IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Cymbopogon Citratus (Lemongrass) :-Its Extraction Method. Properties And Health Benefits :-A Review

Anant Popat Shelar ,prof .Anil B . Jadhav, Dr. Rajendra M. Kawade

Nandkumar shinde College of pharmacy Vaijapur

Dist: Chh. Sambhajinagar

● **Abstract :-**

The article provides a thorough overview of the extraction methods, properties, compositions, and industrial applications of lemongrass essential oil. Traditionally, lemongrass (Cymbopogon Citratus) essential oil has been utilized for centuries in medicine to enhance blood circulation, treat fevers and malaria, aid digestion, and boost the immune system. Lemongrass essential oil finds extensive use across various industries, including aromatherapy, food and beverage, pharmaceuticals, fragrance and flavor, agriculture and livestock, cosmetics and soaps, as well as household products. The quality of lemongrass essential oil is significantly influenced by the extraction method and the conditions under which it is obtained. Various extraction techniques can be employed to obtain lemongrass essential oil, such as steam distillation, Soxhlet extraction, ultrasound-assisted extraction (UAE), hydrodistillation (HD), microwave-assisted hydrodistillation (MAHD), and supercritical fluid extraction (SFE) using carbon dioxide. The Key physicochemical properties of lemongrass oil include specific gravity, optical rotation, refractive index, citral content, freezing point, moisture content, acid value, ester value, carbonyl value, and phenol content. It is important to note that the chemical composition of lemongrass essential oil can vary based on factors such as geographical location, cultivation methods, plant age, photoperiod, harvest time, cultivars, and extraction techniques. To address the limitations of traditional distillation methods, environmentally friendly extraction technologies like supercritical fluid extraction (SFE), steam distillation extraction (SDE) and microwave-assisted hydrodistillation (MAHD) should be considered for industrial-scale production of lemongrass oil.

Keywords:- Extraction, lemongrass, isolation, Essential oil

Abbreviations:- Microwave Assisted Hydro-Distillation (MAHD), Supercritical fluid extraction (SFE), Ultrasound- assisted extraction (UAE),Hydrodistillation (HD).

1).Introduction :-

Lemon grass refers to tall plants with large, striped leaves that have jagged edges. It is well-known for its sweet, herbaceous aroma that carries citrus and smoky notes. The scientific name for lemon grass is

Cymbopogon flexuosus, and it is commonly used in soups, curries, and teas due to its soothing properties. This fragrant sedge belongs to the

•Figure 1:- Cymbopogon Citratus (Lemongrass).

Poaceae family and is native to various regions in Africa and Southeast Asia, thriving in both tropical and subtropical climates. Another species, Cymbopogon citratus, originates from Sri Lanka, India, and Pakistan. In Pakistan, cultivated in the northern regions, particularly in Gilgit and Juglote during specific seasons. In India, it is found in the Western Ghats, including Kerala and Maharashtra, as well as in Karnataka and Tamil Nadu, aside from the foothills of Sikkim and Arunachal Pradesh. The essential oils derived from Cymbopogon are rich in monoterpenes such as limonene, citral, elemol, citronellal, 1,8 cineole, citronellol, linalool, geraniol, methylheptenone, beta-caryophyllene, geranyl formate, and geranyl acetic acid. The chemical composition of these essential oils is typically analyzed using GC-MS. The strong lemon scent, a defining characteristic of this grass, is attributed to its high citral content. This aromatic oil is utilized in products like soaps and detergents, and due to its citral richness, it also plays a significant role in the perfumery and food industries.

2) Physicochemical Properties :-

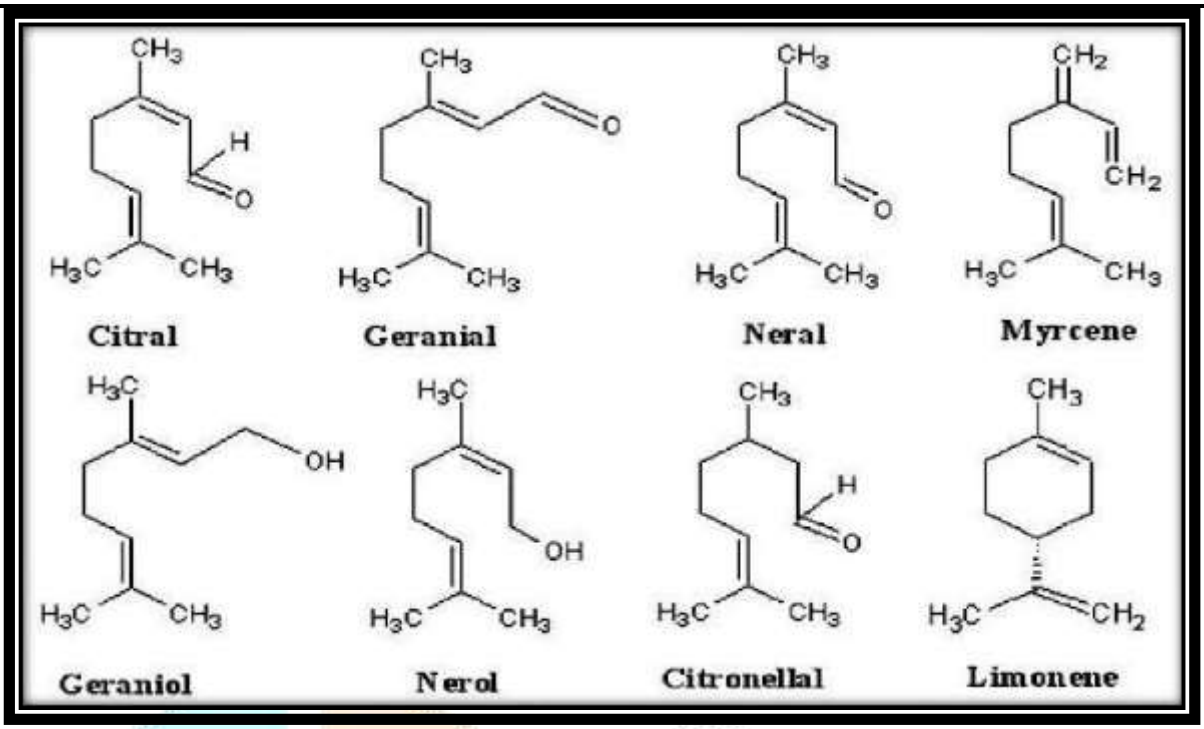
The chemical composition of lemongrass oil shifts as the grass matures. Freshly harvested lemongrass boasts an essential oil content of 0.67%, rich in citral. This oil is typically a semi-viscous liquid, displaying a hue that ranges from **dark** yellow to deep amber, eventually turning red with age. When moisture infiltrates the oil, it takes on a cloudy appearance. Key physicochemical characteristics of lemongrass oil often examined include specific gravity (SG), refractive index (RI), citral percentage, freezing point, moisture level, acid value, ester value, carbonyl value, and phenolic content.

PARAMETERS	ISO Standard for : Cymbopogon Citratus
COLOUR	Yello
ODOUR	Lemon Scented
SPECIFIC GRAVITY	0.871
REFRACTIVE INDEX	1.4830-1.4891(20oC)
OPTICAL ROTATION	-3° to +1
CARBONYL VALUE AS CITRAL	Not l
SOLUBILITY	Fresh oil soluble in 65%(v/v) alcohol at 20oC. Insoluble in 90%(v/v) alcohol.

- **Table :-Physiochemical Properties Standard For Cymbopogon Citratus.**

3) Chemical Constituents :-

The healing power of medicinal herbs may be linked to the presence of phytochemicals or secondary metabolites, which are abundantly found throughout these plants. Key compounds such as phytosterols, anthocyanins, amino acids, organic acids, phenolic substances, volatile compounds, fatty acids, fumesol, flavonoids, isovaleric aldehyde, methylheptenone, valeric esters, L-linalool, furfural, isopulegol, and p-coumaric acid have been extracted and identified from Cymbopogon citratus.



• **Figure 2:-Chemical Constituent of Cympobogon Citratus.**

4) Essential Oil :-

The composition of this plant Is rich and varied, featuring a blend of compounds like citral—a combination of terpenoids and geranial—alongside myrcene, geraniol, and citronellol (which includes cymbopogonol and cymbopogone), as well as α-oxobisabolene. The specific makeup of these constituents can shift based on the species of the plant and its geographical origin. For instance, Indian lemongrass boasts a citral content of 12-15%, while East Indian lemongrass ranges from 10-13%. Citral plays a crucial role in shaping the plant's flavor profile. Noteworthy components include neointermediol (7.2%), selina-6-en-4-ol (27.8%), α-cadinol (8.2%), methyheptenone (1.2%),

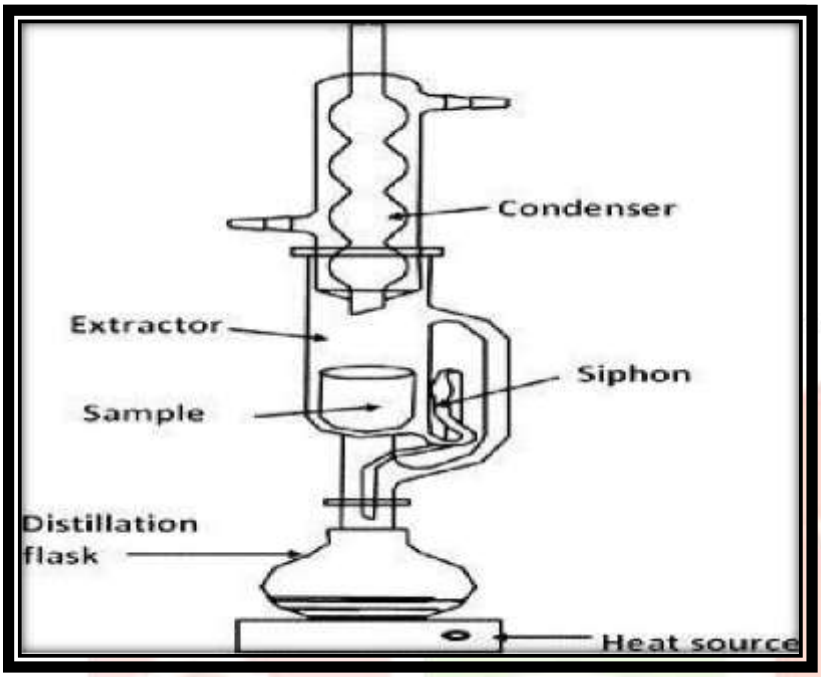
eudesma-7(11)-en-4-ol (5.3%), 3,7-dimethyl-1,3,6-octatriene (0.58%), decanal (0.25%), and naphthalene (0.79%). Recent studies have also identified the presence of elemol (41%), β-eudesmol (45%), cubebol (4.7%), humulene (4%), along with various derivatives like citral acetate and citral diethylacetal. Additionally, compounds such as verbenone, sabinene, geranyl acetate, citronella, and several forms of mentha—including limonene (19.33%), cis-8-dien-2-ol (17.34%), trans-mentha-2,8-diene-1-ol (13.91%), trans-mentha-1(7),8-dien-2-ol (13.95%), and cis-mentha-2,8- diene1-ol (8.10%)—have also been detected.

5) Methods of Extraction of Lemongrass :-

5.1) Soxhelation Method :-

The art of extracting essential oils from the bounty of nature—trees, flowers, herbs, and various plant materials—unveils a world of intricate chemical compositions. At the heart of these fragrant oils lies terpenes, a family of compounds that share kinship with alcohols, ketones, and aldehydes. Citronella oil, a versatile gem, finds its way into the realms of detergents, soaps, perfumes, cosmetics, and even the pharmaceutical industry. The extraction process embraces clean technology, ensuring purity and sustainability. When it comes to lemon grass, it yields a modest one to two percent of essential oil by weight, often referred to as citronella oil.

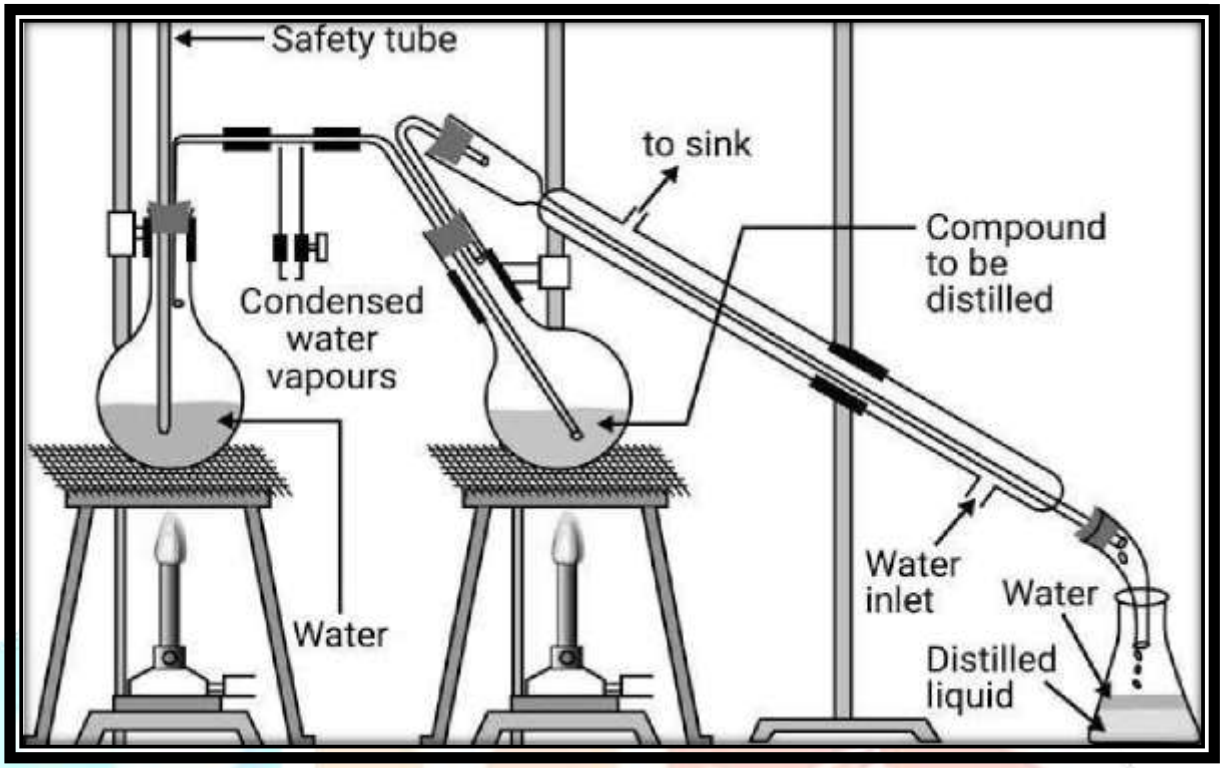
Traditionally, this oil is coaxed from the plant through steam and hydro distillation, although these methods can be quite time-consuming. Enter the innovative Microwave Assisted Hydrodistillation (MAHD), a technique that not only accelerates the extraction process but also preserves the integrity of the oil. Furthermore, studies have highlighted the superior benefits of microwave-assisted extraction compared to conventional hydrodistillation. A cutting-edge approach involves pressurized liquid extraction with nitrogen gas, which has been shown to yield oil of even higher quality than both hydrodistillation and Soxhlet methods. Additionally, research is exploring the potential of supercritical extraction of citronella oil under high pressure, promising even more advancements in the field.



●**Figure 3:- Soxhelat Extraction Assembly For Lemongrass Oil.**

5.2) Steam Distillation Method :-

In this technique, we utilize freshly harvested leaves or other parts of the plant. This approach is commonly employed in numerous laboratories. Here, steam is generated from a boiler and directed into an extraction vessel containing the plant material, allowing the essential oils to be extracted through a diffusion process. It's a straightforward and efficient method for obtaining various herbal remedies.



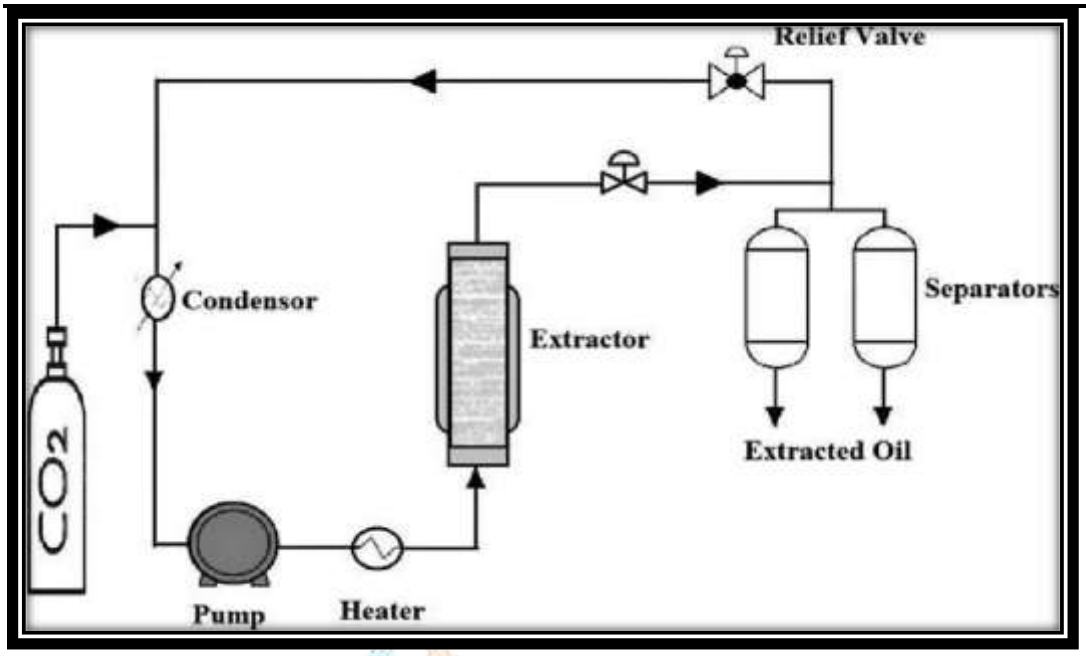
•**Figure 4:- Steam Distillation Extraction Assembly For Lemongrass Oil.**

5.3) Supercritical Fluid Extraction Method:-

Supercritical fluid extraction (SFE) is a technique that separates one substance (the extractant) from another (the plant matrix) by utilizing supercritical fluid, typically carbon dioxide (CO2), as the solvent (Kaur, 2016). Among the various supercritical fluids available, CO2 is the most frequently used in this extraction process. This method is not only faster but also more efficient than traditional solvent extraction, and the supercritical solvents can be removed with ease. The recovery of the extract is achieved by lowering the pressure, which allows the solvent to separate from the extracted compounds. As illustrated in Figure , the SFE process employs CO2 as the solvent.

5.4) Microwave Assisted Hydro-Distillation Technique (MAHD) :-

The MAHD method employs a cutting-edge hydro-distillation technique that harnesses the power of microwave oven. This innovative approach is effective for extracting or recovering bioactive compounds from raw plant materials. The efficiency of MAHD is significantly influenced by the insulation of both water and the plant matter being processed. Illustrated in MAHD stands out as a modern technology designed to isolate biological substances from their original matrices. Its advantages make it a compelling alternative in extraction methods, notably due to its ability to minimize extraction time, reduce the need for solvents, and enhance selectivity. Additionally, the heating process is straightforward to monitor and control.



- **Figure 5 :- Supercritical Fluid Extraction Assembly For Lemongrass Oil.**

5.5) Ultrasound Assisted Extraction Method :-

This method employs a blend of hydro-distillation or steam distillation alongside solvent extraction. It is primarily aimed at extracting volatile compounds from plants rich in essential oils. The selected solvent must be immiscible with water and of high purity. The simultaneous distillation process has been adapted into various forms, taking into account factors like efficiency, scale, and the quality of the final products. This method minimizes solvent usage, reduces the risk of thermal degradation, and prevents the dilution of the extract with water. However, a notable drawback is that it can introduce artifacts into the extract and lead to the loss of compounds that have a strong affinity for water.

5.6) Hydro Distillation Extraction Method :-

This method of extraction is not appropriate for all drugs due to the use of water as a solvent. Certain extracts dissolve in water when heated, and prolonged exposure of plant material to hot water can alter its composition or lead to degradation.

6) Pharmacological Activity of Lemongrass :-

6.1) Antimicrobial Properties:-

Lemongrass extracts showcase impressive antimicrobial properties that combat Streptococcus mutans, making them a valuable in the fight against tooth decay.

6.2) Anti-inflammatory Properties :-

The soothing effects of lemongrass can be traced back to its rich content of citral and geranial. These compounds work together to inhibit the release of specific markers that trigger inflammation in our bodies.

6.3) Antioxidant Properties :-

Lemongrass is packed with a variety of antioxidants, including iso orientin, chlorogenic acid, and swertiajaponin, which work together to combat harmful free radicals that can lead to illness.

6.4) Anti-hepatoxic Properties :-

The water-based leaf extracts of Cymbopogon citratus demonstrated a protective effect against liver damage caused by cisplatin in rats. This suggests that these extracts could serve as a promising option for treating liver diseases and as a supportive therapy in cases of cisplatin toxicity.

6.5) Anti-malarial Properties :-

The study explored the effectiveness of essential oil derived from Cymbopogon citratus in combating malaria in miceinfected with Plasmodium berghei.

6.6) Anti-HIV Properties :-

Citronella oil extracted from the leaves of C. citratus has been shown to effectively treat oral thrush caused by Candidaalbicans in HIV/AIDS patients within just 1 to 5 days.

6.7) Antiglycation Properties :-

Glycation stress is characterized as the alteration of cellular proteins. via chemical reactions that are non-enzymatic and irreversible involving reducing sugars .Glycation is a non-enzymatic process that occurs when free Proteins amino groups and sugars that have reducing properties. This response is referred to as Maillard reaction.The response takes place when the amino acid's amino group reacts with a carbonyl group of sugar that has been decreased. Buildup of glycation substances is increasing. related to different illnesses including primarily diabetes and kidney disease caused by diabetes, small vessel disease and narrowing of arteries due to plaque buildup. The capacity of ascorbic acid to inhibit glycation Effects of lemon grass water and alcohol extracts on hydrogen peroxide were studied. The ethanol extract was examined by Sari et al. and displayed similar results. possibility of inhibiting glycation with ascorbic acid findings indicate that the existence of C. Citratus leaf extract might block the glycation process.

6.8) Anti-Diabetic Properties :-

One of the most deadly illnesses of the 20th century is diabetes. It stops the pancreas from producing enough insulin, which may make it impossible to control blood sugar. Using molecular docking, the in vivo anti-diabetic efficacy of C. citratus was examined at 400 and 800 mg doses. The extracts exhibit a significant decrease in the levels of triglycerides ($p<0.0001$), glucose ($p<0.0001$), and insulin ($p<0.0001$). Using assays that inhibit alpha-amylase andalpha-glycosides, the in vitro anti-diabetic potential of C. citratus was examined against Type 2 diabetes.

7) Uses And Application Of Lemongrass Oil :-

Lemongrass, along with its bioactive compounds, has been a staple in traditional medicine across various cultures for centuries, celebrated for its myriad healing properties, including antifungal, antimicrobial, anti-inflammatory, and pain-relieving effects. The stalks and leaves of this versatile plant are employed globally as remedies for a range of ailments, serving as anticonvulsants, antispasmodics, antiemetics, and hypotensives, as well as addressing bacterial infections, pain relief, cough suppression, rheumatic conditions, and issues related to the nervous and digestive systems. Additionally, lemongrass essential oil finds its way into numerous industries, enhancing food and beverages, cosmetics, perfumes, pharmaceuticals, nutraceuticals, sanitation, agriculture, and flavoring. Overall, lemongrass oil has carved out a significant niche in aromatherapy, cosmetics, perfumery, and the culinary arts, making it a truly multifaceted ingredient.

7.1) Pharmaceutical and Therapeutic :-

Lemongrass oil is a remarkable remedy, celebrated for its ability to soothe a multitude of ailments, from digestive troubles and headaches to fevers, muscle strains, and flu-like symptoms. But its benefits extend far beyond these familiar uses. Research has unveiled its potent antimicrobial and antifungal capabilities against certain harmful pathogens, positioning it as a valuable in the world of medicine. Nambiar pointed out the oil's potential in tackling animpressive array of health concerns, including coughs, constipation, elephantiasis, flu, gingivitis, headaches, leprosy, malaria, eye infections, pneumonia, and vascular disorders.Promila and Madan (2018) noted that lemongrass essential oil is packed with an extraordinary range of benefits, showcasing anti-inflammatory, antiviral, anticancer, antihyperglycemic, antioxidant, anti-malarial, anti-mutation, and antibacterial effects. With such a diverse array of properties and compounds, lemongrass emerges as an essential medicinal plant, pivotal for both the treatment and prevention of various health issues.

7.2) Cosmetics :-

Formulations for soaps, detergents, and cosmetics contain lemongrass oil. Additionally, it helps with muscle toning and the methodical recirculation of blood. When properly diluted, lemongrass is a long-lasting, non-irritating, affordable, and environmentally friendly deodorant with no negative side effects.

7.3) Agricultural Uses :-

Despite its numerous applications across various industries, lemongrass oil is also extensively utilized in agriculture. Oils derived from certain lemongrass species have been used in the production of germicides and bactericides. Additionally, lemongrass oil has demonstrated insecticidal, nematicidal, and fungicidal properties. Essential oil exhibits significant anti-insecticidal effects against the second-instar larvae of Agrotis ipsilon, commonly known as the black cutworm, which poses a threat to the seedling stages of numerous field crops in various countries worldwide.

7.4) Industrial Uses :-

Lemongrass oil is used as an additive ingredient in a variety of products, including as deodorant, insect and mosquito repellent cream, candles, polish, waxes, insecticides, antifungal cream, and fragrances, because of its appealing scent.

8) Health Benefits of Lemongrass :-

Flavonoids and phenolic compounds, which contain antioxidants, are abundant in lemongrass. In addition, it has anti- inflammatory and antioxidant qualities and is a powerful antibacterial and antifungal agent. Quercetin, a flavonoid with anti-inflammatory and antioxidant properties, is found in lemongrass. Iron, calcium, and vitamin C are also foundin lemongrass. Hemoglobin, a critical material that carries oxygen from your lungs to your blood, requires iron as a component.

8.1) Encouraging the reduction of weight :-

Lemongrass encourages the removal of excess fluid due to its diuretic qualities. This is an intriguing choice to incorporate into a weight loss diet since it can lessen bloating in the abdomen. View additional teas for weight loss that you may make at home.

8.2) Treating gastritis :-

Lemongrass includes a lot of flavonoids and tannins, it can help alleviate gastritis. These substances have

anti- inflammatory and antioxidant properties that neutralize and reduce stomach acid, which aids in the treatment of gastritis and acid reflux. Lemongrass can be used as a supplement to medical treatment for H. pylori because it also contains bactericide qualities. This stomach bacterium can lead to peptic ulcers, gastritis, and potentially some types of cancer.

8.3) Reducing LDL cholesterol :-

Antioxidants like limonene and geraniol, which are abundant in lemongrass, aid in the battle against free radicals and the inhibition of fat cell oxygenation. In addition to lowering triglyceride and LDL cholesterol levels, this can help prevent atherosclerosis, heart attacks, and strokes.

8.4) Managing insomnia and anxiety :-

Compounds with sedative properties (such as cirtral) found in lemongrass work on the immune system to enhance the quality of sleep. Lemongrass has calming and relaxing properties that can help with anxiety and stress management. Check out the other herbs for stress and anxiety that might help you relax and lessen symptoms.

8.5) Treating Yeast infection :-

Due to its fungicidal qualities, lemongrass can aid in the fight against Candida albicans, the fungus that causes oral thrush and vaginal yeast infections. Lemongrass may also be useful in treating athlete's foot and mycosis, among other fungal illnesses.

8.6) Managing Blood Pressure :-

Lemongrass encourages the removal of extra salt through the urine since it has diuretic qualities. This may help with blood pressure control. Furthermore, the anti-inflammatory and antioxidant substances in lemongrass, such as geraniol, citral, and lemonene, reduce inflammation and encourage vasodilation. This can lower blood pressure and enhance circulation. Learn about additional natural ways to treat high blood pressure that you can include into your daily routine.

Conclusion :-

The review provides us with a general understanding of lemongrass, including its sources, oil isolation techniques, pharmacological activity, Extraction methods and range of applications and also various health benefits of it.This plant is harmless and has several applications in the food, pharmaceutical, and agricultural sectors. The product has been confirmed to be harmless and nonirritating. Numerous bodily parts benefit from its infusion, which also shields our bodies from a wide range of illnesses. In the food and packaging industries, it serves as a natural preservative. Therefore, there is a lot of room for study and the creation of new formulations in the field of lemongrass.

Refrances :-

1) Oyedele AO, Gbolade AA, Sosan MB, Adewoyin FB, and Soyelu OL developed a topical insect repellent solutionusing lemongrass oil. 259–262 in Phytomedicine 9(3) (2002).

2) De Silveira, S.M., Junior, A.C., Scheuermann, G.N., Secchi, F.L., and Vieira, C.R.W. (2012) conducted the study.Composition and antibacterial properties Effectiveness of essential oils from certain herbs grown in Southern Brazil against food spoilage and foodborne pathogens. Ciencia. St. Maria in the countryside, 42 (7), 1300–1306.

3) Suryawanshi M.A., Mane V.B. and Kumbhar G.B. (2016). Methodology to extract essential oils from

lemongrass leaves: Solvent extraction approach. International Research Journal of Engineering and Technology (IRJET), 3 (8):1775-1780.

4) Lemon Grass: A Literature Review, P. Jayasinha. Industrial Technology Institute, Baudhaloka Mawatha, Colombo, Sri Lanka, 2001; Medicinal and Aromatic Plant Series No. 9.

5) Scientific foundation for the medicinal application of Cymbopogon citratus, staff (Lemongrass), J. Adv. Pharmaceutics Tech. Res, 2011; 2(1): 3–8. G. Shah, R. Shri, V. Panchal, N. Sharma, B. Singh, and A. Mann.

6) Edeh I, Samson O (2023) An in-depth analysis of lemon grass. 8(4): 258-273 EPRA International Journal of Research and Development.

7) Chemical structure of the major constituents of lemongrass .Research Gate.

8) Ferhat MA, Kameli A, Saidi F, Kebir HT, and Boukhatem MN. Essential oil from lemon grass (Cymbopogon citratus) antifungal and anti-inflammatory medication. Journal of Medicine in Libya, 2014, 9:25431-41.

9) Souza AF, Alves AC. Previous information regarding the phytochemical study of Cymbopogon citratus (D.C.)Stapf. Garcia de Orta, 1960; 8:629-638.

10) Sharma N, Singh B, Panchal V, Shah G, Shri R, and Mann AS. Scientific foundation for Cymbopogon Citratus(lemon grass) medicinal application J Adv. Pharm. Technol. Res. 2011; 2(1):3–8.

11) Asian Journal of Chemistry, 22(10): 7787. M.A. Hanif, H.N. Bhatti, M.S. Jamil, R.S. Anjum, A. Jamil, and M.M.
Khan. (2010). Antibacterial and antifungal activity of essential oils derived from medicinal plants using CO2 supercritical fluid extraction technique.

12) M. D. Toungos (2019). In Northern Nigeria, lemongrass (Cymbopogon (L.spreng).International Journal ofSustainable Agriculture, Nutrition, and Innovative Food 7(2):6–14.

13) Tuasaude.com/en/lemon-grass Health Benefits.

14) Soxhlet Extraction - an overview | Science Direct TopicsScienceDirect.com 15) Subodh, D., Ashish, M., and Viabhav, S. (2013). An overview of lemon grass's uses in agriculture and medicine. Journal of Pharmacy ResearchInternational, 4: 42–44.

16) Ziad, A.S., Azhari, N.H., Ranitha, M., Abdurahman, N.H., and Thana Raj, S. (2014). Comparison of the Microwave-Assisted Hydrodistillation (MAHD) and Conventional Hydrodistillation (HD) Methods for the Extraction of Lemongrass Essential Oil (Cymbopogon Citratus). Basic & Appl. Sci. Aust. J., 8(19): 72-76.

17) Saleem, M. Afza, N., Anwar, M.A., Muhammad, S., Hai, A. and Ali, M.S (2003b), A comparative study of essential oil of C. citratus and some members of the genus citrus, Natural Product Research, 17(5), 369-373.

18) Porto, C.D. and Decorti, D. (2009). Ultrasound-assisted extraction coupled with under vacuum distillation of flavor compounds from spearmint (carvone-rich) plants: Comparison with conventional hydrodistillation. Ultrasound Sonochem, 16(6): 795-799.

19) Balakrishnan B, Paramasivam S, and Arulkumar A assessed the antioxidant and antibacterial properties of the lemongrass plant (Cymbopogon citratus) extracted in various solvents against human infections. Journal of Tropical Disease in Asia Pacific 4(1): 134–139.

20) Sunita M. and Sukriti D. (2016) A Brief Overview of Cymbopogon Species' Enzyme Inhibition Activities and Chemical Composition for Therapeutic Use. 9(46): 1–9 in Indian Journal of Science and Technology.

21) Weisheimer V, Silva C, Guterres SS, and Schapoval EE (2008) Lemongrass oil and central's antifungal efficacyagainst Candida Braz Clin Infect Dis 12(1): 63-66.

22) Ajayi, E.O., Sadimenko, A.P., & Afolayan, A.J. (2016). GC-MS evaluation of Cymbopogon citratus (DC) Stapf oil derived using modified hydrodistillation and microwave extraction procedures. Food Chem, 209: 262-266.

23) Abera, A. (2020). Essential oil extraction and physicochemical examination of lemongrass leaves cultivated in Arbaminch, Ethiopia. Issue 10, pages 638–641, International Journal of Engineering Research &

Technology (IJERT).

24) Hassan, A.Y., Bayoum, H.M., Eissa, H.A., and Abd-El Fattah, S.M. (2010). lemongrass extracts' potential as foodadditives and antimicrobials in yoghurt. 582–594 in J. Am. Sci. 6 (11).

25) Oyeyemi, O.A., Asaolu, M.F., and Olanilokun, J.O. (2009). The chemical makeup, phytochemical components, and in vitro biological activity of several Cymbopogon citratus preparations. J Nutr Pakistan, 8(12): 1920–1922.

26) Chantal S., Prachakoli S., & Ruangviriyachai C. (2012). The effect of extraction methods study from Cymbopogon citratus. Journal of AOAC International, 95, 763-772.

27) Sari DM, Lestarisa T, Alexandra FD, Jelita H, Thalib I. Antioxidant and Anti-Glycation Activity of Ethanol fromLemongrass (Cymbopogon citratus) Leaves Extract.2017; 9(5):710-715.

28) Khorshidian, N., Yousefi, M., Khanniri, E., & Mortazavian, A. M. (2018). Potential application of essential oils as antimicrobial Preservatives in cheese. Innovative Food Science and Emerging Technologies, 45, 62–72.

29) Kusuma, H.S and Mahfud, M, (2016). Preliminary study: kinetics of oil extraction from sandalwood by microwave-assisted Hydrodistillation. IOP Conf. Series: Materials Science and Engineering 128, pp.1-7. Doi:10.1088/1757-899X/128/1/012009.

30) Shah G, Shri R, Panchal V, Sharma N, Singh B, et al. (2011) Scientific basis for the therapeutic use of Cymbopogon Citratus, Stapf (Lemon grass). Journal of Advanced Pharmaceutical Technology & Research 2(1):3-8.

31) Wannissorn B, Jarikasem S, Soontorntanasart T (1996) Antifungal activity of lemon grass oil and lemon grass oilcream. Phytotherapy Research 10(7): 551-554.

32) Ranitha M, Abdurahman H, Sulaiman Z, Nour A, Thana S (2014) Comparative study of lemongrass (Cymbopogon citratus) essential oil extracted by microwave-assisted hydrodistillation (MAHD) and conventionalhydrodistillation (HD) method.

33) Dr. Sorabh Sehajpal1*, Ms. Neetu Verma2, Dr. Amandeep Bhatia3, Rohit Raj4, Utkarsh Raj5 (2023) LemonGrass: A Review Article Depicting Its Extraction And Properties.

34) Mahouachi Wifek, Asma Saeed, Rafia Rehman and Shafaq Nisar (2016) Lemongrass: a review on its botany, properties, applications and active components IJCBS, 9:79-84