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A Review On LEMONGRASS ESSENTIAL OIL - A Blessing To Human Being

¹ManyaBajaj , ²Aaliya Naaz

¹ Six Sigma Institute of Technology and Science , Rudrapur , India

² Six Sigma Institute of Technology and Science , Rudrapur , India

Abstract: “Essential oils” (EOs) are plant subordinate metabolites that have volatile , open, and complex traits. EOs are a complex blend of subordinate metabolites (“terpenes, phenolic compounds”, and intoxicating). EOs offer a wide range of organic actions, containing antioxidant, uncontaminated, and antagonistic-instigative belongings. The essential lubricant of the plant is used in flavoring, fragrance, and “aromatherapy”, in addition to curative beverages, able to be consumed in herb, and rash situations. It is familiar as the beginning of ethnomedicine. *Cymbopogon* is a ‘Greek term’. They are "kymbe," that means "boat " and "pogon" that means "beard," both of that hint to a decorative pierce composition. Lemongrass essential oil (LEO), the main product that is extracted from a lemongrass plant, still serves as a commodity, namely used in the foodstuff industry on account of allure unusually extreme citral content, which offers high content of citral that in addition offers antibacterial activity and the pleasant aroma . Lemongrass, likewise popularly known as *Cymbopogon citratus*, presently contains about 55 varieties. *Cymbopogon citratus* is a plant owned by Sri Lanka and Southern India, even though it is also found in “South and Central America, in Savannah, tropical, and semi tropical climates”. The principal phytoconstituents are essential oils (that involve “Citral, Nerol Geraniol, Citronellal, Terpinolene, Geranyl acetate, Myrcene, and Terpeneol, Methyl Heptenone), flavonoids, and phenolic compounds (that contain luteolin, isoorientin 2'-rhamnoside, quercetin, kaempferol, and apiginin”. Lemongrass essential oil can be derived utilizing a sort of methods, containing “Solvent Extraction, Steam Distillation, Hydrodistillation (HD), Microwave Assisted Hydrodistillation (MAHD), and Supercritical Fluid Extraction (SFE) utilizing CO₂”. This review item holds current information concerning lemongrass essential oil , allure distillation techniques, synthetic elements, and pharmacological venture.

Keywords: Essential oil , lemongrass , terpene , pervaporation , solvent extraction, food preservation ,antioxidant

1. INTRODUCTION

Fare manufacturing was supported to cultivate natural options on account of purchasers' choice for more open and less unhealthy food items. This situation has incited physicists to research the singular instinctive compounds about medicinal and pungent plants. "Essential oils (EOs)" are plant subordinate metabolites accompanying changeable, everyday, and complex possessions. The fitness benefits, produced from scented and healing plants, have existed since the distant past.[1] EOs are a complex combination of subordinate metabolites (terpenes, phenolic projectiles for weaponry, and intoxicating). EOs have an assortment of organic possessions, containing antioxidant, antibacterial, and antagonistic-instigative features.[2] In general, EOs give reason for a nearly minor portion of plant overall arrangement, accounting for inferior 5% of legume dry matter. At range hotness, essential oils are volatile, mainly liquid, and colourless. They are dissolved in alcohol, natural solvent, and fixed oils, but not in water. They have an erratic refractive index, a powerful optical activity, and occasionally a unique flavour. Furthermore, essential oils have different odour and are therefore being the reason for the obvious scents that aromatic plants create. EOs are a complex blend of bioactive synthetic elements to a degree terpenes, terpenoids, and phenolics. In character, the fragrant and synthetic properties of EOs do many living purposes for plants, containing (i) inviting beneficial bugs and pollinators, (ii) protection from material stress (heat, cold, etc.), and (iii) care from microbes. These bioactive EOs are famous across the planet for their "antibacterial, antifungal, antioxidant, antiviral, antimycotic, antiparasitic, and insecticidal proficiencies".[2] The plant's essential lubricate is utilised in flavouring, fragrancng, and aromatherapy, in addition to curative beverage, able to be consumed spice, and skin disease situation. It is familiar for being a beginning of ethnomedicine.[3] ISO guidelines delineate essential oils as the amount obtained by energy distillate of parts of plants ("leaves, flowers, arms"), "cold pressing of epicarps (peel) of citrus crops, or dry distillate", afterwards separation of the liquid chapter (if survives) by tangible processes.[4] The content and yield of essential oils are concerned by a sort of basic and abiotic variables, the most important of that are plant person's family tree and miscellaneous stressors (hydric stress, surplus light, hunter and insect assault).[4]

Cymbopogon is a Greek discussion. They are "kymbe," which means "boat," and "pogon," which means "beard," both of which hint at a 'flower spike arrangement'. [5] The citral component in Lemongrass essential lubricate is very accessible to change by 'acid incentives' and 'oxidative' demolition, specifically in the occupancy of light and heat, happening in the production of the force change of flavor. The breakdown of citral can happen at a greater hotness, light, and feasible oxygen in this place compound and can produce different compounds in the way that "p-cymene, p-cymene-8-ols, p-mentha-1,5-dien-8-ol, p-menthadien-8-ol, α ,p-dimethylstyrene, p-methylaceto-phenone, and p-cresol", that may further change the spice force of LEO [6]. Essential lubricate parts are usually recognized utilizing "Gas Chromatography - Mass Spectrometry" (GC-MS) equipped accompanying a "Flame Ionisation Detector" (FID) and MS detectors, a blood vessel pillar (30m, 0.25mm, film denseness 0.25 m), and a split. Test environments grant permission vary established the line and sample.[7]



Fig. 1 : Lemongrass [8]

Lemongrass (*Cymbopogon citratus*) is a repeatedly secondhand plant component in both common and traditional medicine. Lemongrass essential oil (LEO), the important merchandise obtained from the lemongrass plant, is again a possession that is commonly working in the cooking business on account of allure high citral content, that determines a significant uncontaminated operation and a nice, friendly scent. Furthermore, LEO is a common substance used in the production of pharmaceuticals such as antifungal medicines, antidepressants, and nausea cures.[6]Lemongrass, carefully known as *Cymbopogon citratus*, immediately holds roughly 55 classes. It is individual of the plants with an acceptable and attractive aroma, and it is secondhand in a sort of beautifying technologies (such as, scent, perfume and usually cleanser) as well as bread (for example, tea, searing spices).

Table- 1 - Taxonomic classification of lemongrass [16,41,60]

Kingdom	Plantae
Clade	Tracheophytes
Clade	Monocots
Order	Poales
Family	Poaceae
Subfamily	Panicoideae
Tribe	Andropogoneae
Genus	<i>Cymbopogon</i>
Species	<i>citratus</i>

Other names for lemongrass- “Serai, West Indian LemonGrass, Oil Grass, Fever Grass, Serai Makan, Serai Makan, Lemongrass” [9]

Cymbopogon citratus, is a plant that owned by Sri Lanka and pertaining to South India, is establish/refined in “South and Central America, in Savannah, sultry and subtropical climates”.[10] “Lemongrass is a year-round plant” accompanying “thin, long leaves” that is to say widely used medicinally and ultimate oil extracted plant in tropical countries such as Asia, Africa, and America.[11] Several earlier written research marked the vicinity of “terpenes, alcohols, ketones, aldehydes, and esters in citronella. Citral, Nerol Geraniol, Citronellal, Terpinolene, Geranyl acetate, Myrcene, and Terpinol Methyl Heptenone” are all elements of essential oils. [11] Components of essential oils, in the way that those in the direction of *C. citratus*, commonly have corresponding profiles in agreements of incorporation, absorption, and excrement. They are expeditiously preoccupied subsequently with oral, pulmonary, and cutaneous use. Most are metabolised and detached apiece kind as glucuronides, or given off as CO₂. Because of their fast go-ahead and short organic half-lives, they are absurd to accrue in the carcass.[12] ‘Citronella’ is commonly confused with lemongrass, but lemongrass is arisen from the *Cymbopogon* variety “ *C. citratus*, *C. pendulus*, and *C. flexuosus* ” and holds citral (cis and trans) as alive additive, in as much as both class of citronella, “*C. winterianus* and *C. nardus*”, hold citronellal (‘mono-terpene aldehyde’) as its main constituent and different alive compounds are ‘citronellol and geraniol’ individually.[13] (Table-2 contains list of common name and species of *Cymbopogon* and their region.

Table -2 Some *Cymbopogon* species ,common name and their region [14,15]

Species	Common Name	Region
<i>Cymbopogon citratus</i>	lemongrass or West Indian	Indonesia , Malaysia , India,

	lemongrass	Philippines
<i>Cymbopogon flexuosus</i>	East Indian Lemongrass	Indian Subcontinental,
<i>Cymbopogon nardus</i>	Citronella grass	Indian subcontinent, Indochina , central and Southern Africa
<i>Cymbopogon ambiguus</i>	Australian lemon scented grass	Australia, Timor
<i>Cymbopogon winterianus</i>	Java grass	Brazil ,Java ,Sumatra
<i>Cymbopogon pendulus</i>	Jammu lemongrass	eastern himalayans , Myanmar
<i>Cymbopogon refractus</i>	barbed wire grass	Australia
<i>Cymbopogon martini</i>	palmarosa	Indian Subcontinent , Vietnam

Essential lubricate components have happened proved to quickly adapt each one due to their fundamental link within the alike synthetic group, which concede possibility be begun either by enzymes or chemicals.[16]

Table 3 -Minerals and Vitamins present in Lemongrass [17]

Minerals	Percent	Vitamin	Percent
Folate	19%	Calcium	6.5%
Niacin	7%	Copper	29%
Pyridoxine	6%	Zinc	102%
Riboflavin	10.5%	Magnesium	15%
Thiamin	5.5%	Manganese	228%
Vitamin A	<1%	Selenium	1%
Vitamin C	4%	Zinc	20%

2. Chemistry of essential oil -

Terpenes are the ultimate accepted type of compound present in unnecessary oils. Terpenes are hydrocarbon compounds derived from 5-element isoprene (C_5H_8) parts. Numerous compounds, two together undeviating-tethered chemicals and fragments accompanying individual or more ring forms, may be built from these elements in biosynthesis. Terpenes are top-secret in accordance with the amount of isoprene parts they contain; the most famous unnecessary oils are “monoterpenes and sesquiterpenes”. ‘Monoterpenes’ have ‘10 element atoms’ and are made up of two isoprene parts ($C_{10}H_{16}$), that can be found in an assortment of element skeletons. Monoterpenes are classified into three types: ‘uninterrupted (acyclic), monocyclic, and bicyclic’. “Sesquiterpenes” have 15 element atoms and are composed of three isoprene units ($C_{15}H_{24}$). They may be ‘acyclic, monocyclic, bicyclic, or tricyclic’. These are the ‘terpenes’ that have higher angled points. The bigger elements of essential oils are monoterpenes and sesquiterpenes, accompanying

sesquiterpenes giving reason for around 25% of the terpene part. Both classifications are the reason for essential lubricate evaporation and odour. Terpenoids are chemicals made by way of synthetic qualification of terpenes and sesquiterpenes, such as rearranging element skeletons or disintegration.[18]When essential lubricate is dropped on filter paper, it evaporates completely; still, fixed oil devises a mark that does not dissipate even when heated .[19] “Apiaceae, Asteraceae, Cupressaceae, Hypericaceae, Lamiaceae, Lauraceae, Myrtaceae, Pinaceae, Piperaceae, Rutaceae, Santalaceae, Zingiberaceae, and Zygophyllaceae” are some famous offspring , rich unnecessary oil holding plants.(Table -3 holds few models of these families).Essential oils are found in plants in oil cells , secretory ducts or craters, and ‘glandular hairs’. In added positions, they are coupled with ‘carbohydrates in the form of glycosides’ . In aforementioned instances, they must be made public through hydrolysis of the glycosidic link. This is proficient by being concerned with atom and molecule change processes to occur all along failing superior to distillate of fresh plant matter. Essential oils have again been found in mosses, liverworts, seaweeds, sponges, and fungi. Aside from greater plants, several earthly and sea mammals, bugs, fungi, and bacteria are known to biosynthesize changeable projectiles for weaponry.[19]

Table -4 Describing examples of plants of different families that are rich in essential oils [20-32]

Family	Example
Apiaceae	caraway ,carrot, parsley , fennel , cumin,coriander
Asteraceae	Sunflower, Dahlia ,Artemisia, Marigolds,Chamomile
Cupressaceae	redwood,callitris
Hypericaceae	St.John’s wort
Lamiaceae	mint , rosemary , lavender,basil,beautyberry,oregano
Lauraceae	cinnamomum ,litsea ,ocotea,california bay
Myrtaceae	eucalyptus,eugenia, clove,java apple , rose apple
Pinaceae	pinus ,cedar ,fir,douglas fir
Piperaceae	black pepper,manekia, peperomia,verhuellia
Rutaceae	bael fruit ,lemon, orange ,tangeri
Santalaceae	sandalwood
Zingiberaceae	ginger,turmeric ,cardamom
Zygophyllaceae	bean-caper ,caltrop

In type, there are two types of metabolites: basic metabolites and subordinate metabolites. Proteins, carbohydrates, lipids, and deoxyribonucleic acid are instances of basic metabolites, that are about all living structures. Secondary metabolites are present in just any variety and are categorised as “terpenoids,

shikimates, polyketides, and alkaloids". 'EOs' contain an assortment of synthetic elements. Plant EO factors are detached into two synthetic groups: "terpenes and phenylpropanoids". Although terpenes and their aerate descendants (terpenoids) are more coarse and abundant in EOs, select variety have solid amounts of shikimates, that is to say phenylpropanoids, and when these projectiles for weaponry are present, they offer additional odour and flavour to the plant.[32] Most EOs are very complex alliances of monoterpenes ($C_{10}H_{16}$) and sesquiterpenes ($C_{15}H_{24}$), in addition to biogenetically connected "phenols (phenylpropanoids and cinnamates), carbohydrates, alcohols, ethers, aldehydes, and ketones that are being the reason for their characteristics".[33] Many of the "phenylpropanoids" in the direction of EOs are 'phenols or phenol ethers' accompanying the side chain diminished in few cases. The oxygenated "**hydrocarbons anethole, eugenol, and safrole**", that all contain an 'element-carbon double bond supplementary chain' (and are so 'phenylpropanoid alkenes or phenylpropanoids'), are their principal members in EOs. The 'phenylpropanoids' - "**asarone, estragole, methyleugenol, and safrole**" are all malignant in rodents.[33]

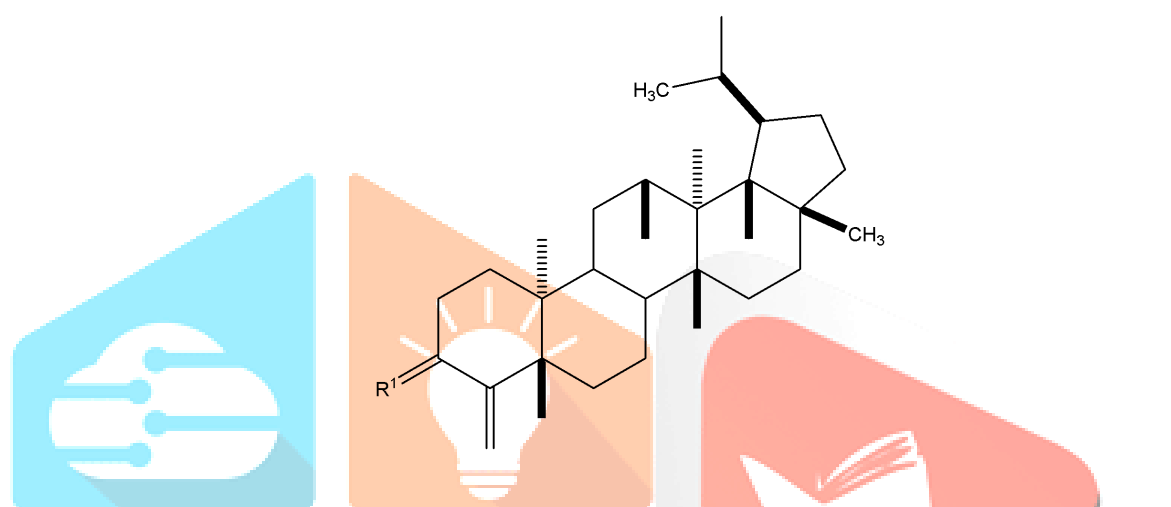


Fig. 2 : The structure of Cymbopogon and Cymbopogonol

Several studies have existed transported in consideration of further understanding of the synthetic structure of the essential oil about these class leaves. These reasoning have told that, while the synthetic composition of *C. citratus* essential lubricate changes in accordance with its terrestrial inception, a chemical compound in the way that 'hydrocarbon terpenes, alcohols, ketones, esters, and, most especially, aldehydes' have usually happened recognized. Alkaloids, saponin, ("â- sistosterol, terpenes, alcohols, ketone, flavonoids, chlorogenic acid, caffeic acid, p-coumaric acid", and sugars are between numerous private and acknowledged compounds from the leaves and ancestries of lemon grass. The total capacity of essential lubricate derived from leaves changes greatly, grazing from "0.28 to 1.4%". The best stated worth was 3.0%, that was created by hydrodistillation of dry leaves.[34]

Limonene, an accepted monoterpene of essential oils, may be present in lemongrass oil. This was unique at quantities varying from 0.3 to 5%.

The terpene α -pinene was too unique. In addition, hydrodistillation was used to generate α -caryophyllene, another hydrocarbon sesquiterpene present in many essential oils. α -caryophyllene was again found in the essential lubricate utilizing the supercritical fluid distillation order.

Other labeled terpenes were phellandrene and α -oxobisabolene, the latest being the second most prevalent component (12%) in the essential lubricate studied.[34]

The synthetic structure of 'essential oils' derived from *C. citratus* dry leaf examples and new plant leaves maybe examined utilizing Gas Chromatography/Mass Spectroscopy.[35]

3. Extraction methods for lemongrass-

Many various processes concede possibility be used to extract lemongrass essential lubricate, containing “Solvent Extraction, Steam Distillation, Hydrodistillation (HD), Microwave - Assisted Hydrodistillation (MAHD), and Supercritical Fluid Extraction (SFE) using CO₂”. A number of studies proved that the condition of essential oils is generally determined by their parts that are affected considerably by the distillation process. Furthermore, warming processes can cause warm decay or hydrolysis of impressionable materials.[36] Because essential oils hold thermolabile compounds (hotness impressionable) that disintegrate/oxidize at larger hotnesses, the common procedure for fractionating essential oils is fractional emptiness distillate. Pervaporation is operated at temperature beneath 30°C, contingent upon the sheath and feed properties and can happen at range hotness. The pressure range of the sheet is 1 to 10 mmHg (0.13 to 1.33 kPa), that is more in the earlier systems. Pervaporation is usually used to fractionate essential oils by disintegrating bureaucracy in water (liquid resolution/hydrolate), intoxicating (ethanolic/alcoholic resolution), or hydroalcoholic answer, the ratio of that depends on the essential lubricate's type.[4]

3.1 Solvent extraction-

In order to annul the essential lubricate, a hydrocarbon firm (often “n-hexane”) is added to the plant material. After winnowing the answer and distilling it, a material encompassing sticky substance (resinoid) or a mixture of fuller and essential lubricate is abandoned. The process is intensely productive for lemongrass essential oil origin and somewhat smooth, still it usually takes big amounts of solvent and frequently gives average repeatability. Following distillation, the sample is reduced by dissolution, during which volatiles grant permission to be dropped. Furthermore, adulteration of the essential lubricate by solvent residues is likely.[36]

Lemongrass oil grant may be culled utilizing the techniques and solvent are filed beneath -

- **Maceration:** It is the process of macerating drained plant material in the demeanour of a non-polar solid in the way that hexane, before winnowing and collecting the extract to recover the financially sound.
- **Percolation:** The stable is willing to seep below a line of dried plant material in this place process. The percolate is distilled in order to extract, lubricate and restore the solvent. Soxhlet ancestry is an unending percolation process that demands complex supplies. The plant material is sunk into an origin tank in an absorbent bottle. The fit is evenly and steadily put into the crate. The extract is sucked into an improvement container, and the stable is extracted away. The composed financial sound is restored to the absorbent can. [37]

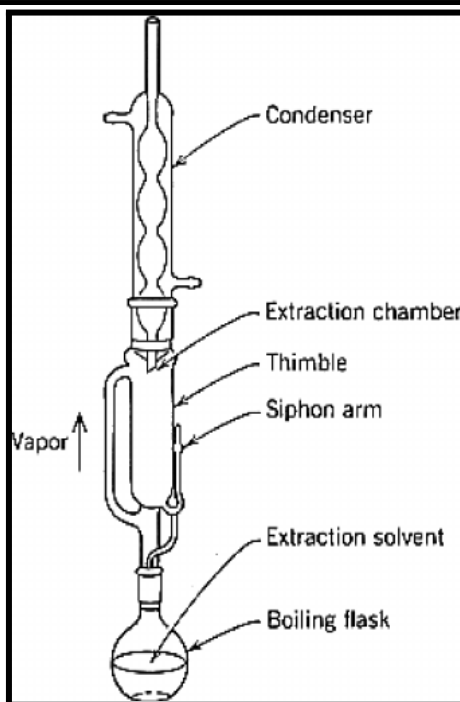
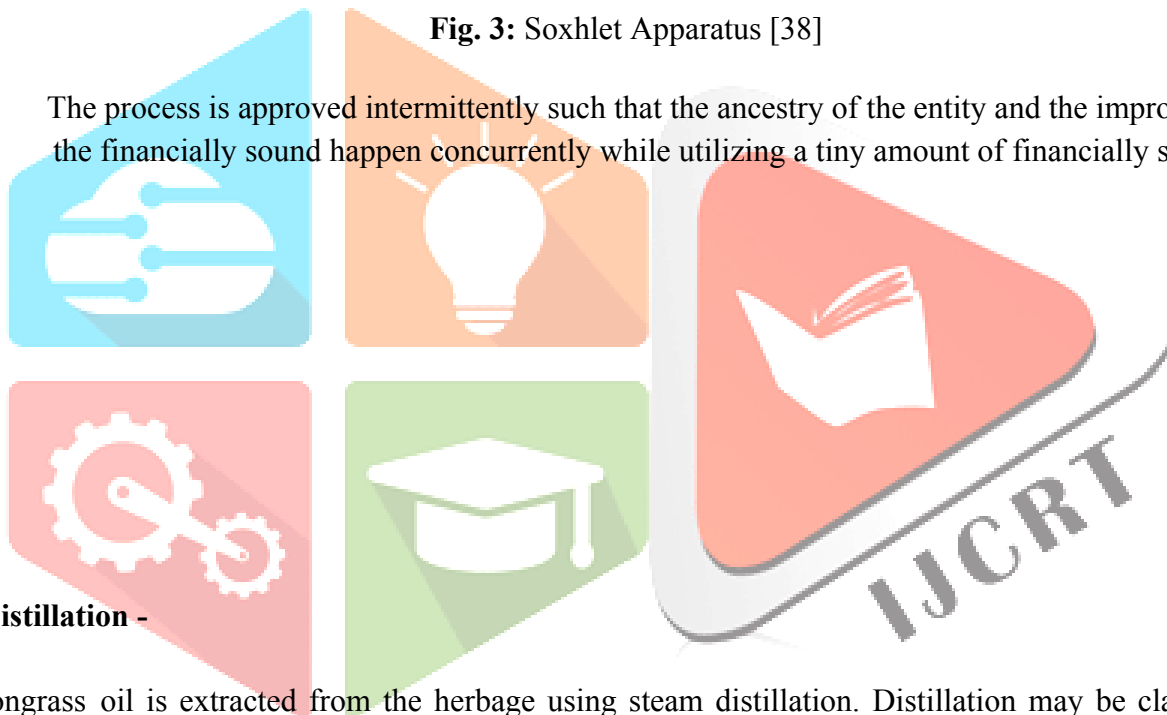


Fig. 3: Soxhlet Apparatus [38]

The process is approved intermittently such that the ancestry of the entity and the improvement of the financially sound happen concurrently while utilizing a tiny amount of financially sound.[37]



3.2 Distillation -

Lemongrass oil is extracted from the herbage using steam distillation. Distillation may be classified into these categories.

1. **Hydro-distillate:** the spice is full in a vessel namely incompletely suffused accompanying water in this place procedure. Direct fire, energy covering, or mesmerized energy coil are used to heat the container.
2. **Hydro and energy distillation:** the plant material is full on a gridiron, namely equipped at an altitude above the still's base. The bottom section of still is suffused with accompanying water until the gridiron level and chance from below. The energy in this process is forever completely soggy, moist, and never superheated. The plant material is plainly connected energy, not angered water.
3. **Steam distillate:** no water is still in this process. Instead, soggy or superheated energy is introduced beneath the charge via open or punctured energy coils. When the distillate cools, it isolates into a tier of oil that floats above most of the water. Steam distillate without a stain fortifies holes with an energy pressure of an '18-32 kg/cm²' in the furnace is ideal for seizing prime lubricate. The lawn is distilled either new or subsequently it has failed. Wilting plant life before distillate decreases moisture content and boosts lubricate improvement. Sun drying lowers lubricate improvement while having no influence on lubricate arrangement. In general, Clevenger supplies is working to distill

ordinary amounts of spice (until 1.0 kg). Large-scale distillate plants worth distilling '500 kg or more' of the spice at a time are erected. The plant life of *C. flexuosus* holds 0.2-0.4% lubricate approximately, and the oil manufacturing is 100-125 kg/ha/period.[39]

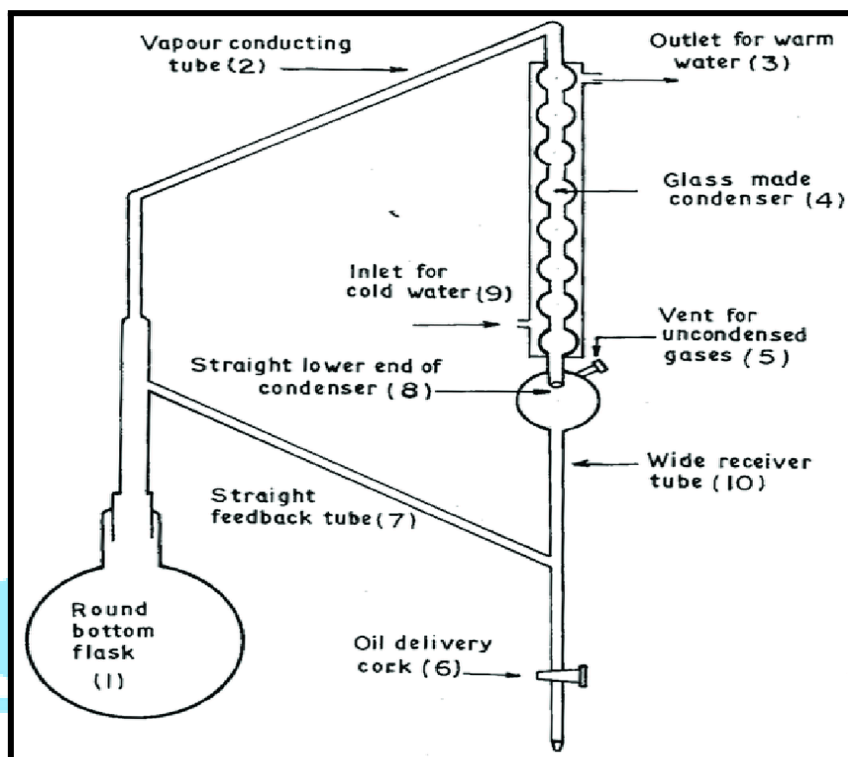


Fig. 4: Clevenger apparatus [40]

Lemongrass oil is a thick liquid that ranges in colour from 'yellow to dark yellow or dark amber' and becomes crimson when stored for an extended period of time.[39]

3.3 Microwave assisted extraction -

In the "MAE" whole ("M/s Falcon Microwave Technology, Mumbai, India"), essential lubricant was derived from lemongrass leaves. The water-saturated plant material ('100 g on a dry support') was stocked in a chalice with a volume of 2 L, in addition to miscellaneous quantities of water.

When microwaves are used, water fragments in the containers of leaves endeavor to reorganize themselves, accompanying the magnetic field of currents intensely fast. The upset fragments create plenty of heat and dissolve. The growing vapor aggregation inside the containers causes a rise in pressure against the cell wall, developing in a container obstruction rupture. Because essential lubricate is volatile, it is evaporated and it moves with water vapor toward the condenser, that is upheld or maintained above the cavity of microwave. The essential lubricant and water are before being divided and decanted. Oil was dried out and observed at 2 strengths Celsius. The MAE unit was fight attack 850 W. Each experiment was recurring three periods., and therefore retained at 290 °C for 2.5 record; and the ionization fad, photoelectric impact at '70 eV'. [40]

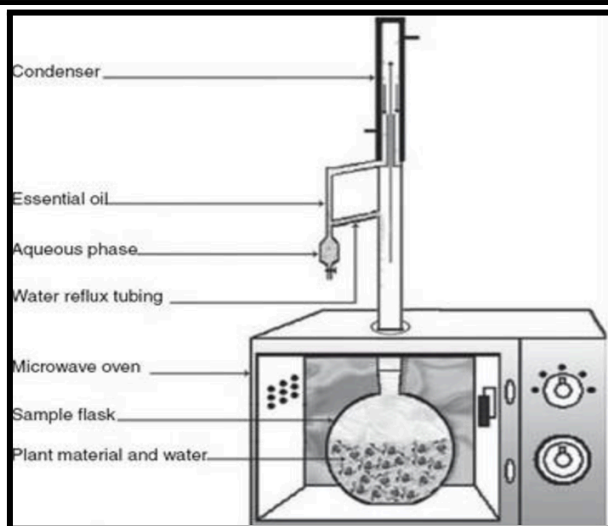


Fig. 5 : Microwave assisted hydrodistillation[41]

3.4 Supercritical Fluid Extraction-

SFE completed activity in an “Isco SFX 2-10 Supercritical Fluid Extractor” accompanying two Isco **model 260D syringe pumps (Isco, Inc., Lincoln, NE)**. Each origin utilized about “2.5 g of plant material”. The material was culled utilizing supercritical CO₂; afterwards it was introduced as an ancestry container. The pressure was kept constant at ‘80 atm’ at ‘50 °C accompanying flow rates grazing from “0.2 to 1.5 mL/min”. All extractions were composed in “HPLC grade dichloromethane”.

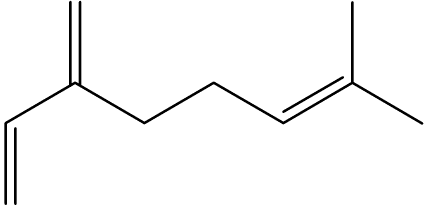
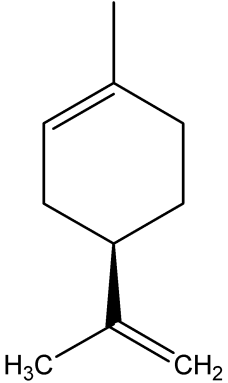
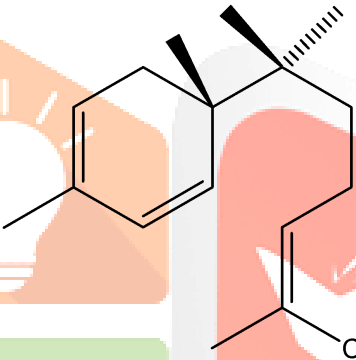
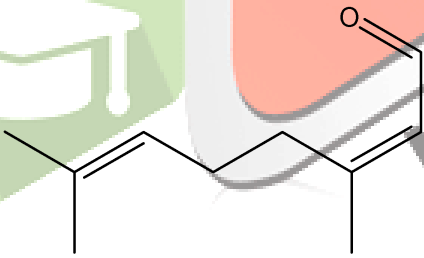
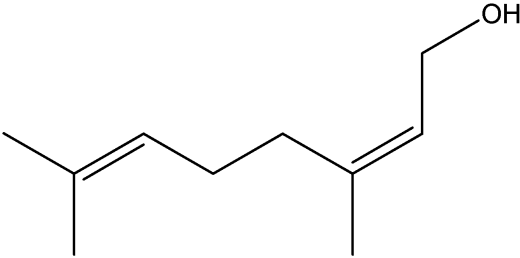
The primary extraction used supercritical CO₂ accompanying ‘10% hexanes’ as limiter for ‘1, 2, and 4 h three periods’ each; ‘30% hexanes’ as limiter, ‘10% dichloromethane’ as limiter, and ‘100% CO₂’ were more reliable. Extraction tests were completed in trio. The acquired samples were concentrated in vacuo and weighed. Each sample was dissolved in ‘10 mL’ of within standard resolution before being analyzed by GC-FID.[42]

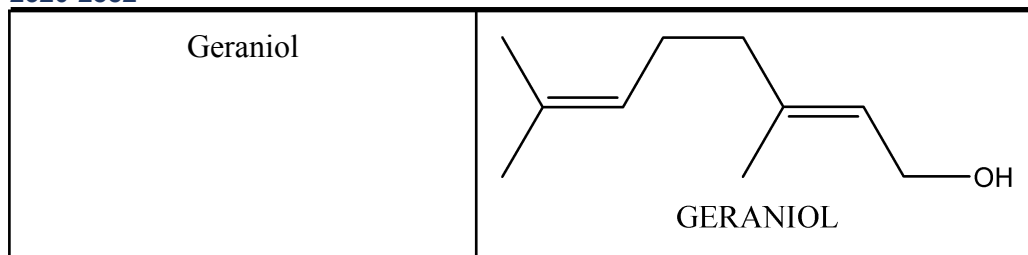
4. Constituents of lemongrass oil -

“Terpenes, alcohols, ketones, aldehyde, and esters’ ’ were established as the major elements in ‘*Cymbopogon citratus*’ . The basic phytoconstituents are essential oils (that hold “**Citral, Nerol Geraniol, Citronellal, Terpinolene, Geranyl acetate, Myrcene, and Terpinol, Methyl Heptenone**’.) flavonoids, and phenolic compounds (that contain “ **luteolin, isoorientin 2'-rhamnoside, quercetin, kaempferol, and apigenin** ”.The phytochemical parts of *Cymbopogon citratus* leaves were determined by utilizing the methods of Lemon Grass containing “alkaloids, saponins, tannins, anthraquinones, steroids, phenol, and flavonoids”, in accordance with research. Each of these phytochemicals has happened connected to a sort of guarding and healing benefits.[43]

Table -5 Chemical constituents and their structures

Chemical constituents	Structure
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<p>Myrcene</p>	 <p>MYRCENE</p>
<p>Limonene</p>	 <p>H₃C CH₂</p>
<p>Zingiberene</p>	 <p>CH₃</p>
<p>Citral</p>	 <p>CITRAL</p>
<p>Nerol</p>	 <p>NEROL</p>



Citronellol is often used to enhance the fragrance of citrus compositions. Pinene is a key ingredient in the fragrance and flavor industries.[38]

Citral, often known as “**lemonal**”, is a pair or a combination of terpenoids having the chemical formula ‘C₁₀H₁₆O’. Both molecules are ‘double bond isomers’. The ‘E-isomer’ is referred to as “geranial or citral A”. The ‘Z-isomer’ is also known as “neral or citral B”.[44]

Among the flavonoids identified from the leaves and rhizomes of *C. citratus* are “luteolin, luteolin 7-O-glucoside (cynaroside), isoscoparin, and 2"-O-rhamnosyl isoorientin” [45].

Menthone and menthol, which are uncommon in other Cymbopogon oils, were identified in trace amounts. The following components are often found in the genus. The discovered chemicals account for more than 80% of oil. The remaining components are largely monoterpene hydrocarbons with a few sesquiterpenoids that are currently unknown.[46]

5. Pharmacological Activity

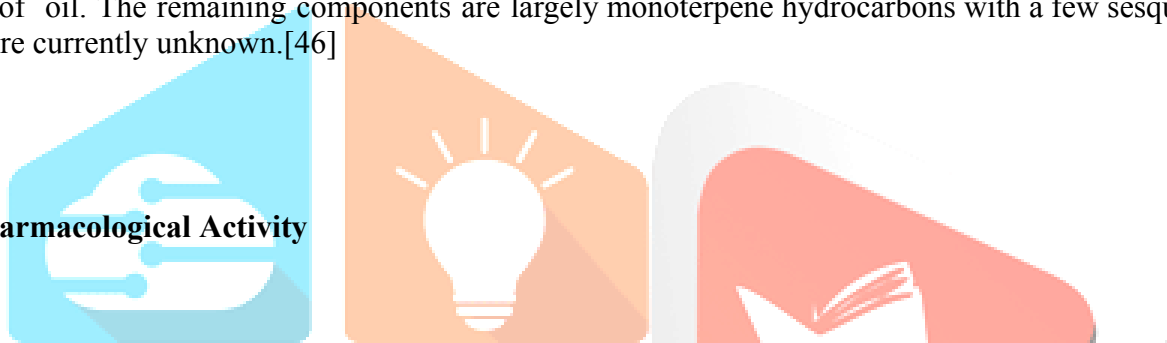


Table 6: Some of the pharmacological activity of Cymbopogon species [46]

<p><u>Obesity</u></p> <ul style="list-style-type: none"> ● decrease accumulation of abdominal fat ● decrease diet induced weight gain 	<p><u>Respiratory disorder</u></p> <ul style="list-style-type: none"> ● decrease nasal blockage ● decrease flu and asthma 	<p><u>Anti-nociceptive</u></p> <ul style="list-style-type: none"> ● decrease descending pain pathway 	<p><u>Antidiabetic</u></p> <ul style="list-style-type: none"> ● decrease glucokinase activity ● decrease hyperglycemia ● increase glucose tolerance, insulin sensitivity
<p><u>Anticancer</u></p> <ul style="list-style-type: none"> ● decrease expression of HSP90 gene in breast cancer cell lines 	<p><u>Hepatoprotective effect</u></p> <ul style="list-style-type: none"> ● decrease 3A ● decrease CYP1A1 ● decrease liver oxidative stress 	<p><u>Anti-inflammation</u></p> <ul style="list-style-type: none"> ● decrease lipoxygenase enzyme 	<p><u>Body odour</u></p> <ul style="list-style-type: none"> ● decrease odour ● cleansing and antibacterial properties

The responsiveness to stimuli of essential oils to various beginnings changes considerably.

“Essential oils” are gleaned from a variety of plants, containing flowers, timbers, grasses, bushes, crops, and herbs” . The oils assembled are intense vague divisions of the plant. Many essential oils are popular for their decontaminating properties.[46] It is utilized in the drug trade for the production of colognes, deodorants, and soaps on account of an allure friendly bouquet. Its main elements are ‘citral monoterpenes’ (“an isomeric mixture of geranial and neral”) and ‘myrcene’, two together of which have antagonistic-bacterial and healing possessions [47]. ‘Lemon grass’ was initially used to create soups, curries, and a native liquor popular as "frenzy beverage," which was understood to recover not just fevers but more looseness of the bowels, uneven period, stomach disorders, and skin ailments in East India and Sri Lanka. Lemongrass Essential Oil has an expansive range of uses, from curative to savory to beautifying. Oils, gels, lotions, soaps, shampoos, sprays, and candle produce are just any of the common people forms it takes. [48] Cymbopogon plants have long existed to repulse mosquitos in rainforest areas like the Bolivian Amazon. Various extracts in addition to ‘essential oils’ that came from these types of plants have been ‘proven against any arthropods’. When proven , against *Anopheles arabiensis*, *Cymbopogon excavatus* supported 100% repulsion for 2 hours and therefore lowered to 59.3% subsequently 4 hours.[49]

- **Antibacterial activity** - Gram-negative microorganisms are frequently more tolerable to essential oils than Gram-positive microorganisms. [50] Lemongrass has existed in usual cure to treat coughs, consumption, elephantiasis, sickness, ‘**ophthalmia, pneumonia, and vascular disorders**’ . Lemongrass has been recognized by studies to have “antidepressant, antioxidant, antiseptic, harsh, decontaminating, fungicidal, nervine, and sedative features”. Furthermore, multiple studies have established that lemongrass oil exhibits decontaminating activity against a broad difference of species, containing ‘gram positive’ and ‘gram negative’ microorganisms, yeast, and fungus . ‘Gram positive’ creatures are more sensitive to the lubricant than ‘**Gram negative**’ organisms. ‘Lemongrass oil’ was stated to be effective against “ *Acinetobacter baumannii* (*A. baumannii*), *Aeromonas veronii* (*A. veronii*), *Enterococcus faecalis* (*E. faecalis*), *Escherichia coli* (*E. coli*), *Klebsiella pneumonia* (*K. pneumoniae*), and *Salmonella enterica* (*S. enterica*)”[51].Lemongrass lubricate and citral, at a “minimum inhibitory” level of ‘0.17mg/ml’, have been found to destroy sulfate lowering microorganisms, that is significant in the oil area.[53]
- **Antifungal activity** - Lemongrass essential oils are well opposed to pathogenic fungal cells that hinder the usual release of mycotoxins during seed and different food depository. It likewise demonstrates big abolition against fungal disorders such as ringworm of the feet, ringworm, athlete itch, and yeast contaminations, in addition to antagonistic and cooperative endeavors by blocking the formation of filamentous fungi (thread) due to inactivation of yeast cell .[52] Lemongrass lubricate can also be utilized as an “antifungal” powder for ‘skin’ contaminations (‘Cutaneous Candidiasis and Dermatomyces’).[54]
- **Antinociceptive activity** - Lemongrass has long existed in established cures to treat pain and worry in living beings. In distant past, the plant worked to relieve pain or anesthetic for surgical processes, and it power help reduce the crowd's behavioral and physiological responses to extreme pains [53]
- **Insect repellent activity**- The ‘essential oils’ of ‘Cymbopogon class’ (“ *C. citratus*, *C. nardus*, *C. martini*”) were very active against anopheline mosquitoes, “*Anopheles culicifacies*” and “*Anopheles quinquefasciatus*”, and it still shy sure incident chapters of the pest *Aedes aegypti*, the host heading of yellow turmoil and dengue [35].
- **Anticancer activity** - In mammary containers, ã-myrcene demonstrated antimutagenic operation. These plant chemicals, ä-limonene and geraniol, inhibited liver and mucosal membrane intestinal cancer in rodent.The ethanolic extract of *C. Citratus*. This plant's liquid squeezed from the plant holds inhibitors of the developing state of cutaneous malignancies. The methanolic extract of the Thailand-cultivated plant revealed antitumoral "in vitro" operation [35].

- **Anti hepatotoxic action** - The ‘aqueous leaf extracts’ of *Cymbopogon citratus* inhibited “cisplatin-induced liver damage” in rats. As a result, the extracts have the potential to be employed to treat ‘hepatopathies’ and as a therapeutic adjuvant in ‘cisplatin toxicity’.[48]
- **Antioxidant activity**- The ‘phenolic phytochemicals’ and ‘antioxidant properties’ of *Cymbopogon citratus* “Cold Water Extract” (CWE) and “Hot Water Extract” (HWE) revealed that, in a ‘dose dependent manner, “Hot Water Extract” had “significantly higher DPPH radical scavenging ability, Fe²⁺ chelating ability, and OH* scavenging ability than Cold Water Extract”. Finally, “heat treatment” may impact antioxidant activities due to the ‘release of phenolic phytochemicals’ adding to the “health promoting and disease preventing capacities” of *Cymbopogon citratus*. [44]
- **Food preservation**- The lubricate of *C. citratus* has existed to be identified as ultimate hopeful for use as a cooking preservative on account of a number of fundamental and unique bioactivities. Lemongrass lubricate have an essential role in the abolition of abundant key postharvest pathogens such as “*Botrytis cinerea*, *Colletotrichum coccodes*, *Cladosporium herbarum*, and *Rhizopus stolonifer*” . Lemongrass essential lubricate and powdered plant extract have existed to decrease depository degradation and aflatoxin adulteration in melon seeds infected with *Aspergillus avus*.[37]
- **Anti hypertensive activity**- Citral has happened to be studied for its vasorelaxant action in the “aorta and superior mesenteric channels” of ‘active and hypertensive rats’. Citral precipitated Phenylephrine (PE)-precontracted aortae to lessen in a dose-contingent conduct. Citral persuaded vasorelaxation in both endothelium-intact and endothelium-denuded channels, signifying that it acts alone of the endothelium. Furthermore, citral reduces arterial contraction induced by Calcium Chloride (CaCl₂) and potassium chloride (KCl), two together of that depolarize Vascular Smooth Muscle (VSM) containers.[56]

“*C. citratus*” is captured as a beverage, amounted to ‘non-alcoholic drinks’ and dried merchandise, and utilized as a ‘flavoring and preservative’ in ‘candies and cuisines’ apart from allure medicinal benefits. Its ‘essential oils’ are utilized as the fragrance result of “ **perfumes, soaps, detergents, and creams**”in the cosmetic manufacturing.[58]Oil contains â-ionone, a forerunner of Vitamin B₁₂; it is also antibiotic and anti flatulent . [59] To be used in fluids, EOs must be convinced into liquid colloidal dispersions, nano-emulsions, and microemulsions, or they can be included into water-dissolved microscopic structures like cyclodextrins. Polymer micro - and nanocapsules holding EOs are used in dairy , bread ,meat, and candy store merchandise.[55]

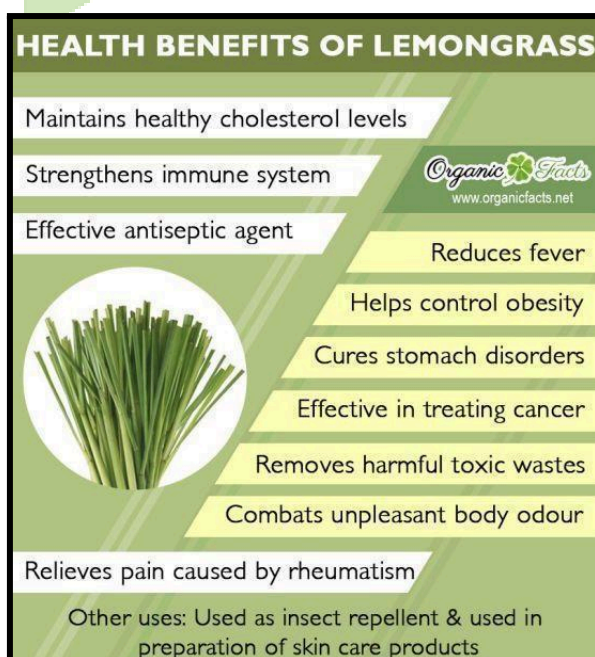


Fig. 7 : Health Benefits [57]

Conclusion

A lemongrass review research was published in this article. It basically provides its taxonomy classification, ethnopharmacology, and chemical makeup. Citronella is the main component of lemongrass. It has been reported to be beneficial in cancer and inflammation, as well as having anti-hepatotoxic, anti-nociceptive, and antibacterial properties (effective against a wide range of bacteria). It was also necessary to discover ways to extend the shelf life of items used in food preservation. Different extraction procedures have been discovered, such as “solvent extraction, microwave aided extraction, distillation, and supercritical fluid extraction”.

Terpenes, esters, phenols, flavonoids, and phenylpropanoids are components of plant chemistry. This plant is abundantly accessible, commercially lucrative, and widely employed in ‘food’ businesses as well as in ‘traditional remedies’. Commonly found in “fragrances, perfumes, and cosmetics such as creams and soaps”.

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