frontier wine because it produces high violet heads of seed. East India is frequently cultivated on hills to reduce soil erosion. (IKEDA *et al.,* 1962).

C. albescenes

Typically, the white grass is characterized by the white color of the trunk. The essential oil contains below 65-70% citrus fruit and is poorly soluble in alcohol and therefore of lower quality.

C. citratus

It is named U.S Lemongrass or West Indian lemongrass. It is a perennial, stemless, green made of broad tussocks and with many steep tillers that arise from the rhizomatous rootstock. It rarely develops into flower, the blade is narrow, the blade is linear, it is gluttonous, drooping at a grotesque margin while the truncate ligules, inflorescence uncommon in this species. This essential oil is made from 74-76 percent citrus fruits and is badly soluble in alcohol. Because of its good adsorbent properties of a cellulosic substance, the lemongrass of good organic properties such as antimicrobials, antioxidants, etc. was widely used in cosmetics, food conservation, and agriculture. *C. citratus* (lemongrass) is biomass with approximately 40% cellulose and 23% hemicellulose. *C. citratus* may also increase its applicability in dye adsorption by offering good anti-fungal and antibacterial properties (Fokom *et al.,* 2019).

Cymbopogon pendulus

It is white and dwarf-like, popularly known as Jammu lemongrass. The plant is resistant to frosts and ideal for the North India Sub-Himalayan regions (Joy et al. 2006).The essential oil contains approximately 75% to 80% citrus fruit(Pandey *et al.,* 2019).

Lemongrass species

In America, ornamental lemongrass is also known as oil grass and western Indian lemongrass. Farm resistance zones 10 to 11 of the Department of Agriculture. The roots of USDA Zone 8 are always resistant, and the plant can sleep with a harsh freeze and begin development in the next season. Lemongrass forms thick clumps with long, arching, and light-green trunks, usually up to 3 feet wide and up to 6 feet high. The plant tolerates shade and is not fussy about a form of soil, but in maximum sunshine with loamy and well-drained soil. In spring and summer, break the clumps (Dos *et al*., 2019).

Citronella

The type of lemongrass from which citronella oil is made is C*ymbopogon nardus* and known as the mana grass and nard grass. This oil is widely regarded as an insect repellent but is also used in the manufacturing of perfumes and cosmetics. In USDA zones of 10-12 Citronella is perennial, but rainy winters cannot ever be relied on (Galadima *et al.,* 2020). Divided and replanted clumps increase the chances of growth in late summer or early fall, in particular, if those divisions are kept indoor to the next spring. *Lemonella cymbopogon* comes from Java Citronella Island of Indonesia. It often develops in compact, thick clumps and produces large arching branches, which are yellow or reddish-purple. Sandy, dry loam with a pH of 5.8 to 8.0 needs a lot of humidity and sunlight and is the best cultivated. Sustainable seeds, like many lemongrasses, allow the division of clumps the easiest way to spread. The plant is permanently cultivated in colder areas within USDA Zones 9 to 11 and annually (Pontes *et al.,* 2019).

Lemongrass species of East India

The Asian continent with its climate variations is one of the leading producers in parts of Asia, Africa, and America for its essential oil lemongrass (*C. citratus*) a perennial plant with long, fine leaves. Lemongrass (*C. citratus*) contain lemon leaves and have a traditional hard taste to their key substance, citrus, and are very important for the industry. These traditional methods may, however, cause individual fragrance constituents to degrade, to become hydrolysis, and to solubilize water (Diop *et al.,* 2017). Various forms of lemongrass have been shown to absorb different metal ions and teint from aqueous solutions, including powder, ash, and waste oil. Only an individual article regarding lemongrass paint adsorption reported that lemongrass painting ash is an effective adsorbent for methylene blue adsorption from lemongrass wastewater in membranes as a color absorbing agent for studying the properties of paint adsorption, as well as for resolving the problem of lemongrass powder or ash. The use of plant extracts is a competing part of the market including drugs, food, cosmetics, and perfumery (Majewska *et al.,* 2019). In Table 2 various varieties of lemongrass are depicted.

CHEMICAL COMPOSITION

The chemical composition of various *Cymbopogon* species essential oils, as well as their multiple plant components. The analysis on *C. citratus* only showed citrus is a major component of essential plant oil. Progressively, a technique has been established for this experiment, and the scientists will now sophisticate their study. The primary and traces are the essential oils of *C. citratus* (Viturro *et al.,* 1998, Diop *et al*., 2017). In Table 3 the chemical composition of lemongrass is shown.

Table 2: Improved varieties of east India lemongrass.

Varieties	Description
Sugandhi	▪ It adapts to a large variety of climatic and soil conditions. ▪ A red-stemmed variety with a 1 to 1.75 cm plant height and a lot of tillering. ▪ Under rain-fed conditions, the oil yield ranges from 40 to 50 kg per hectare, with 85-88 percent of total citral grown (with lifesaving irrigation).
Pragathi	▪ It is a tall-growing variety with dark green leaves sheath that is ideal for the subtropical and tropical climates of the north Indian plains and Tarai belt, with an average oil content of 0.63 percent and 85-90 percent citral.
Praman	▪ *C. pendulus* is a medium-sized variety with erect leaves and abundant tillering that evolved through clonal selection. Citric oil yields are high, at 82 percent
Jama rosa	▪ 0.4 percent oil (FWB) containing crude is used to produce approximately 35 tonnes of herb per hectare. In 4-5 reductions of 16-18 months, up to 300 kg of oils are made.
RRL.16	▪ It produces 15-20 tonnes of grass/hectare per annum, which gives 100-110 kg of oil. The fresh weight value is varying from 0.6 to 0.8 % of 80% citrus.
CKP.25	▪ *C. pendulus* hybrid. States 60 t/ha of posture irrigated at North Indian plains and the oil has a citrus content of 82.85 percent.
Other varieties	▪ OD- 408, Kaver ▪ The collection of white stems from the is OD-408 which reflects an increase in oil which citrus fruits. ▪ To produce luxurious growth, Kaveri requires high soil humidity and develops for stretches of the river valley

Table 3: Lemongrass chemical composition.

S. No.	Components	Percent of Oil	
1	Terpene	20–70	Langan *et al.*, 2017, Diop *et al.*, 2017, TA Tran *et al.*, 2018, Olayemi *et al.*, 2017, Premathilake *et al.*, 2018, Boeira *et al.*, 2020, Bhatt *et al.*, 2019, Markovic *et al.*, 2018, Bonferroni *et al.*, 2017
2	Tetaraniol	20–24	
3	Cihronellular	30–40	
4	Ci-Malic	0.0–3.5	
5	Geraniol	0.0–22.5	
6	β-pinene	3.5	
7	Gel-terpine	7.5	
8	Jwarankusa	20 – 6	
9	Terpene-piperitone	20 – 6	
10	Citral α	40.8	
11	Citral β	32	
12	Nerol	4.18	
13	Methylheptenone	0.2	
14	Borneol	0.1-0.4	
15	Nerol	4.18	
16	Geraniol	3.04	
17	Citronellal	2.10	
18	Geranyl acetate	0.83	
19	Myrecene	0.72	
20	Terpinol	0.45	
21	Linalyl acetate	0.1	

Traces - alloaromadendrenes, α-bisaboles, β-bisabolens, borneoli, d-cadinens, calamins, campheses, camphires, β-caryophillene oxides, α-chamigrenes, β-caryophylene oxides; α-cubebine, cuprene, o-cymen, 1.8-cineole, citronellol; 5.6-dimethyl-5-norborne-2-ol. β-element, d-element, elemi; d-element, d-element; Carvone in the European Union, Eudemon, Fernone, geranyl, geranyl acetate, geranyl formate, geranyl propionate, germacrene, α-farnesene, ßen-farnesene, fenchone, geranyl acetate. Iso-borneol, α-humulene; Spirit cassock, lavender, linalool. Cis and α-p-mentha-2, p-mentha-2, 8-dien-1-ol, methyl thymol ether, α-murolen, myrtenal, phellandrene, myrtenal, alpha-pineol;, α-pineol;, β-thuj,-2,-en-4-ol; verbenone; and β-ylangen. α-pineol, and cis-peperitol. The main leaves components of *C. citratus.* The proportion of geraniol and geranyl acetate differs markedly throughout the

growth of the leaf. Geraniol and geranyl acetate were respectively ~59% and ~33% in the simple oil on day 10 after the leaf emergence. The key ingredients of essential oil are just two components, such as Piperidone 54,36% and Phellandrene 30,86%. *C. citratus* Base oil contains saponins, tannins, quinines of anthrax, alcohol, phenols, and flavonoids. Citrates terpenes, alcohols, ketones, aldehyde, and esters were the main compounds in essential oils. Citral alpha, citral β, geraniol, nerol, citronellal, geranin acetate, terpinolen, myrcene and terpinole are the essential oils of luteolin: orientin 2-O-rhamnoside, quercetine, kaempferole and apigenin (Majewska *et al.*, 2019). In table 4 minerals and vitamins of lemongrass are depicted

.Table 4: Mineral/Vitamin Content of Lemongrass.

S.No.	Mineral/ vitamin	Quantity (mg/100g)	References
1	Na	54.8	Asaolu *et al*., 2009, Ekpenyong *et al.*, 2014
2	Ca	39.5	
3	K	59.5	
4	Mg	7.0	
5	Fe	0.0024	
6	Zn	121	
7	Mn	0.952	
8	p	89.3	
9	Phytate	11860	

There are much more calories in flavored lemongrass oil, so it usually combines a cooking oil (like canola oil) with lemongrass extract. For example, 40 calorie(s) (1 teaspoon) and 4.5 gram fat per serving preparation or storage are contained in a well-known flavored oil spray brand. Please note that flavored lemongrass oil contains much more calories. Therefore it typically combines cooking olives with lemongrass extract (such as canola oil). A famous lemongrass flavored oil spray brand, for example, contains 40 calories (1 teaspoon) and 4.5 grams of fat per serving. Lemongrass stalks are crushed and aromatic oils are released when they are used in teas, soups, broth, and other liquids. To release aromatic oils, the fragments are immersed in the liquid. Before drinking the cocktail, the stalks must be cut. Before applying the bulb or lower part of the stalks to a curry, salad, marinade, or stir-fry, we will need to chop or mince them, depending on the recipe (Asaolu *et al*., 2009, Ekpenyong *et al*., 2014).

ENVIRONMENTAL REQUIREMENTS OF LEMONGRASS GROWTH

At elevations below 750 m, *C. citratus* thrives in sunny, mild, and humid conditions, with mean annual temperatures varying from 23°C to 30°C and mean annual rainfall ranging from 2500-3000 mm. It can grow in a variety of soil types but prefers well-drained soils with a pH range of 5.5 to 7.5. This species was nevertheless reported in Australia to grow on pH 9.6 terrestrial soils. No salt grounds or freeze conditions are permitted C. *flexuous*. In sunny, humid, wet tropical conditions *citratus* flourish. Lemongrass well grows in Kerala from the average sea level between 900 and 1250 m. Both species have the highest oil return per ton of weed, with an annual average precipitation of 2500-3000mm C. Drought-Tolerant *citratus* can be cultivated in areas with low rainfall (Fokom *et al*., 2019).

For optimum oil output, an additional watering day temperature of 25-30°C is recommended, with a night temperature of 0°C. Plants are unaffected by temperatures above 30°C for short periods, but the oil content is significantly reduced. The plant is hardy and resistant to draughts. Rainy plant height was recorded at the least during the rainy season and not during the second harvest. In Table 5 climatic conditions required for lemongrass are depicted. In Table 6 rainfall required for different species of lemongrass is mentioned and in Table 7, the pH condition required for lemongrass growth.

Table 5: Climatic conditions for lemongrass.

S.No.	Climate	Description
1	Tropical rainforest climate	60mm precipitation per month
2	Tropical savanna climate with dry summer	60mm precipitation driest month (in summer) and (100 -[total annual precipitation{mm}/25])
3	Tropical monsoon climate	Tropical monsoon climate 60 mm precipitation driest month but (100 - [total annual precipitation(mm}/25]))
4	Tropical wet and dry savanna climate	60mm precipitation driest month (in winter) and (100 - [total annual precipitation{mm}/25])

Table 6: Rainfall.

S. No.	Parameter	Lower limit (mm)	Upper limit (mm)
1	Mean annual rainfall	2500	3000
2	Meanannual Temperature	23	30

Table 7: Preferred pH conditions for lemongrass.

S. No.	Varieties of lemongrass	Soils of pH	Soils	References
1	*C. flexuous*	5.5 to 7.5	Sandy loams	Silvestre et al. 2019
2	*C. citratus*	7.5	Grow on soils with a higher acidity than C. flexuous	

SOILS

In a large range of soils, Lemongrass flourishes between rich and poor laterite. In sandy loam and red soils, it needs good manuring. Calcareous and water-rich soils are inadequate for cultivation. Both species can be grown in a variety of soils, with good drainage being the most important factor. Plants that grow in sandy soil produce more citrus fruits and leaf oil. C. flexuous prefers well-drained sandy loams, but it grows in a wide range of conditions, from very light sandy soils to highland laterites in India. The pH of soils is used between 5.5 and 7.5. *C. citrate* is more frequently cultivated on acidic soils than *C. flexuosus*. The greatest yield per hectare of grass and oil in India.

With the season, plant material quality, moisture content, and the season of plants, oil yield varies considerably. In changing the oil content of north-eastern countries under agroclimatic conditions, the location of a large number of environmental components such as temperature, precipitation, relative humidity, and soil humidity is addressed. The span of the mountain consists of higher oil content and relatively less oil in winter and autumn. The above relevant environmental components do not appear to be directly related to the oil material, however. There is a collective effect on the climatic conditions (Ullah *et al*., 2020).

PRODUCTION VS VARIETIES

In the semi-arid tropical climate of Andhra Pradesh, four field experiments were performed to investigate the reaction of various varieties of lemongrass in different spacing to NPK engravings. In terms of essential oil yield, the improved Cauvery and Pragati cultivars outweighed the OD-19 variety for two years successively. Lemongrass replied to the application of 100 kilograms N/ha. The application of N did not affect essential oil concentrations and consistency. In rainfed conditions, Lemongrass did not rely on the use of P and K fertilizers or various plant spacing. During the summer season harvest of all varieties, biomass and essential oil recovery were maximum, and results for two consecutive years were similar (Thorat *et al.,* 2017, Thiagamani *et al.,* 2019). Lemongrass grows well in a wide variety of soils, including both rich and poor laterite. In sandy loam and red soils, it needs good manuring. Calcareous and water-rich soils are inadequate for cultivation. Plants that grow in sandy soil produce more citrus fruits and leaf oil. Even though C. flexuous prefers well-drained sandy loams, it grows in a wide range of conditions, from very light sandy soils to highland laterites in India. The pH of soils is used between 5.5 and 7.5. *C.citrate* is more frequently cultivated on acidic soils than C. *flexuous* and *flexuous*. The greatest yield per hectare of grass and oil in India. *flexuous* is done in PH 7.5 soils. Average weeds and oils will be grown and developed on very saline soils. Lemongrass in pot-tests *C. flexuous* grown in 11.5, 10, and 5.5 mmhos/cm electrically conductive soil (Silvestre *et al.,* 2019).

TISSUE CULTURE AND MICROPROPAGATION OF LEMONGRASS

The cultures of plant tissue combine in vitro cell, tissue, or organ culture techniques. The process starts by removing sections, that is to say, explants that can develop plantlets directly from the selected material if brought into the growing medium, or indirectly from the explant through calluses or embryos. Since these methods are based on the cell to potentiality and replication, each cell theory may generate cells new and thereby discriminate between tissues, organs, and whole species**.** However, due to the stress of in vitro environments, culture media, and different factor factors, including the genotype and explant source, the genetic properties of regenerants will alter. These technologies enable the preservation of the same genotype properties in the original plant (Galadima *et al*., 2020). Therefore, genetic variance i.e soma clonal differences arising from genetic and epigenetic changes at the human level-morphological, cytologically, cytochemical, biochemical and molecular-may be a valuable method for producing genetic diversity.

In general, usage of techniques for culturing plant tissue aims at obtaining plants or plant products in the large-scale output of high phytosanitary efficiency, including secondary metabolites uniformly. The protection of tissue crops produced by seedlings is a prerequisite and a benefit in contrast to conventional crops. Such crops are cultivated in sterile environments and are much lower in the acclimatizing process than those produced

traditionally. The economic effect of infection of plants by pathogens, such as bacteria, viruses, and fungi, on the development of plants of high-quality plants, especially in meristem cultivation and with treatment, will result in high financial losses in medicinal and ornamental crop cultivations and crop cultivations of plant tissues. Clonal plant cultivation, often referred to as micropropagation, is one of the most utilized strategies for plant tissue cultivation and, using these strategies, it can also, independently of genetic crosses and combinations, be selected aseptically and on a wide scale in a short time.

Many sectors are benefiting from plant tissue culture techniques such as forestry, ornamental or medicinal plant processing, the manufacture of essential oils and other secondary metabolites for pharmaceutical and cosmetic applications, and the generation of plant and plant seed or synthetic plants. The evaluation of somaclonal variation, as a plant breeding strategy and conservation of genetic resources (germplasm) of diverse species through synthetic seeds or synthetic seed, especially those with difficult sexual or asexual propagation, the seeds of which are not viable, and plants threatened with extinction (Pandey *et al*., 2019).

Medicinal and ornamental plants are commonly manufactured in vitro, using various plant tissue cultivation techniques. In this section, we looked at the current state of tissue culture techniques in the production of ornamental and medicinal plants in Brazilian companies that use tissue cultivation to produce medicinal and ornamental plants, as well as the differences between tissue culture patents for plants and the products that are currently in use around the world. This research aimed to identify the major countries engaged in this technology and to examine the principal techniques used in the cultivation of plant tissue (Dangkulwanich *et al.*, 2020).

LEMONGRASS - A THERAPEUTIC GRASS

Medicinal and ornamental plants are commonly manufactured in vitro, using various plant tissue cultivation techniques. In this section, we analyzed the current status of tissue culture techniques in the development of ornamental and medicinal plants in companies in Brazil using tissue cultivation to achieve medicinal and ornamental plants and the contrast between tissue culture patents for plants and the products currently used worldwide (Dangkulwanich *et al.*, 2020).

Lemongrass is an herb. The leaves and oil are used for medicinal purposes. Lemongrass has been used to relieve bowel spasms, chest pain, elevated blood pressure, epilepsy, dysentery, cough, knee achy (rheuma), flu, common cold, and fatigue. It is sometimes used as a mild astringent to destroy germs. For headaches, stomach pain, intestinal pain, and muscle pain, some people specifically use lemongrass and its essential oil on their skin. The basic lemongrass oils are used for the management of muscle pain by inhalation. Lemongrass is used as a flavoring in food and drink. Lemongrass leaves, for example, are frequently used in herbal herbs as a "lemon" spice. For the manufacture of soaps and cosmetics, lemongrass is used as a fragrance. In the processing of vitamin, A and natural citrus, Lemongrass is also used.

For medicinal usage, lemongrass may be consumed orally, rubbed on the affected portion of skin, through aromatherapy treatment processes by inhaling. Lemongrass soothes the stomach and other gastrointestinal problems, such as cramps and vomiting when taken orally.

Some of the common uses of lemongrass are mentioned in the below Table 8

Table 8: Lemongrass and their benefit in common diseases.

S.No.	Disease	Benefits	References
1	Cancer prevention	Kill cancer cell	Gavahian Mohsen *et al.*, 2020, Dangkulwanich *et al.*, 2020, Majewska *et al*., 2019.
2	Common cold	Strong immune system	
3	Cough	Antioxidant	
4	Diabetes	Lower blood sugar level	
5	Epilepsy	Antiepileptic drugs	
6	Fever	Preventing infection	
7	Hypertension	Control high BP	
8	Musculoskeletal pain	Reliever	
9	Rheumatism	Relieves arthritis pain	
10	Sleeplessness	Freshness and delightful smell	

Used to treat headache and musculoskeletal discomfort in the skin, lemongrass, or lemongrass oil. Lemongrass oil extract can be inhaled as an aromatherapy drug to relieve body pain, infections, colds, or influenza symptoms (Gavahian *et al*., 2020, Majewska *et al.*, 2019). Along with animal experiments and minimal experimental studies, there is no data to support this large-scale therapeutic benefit. However, a few reports confirm any restricted lemongrass advantages. According to preliminary studies, a hair tonic containing lemongrass oil can help to reduce dandruff. This study aimed to compare the safety and efficacy of lemon juice and lemongrass in treating thrush in HIV/AIDS patients to a control group using a gentian violet aqueous solution of 0.5 percent. A common HIV complication is oral thrush. Because of financial constraints, lemon juice or the infusion of lemongrass (*C.citratus*) made of Limon grazing grown and dried in the hospice is a standard treatment for patients with oral thrush at the More tele Hospices. The two remedies were found to be highly successful, and are commonly

used. The primary medical clinics in South Africa don't choose gentian violet, the first-line oral thrush drug, because of the obvious purple stain, which contributes to the HIV-positive stigmatization. Antifungal properties were known to *C. citratus* and *Citrus limon*.

Herbal uses of lemongrass

The sore throat relief, a decoction is taken by mouth. *C.citratus* (*Cymbopogon* leaves) contain lemon leaf and have a typical hard flavour of its primary substance, cirtal, that is, of considerable value for the industry and are a meticulous anti-inflammatory, diuretic, and sedative medicine. However, these conventional approaches can result in a decomposition, hydrolysis and water solubilization of some fragrances.

Antifungal activity

The anti-fungal properties of Lemongrass Oil are excellent (Viabhav S. *et al*., 2013, Asaolu MF *et al*., 2009, Ekpenyong CE *et al.,* 2014). Undiluted lemongrass, mushrooms, and benzoic acid, nystatin, or tinea fax are safer for pathogens than for commercial fungicides. Another in vitro study reported the highest efficiency in the killing of lemongrass oil and the most considerable inhibitory influence in Candida biofilm growth(Pontes *et al.,* 2019). The anti-fungal activity can be correlated with high citral content. Oil show inhibition to the growth of sticky germ tubes. The lemongrass oils showed good anti-fungal activity in the Candida tropicalis and *Aspergillus niger*. The successful lemongrass inhibitor for the Candida species has been suggested by a synergy of monoterpenes and other compounds such as cymene, terpene, and linalool (Manvitha *et al*., 2014).

Antibacterial activity of lemongrass

This lemongrass oil isbeneficial for antimicrobials (Costa *et al*., 2016, Rabe *et al*., 2017, Dangkulwanich *et al*., 2020) Lemongrass and other essential oils rich in oxygenated compounds such as aldehydrate and monoterpene spirits have been proposed to be more potent. In contrast, certain essential oils containing a greater concentration of monoterpenes and sesquiterpenes have lower antimicrobial activity. The lemongrass oil demonstrated strong antibacterial activity (Gautam *et al*., 2017) in Streptococcus pyogenes, which plays a crucial role in tonsillitis pathogenesis. Lemongrass oil outperformed Cinnamomum Verum, Thymus vulgaris ct. thymol, Origanum compactum, and Stature Montana essence oils in terms of antimicrobial activity (Manvitha *et al*., 2014). The constituent elements of living products (herbs and essential oils) affect, and the combination of trace components is just as important as the primary constituents. Some minor constituent elements can appear to have a synergistic (controlling and strengthening) impact on the product's key constituents. The majority of these trace elements aid in the successful healing of the herbal product or essential oil. They may not have the negative side effects that are associated with synthetic reconstructions (drugs or oils) that lack trace elements. For this purpose, the modern world is incorporating aromatherapy into building designs and medical practices (Majewska *et al*., 2019).

Antiprotozoan activity

The trypanosomatidae family contains protozoans that cause severe illness in humans, animals, and plants. Crithidia, blastocrithide, and herpetomonas are lower trypanosomatids that are normally found in insect hosts in the family.Anti-protozoan activity against *Crithid* Deanie was demonstrated by essential oil extracted from *Cymbopogon citrates*(Manvitha *et al*., 2014).

Antioxidant activity

Due to their pharmacological behavior, phenolic acid and flavonoids have played a role as natural antioxidants and free radical scavengers. The antioxidant profile of phenolic acids presents in the plant. Antioxidants are compounds that can delay or inhibit lipid and other molecules' oxidation and, by doing so, prevent oxidative chain reactions from starting up and propagating. They work by one or more of the following mechanisms: activity reduction, free radical scavenging, pro-oxidant metal potential complexation, and oxygen quenching. The screening of essential oils and different plant extracts for natural antioxidants was highly interesting in recent decades due to their good antioxidant properties (Meenapriya *et al*., 2017).

Antidiarrhoeal activity

In practice, the entire stalk is boiled and the leaf of lemongrass is drunk to relieve diarrhea. Because of its popular use of the antidiarrheal efficacy of *Cymbopogon* in conventional medicines. The main chemical constituent citrus of citrus stalk decoction has been examined (Tangpu *et al*., 2006)**.**

Anti-mutagenic activity

Anti-mutagenic properties in the salmonella typhimurium strain TA98 and TA100 have been detected to contain ethanol extract from lemongrass (Med *et al*., 2016).

Anti-inflammatory activity

A *Cymbopogon citrate* leaf infusion has been investigated and used to treat inflammatory diseases, notably in the gastrointestinal tract, in lip polysaccharide stimulated dendritic cells. In this work, a commonly used drink for treating inflammatory conditions, the *Cymbopogoncitratus* (DC). Stapf – infusion leaves, were examined.Magnet resonances isolated and classified Luteolin O, C, and O, C-glycosides from the Cassiaoccidentalin B structure, which is thoroughly characterised for the first time by the lemongrass. The anti-inflammatory activity of luteolin and its glycosides was tested in lipopolysaccharide-stimulated macrophages. Luteolin glycosides have lower cytotoxicity than luteolin itself. Although glycosylation decreases the anti-inflammatory properties of luteolin and is higher than Cg, the inhibition of luteolin 7-O—glucopyranoside has been reported without cytotoxic effects on inflammatory mediator development (nitric oxides and IL1). Luteolin glycosides have therefore been shown to be a less toxic alternative to currently available anti-inflammatory medications, with potential applications in the pharmaceutical and food supplement industries. It establishes structure-activity relations in the design of

nontoxic anti-inflammatory luteolin glycosides. This work contains useful material(Manvitha *et al*., 2014).

Antimalarial activity

The antimalarial activity of essential oil from Cymbopogon citritus in a plasmodium berghei-infected mouse was investigated in vivo (Med *et al.,* 2016).

Antihepatotoxic activity

Anti-hepatotoxic action against cisplatin has been found in aqueous leaf extracts of *Cymbopogon citrates* that induced hepatic toxicity in rats. The extracts can be used as a therapeutic adjuvant for cisplatin toxicity and hepatopathy treatments (Arhoghro *et al.,* 2012).

Antinociceptive activity of lemongrass

The significant anti-social activity of lemongrass oil. (Viabhav *et al.,* 2013, Dangkulwanich *et al.,* 2020) The other study has confirmed that myrcene has been identified as the most potent analgesic ingredient in essential lemongrass oil. It was noted that myrcene did not withstand repeated injections in rats, as opposed to the core analgesic effect of morphine. Myrcene affects opiates with a similar direct analgesic effect (Manvitha *et al*., 2014).

Cardioprotective activity of lemongrass

In vivo mice study confirmed that oral doses of lemongrass oil at a bodyweight dosage of 200 mg/kg demonstrated cardioprotective and anti-lipid peroxidative anti-vitamin E (Ullah *et al.,* 2020).

Anticancer activity of lemongrass

Essential oils of *Cymbopogon flexuosus* [lemongrass oil (LO)] are used in a variety of food and fragrance products and have biological properties such as anti-cancer and antimicrobial activity. Male Sprague-drawl rats were fed a pelleted diet and given LO or citral gavage for two weeks to see how 200 LO (200 mg/kg) and 400 LO (400 mg/kg) and their main ingredient, Citral (240 mg/kg) affected their behavior. Following two weeks of feeding, LO and citral assessed the metabolism and toxicity of acetaminophen. The activities of hepatic testosterone 6-hydroxylation and ethoxyresorufin O-demethylation were significantly reduced in rats given 400 LO or citrus. Citrus significantly increased NADPH: quinone oxidoreductase 1 activity and glucosyltransferase activity in Uridine 5″ diphosphate (UDP) significantly increased in the rat liver by 400 Lo. Reduced lipid peroxidation and liver reactive oxygen levels after a 400 LO or citrus injection. However, after acetaminophen treatment, LO and citral treatment had little to no effect on plasma alanine aminotransferase activity or adduct acetaminophen-protein content in the liver (Li *et al*., 2018). In Table 9, the antimicrobial properties of lemongrass are shown.

Table 9: Antimicrobial Effects of Lemongrass Oil.

Microorganism	Zone of Inhibition Lemongrass
E. coli	No Zone of Inhibition
P. aeruginosa	14.9+0.24
K. pneumoniae	14.2+0.41
P. mirabilis	8.9+0.21
S. aureus	15.5+0.33
C. albicans	16.5+0.49

CONCLUSION

Cymbopogon sp. is a fragrant grass that contains a wide range of bioactive compounds with a wide range of therapeutic properties. In the cosmetics and perfume fields, applications have already been discovered. The therapeutic value and essential oil of lemongrass could be used in the future in herbal medicine. It can help to prevent teeth and rubber diseases such as periodontitis and gum disease by removing bacteria from the oral cavity as well as by cure infectious diseases associated with the respiratory system. The *Cymbopogon citratus* is well known for its antibacterial activity. *C. citratus* demonstrated a high content of total flavonoids and total phenolic as well as an antioxidant potential for high free radical scavenging. *C. citratus* has good activity in anti-fungal, antimicrobial, anti-nociceptive, cardioprotective. *C. citratus* has vasorelaxant, antithetical, and sedative potential. For the preservation of our health, medicinal plants are very important. The pharmacological assessment of several herbs used in Indian traditional medicine systems has become increasingly interesting. Lemongrass is of great interest because the essential oils are commercially useful and commonly used in food technology and traditional medicine. A proper phytochemical and pharmacological study is needed, which will open new pharmacological avenues in this majestic plant that are helpful for clinical experimentation as well as for the development of novel medicines, because of the new attraction of natural products obtained from lemongrass.

FUTURE SCOPE

There are various species of lemongrass grown worldwide, the molecular diversity analysis of lemongrass will be the future project. The extraction of essential oils techniques can be improved from the existing ones to ensure availability of all components of oil. There are various applications of lemongrass oil need to be explored.

Conflict of Interest: We declare that we have no conflict of interest.

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REFERENCES

Alzawqari, M. H., Al-Baddany, A. A., Al-Baadani, H. H., Alhidary, I. A., Khan, R. U., Aqil, G. M., & Abdurab, A. (2016). Effect of feeding dried sweet orange (*Citrus sinensis*) peel and lemon grass (*Cymbopogon citratus*) leaves on growth performance, carcass traits, serum metabolites and antioxidant status in broiler during the finisher phase. *Environmental Science and Pollution Research*, *23*(17), 17077-17082.

Arhoghro, E. M., Kpomah, D. E., & Uwakwe, A. A. (2012). Curative potential of aqueous extract of Lemon Grass (Cymbopogon citratus) on cisplatin induced hepatotoxicity in Albino Wistar Rats. *J Phys. Pharm. Adv.*, *2*(8), 282-294.

Asaolu, M. F., Oyeyemi, O. A., & Olanlokun, J. O. (2009). Chemical compositions, phytochemical constituents and in vitro biological activity of various extracts of *Cymbopogon citratus*. *Pakistan Journal of Nutrition*, *8*(12), 1920-1922.

Battaglia, S. (2019). Lemongrass.

Boeira, C.P., Piovesan, N., Flores, D.C.B., Soquetta, M.B., Lucas, B.N., Heck, R.T., dos Santos Alves, J., Campagnol, P.C.B., Dos Santos, D., Flores, E.M.M. and da Rosa, C.S., (2020). Phytochemical characterization and antimicrobial activity of *Cymbopogon citratus* extract for application as a natural antioxidant in fresh sausage. *Food chemistry*: *319*, 126553.

Costa, G., Ferreira, J. P., Vitorino, C., Pina, M. E., Sousa, J. J., Figueiredo, I. V., & Batista, M. T. (2016). Polyphenols from *Cymbopogon citratus* leaves as topical anti-inflammatory agents. *Journal of ethnopharmacology*: *178*, 222-228.

Fokom, R., Adamou, S., Essono, D., Ngwasiri, D.P., Eke, P., Mofor, C.T., Tchoumbougnang, F., Fekam, B.F., Zollo, P.A., Nwaga, D. and Sharma, A.K., (2019). Growth, essential oil content, chemical composition, and antioxidant properties of lemongrass as affected by harvest period and arbuscular mycorrhizal fungi in field conditions. *Industrial Crops and Products*: *138*, 111477.

Gautam, Meenu, and Madhoolika Agrawal (2017). Influence of metals on essential oil content and composition of lemongrass (*Cymbopogon citratus* (DC) Stapf.) grown under different levels of red mud in sewage sludge amended soil. *Chemosphere*: *175*, 315-322.

Gavahian, M., Sastry, S., Farhoosh, R., & Farahnaky, A. (2020). Ohmic heating as a promising technique for extraction of herbal essential oils: Understanding mechanisms, recent findings, and associated challenges. In *Advances in food and nutrition research*, *91*, pp. 227-273). Academic Press.

Geetha, T. S., & Geetha, N. (2015). Pharmacognostic and physicochemical evaluation of Cymbopogan citratus (DC) Stapf leaves. *Ann. Phytomedicine*, *4*(1), 99-104.

Hammer, K. A., Carson, C. F., & Riley, T. V. (1999). Antimicrobial activity of essential oils and other plant extracts. *Journal of applied microbiology*: *86*(6), 985-990.

Haque, A. N. M. A., Remadevi, R., & Naebe, M. (2018). Lemongrass (*Cymbopogon*): a review of its structure, properties, applications, and recent developments. *Cellulose*: *25*(10), 5455-5477.

Hidalgo, E. S. (2019). Adapting the Scrum framework for agile project management in science: a case study of a distributed research initiative. *Heliyon*: *5*(3), e01447.

Ikeda, R. M., Stanley, W. L., Vannier, S. H., & Spitler, E. M. (1962). The monoterpene hydrocarbon composition of some essential oils. *Journal of Food Science*, *27*(5), 455-458.

Joy, P. P., Skaria, B. P., Mathew, S., Mathew, G., & Joseph, A. (2006). Lemongrass: the fame of Cochin. *Indian Journal of Arecanut, Spices and Medicinal Plants*: *8*(2), 55-64.

Majewska, E., Kozlowska, M., Gruszczynska-Sekowska, E., Kowalska, D., & 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).

Manvitha, Karkala, and Bhushan Bidya (2014). Review on the pharmacological activity of *Cymbopogon citratus*. *International Journal of Herbal Medicine*: *1.6*, 07-07.

Med, J. Ayu Herb (2016). Antibacterial activity profile and quality standards of *Cymbopogon citratus* Stapf-an aromatic grass used in Indian system of medicine. *Journal of Ayurvedic and Herbal Medicine*: *2.3*, 63-66.

Meenapriya, M., and Jothi Priya (2017). Effect of lemongrass oil on rheumatoid arthritis. *Journal of Pharmaceutical Sciences and Research*, *9.2*, 237.

Okémy, N. A, Moussoungou, A. S., Koloungous, B. C., & Abena, A (2015). Topical anti-inflammatory effect of aqueous extract ointment of *Ageratum conyzoïdes* L. in Wistar rat. *International Journal of Phytopharmacy*: *5*, 37-41.

Pandey, Janhvi, Rajesh Kumar Verma, and Saudan Singh (2019). Screening of most potential candidates among different lemongrass varieties for phytoremediation of tannery sludge contaminated sites. *International journal of phytoremediation*: *21.6*, 600-609.

Patra, D. K., Pradhan, C., & Patra, H. K. (2018). Chelate based phytoremediation study for attenuation of chromium toxicity stress using lemongrass: *Cymbopogon flexuosus* (nees ex steud.) W. Watson. *International journal of phytoremediation*, *20*(13), 1324-1329.

Pontes, E. K. U., Melo, H. M., Nogueira, J. W. A., Firmino, N. C. S., de Carvalho, M. G., Júnior, F. E. A. C., & Cavalcante, T. T. A. (2019). Antibiofilm activity of the essential oil of citronella (*Cymbopogon nardus*) and its major component, geraniol, on the bacterial biofilms of Staphylococcus aureus. *Food science and biotechnology*, *28*(3), 633-639.

Rabe, A. M., Aliero, B. L., Galadima, A., & Baqi, A. S. (2017). Thermal Decomposition of Camel Grass and Lemon Grass. *Journal of Scientific Research and Reports*, 1-4.

Ross, I. A. (2001). Chemical Constituents, Traditional, and Modern Medicinal Use. *Humana Press*.

Silvestre, W. P., Livinalli, N. F., Baldasso, C., & Tessaro, I. C. (2019). Pervaporation in the separation of essential oil components: A review. *Trends in food science & technology*, *93*, 42-52.

Sisay, B., Debebe, E., & Meresa, A. (2020). Phytochemistry and method preparation of some medicinal plants used to treat asthma-review. *J. Anal. Pharm. Res.*, *9*(3), 107-115.

Thiagamani, S. M. K., Rajini, N., Siengchin, S., Rajulu, A. V., Hariram, N., & Ayrilmis, N. (2019). Influence of silver nanoparticles on the mechanical, thermal, and antimicrobial properties of cellulose-based hybrid nanocomposites. *Composites Part B: Engineering*: *165*, 516-525.

Thiam, A., Gueye, M. T., Sanghare, C. H., Ndiaye, E. H. B., Diop, S. M., Diop, M. B., ... & Fauconnier, M. L. (2020). Chemical composition and anti-inflammatory activity of Apium graveolens var. dulce essential oils from Senegal. *American Journal of Food Science and Technology*, *20*(8 (6)), 226-232.Ullah, M. A., Rasheed, M., & Hyder, S. I. (2020). Medicinal Plant Lemon Grass (*Cymbopogon citratus*) Growth under Salinity and Sodicity. *The Korean Journal of Food & Health Convergence*, *6*(1), 9-15.

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