

Lemon Grass and Its Extraction Methods

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Lemongrass (*Cymbopogon citratus*), a perennial plant known for its aromatic and medicinal properties, is widely used in pharmaceuticals, cosmetics, food flavoring, and as a natural insect repellent. Rich in essential oils, lemongrass is predominantly valued for its citral content, which possesses anti-inflammatory, antimicrobial, and antioxidant properties. The extraction of essential oil from lemongrass can be achieved through various methods, including steam distillation, solvent extraction, and cold pressing. Among these, steam distillation is the most common and efficient method for obtaining high-quality essential oil. Supercritical fluid extraction using CO₂ is also gaining attention for its ability to preserve the bioactive components in lemongrass. The method of extraction significantly influences the quality, yield, and composition of the essential oil, which in turn determines its potential applications in various industries.

Keywords : Essential oil , steam distillation, solvent extraction ,cold pressing.

Introduction

Lemongrass (*Cymbopogon citratus*) is a tropical and subtropical plant widely cultivated for its essential oil, which is used in various industries, including cosmetics, pharmaceuticals, and food flavoring. Known for its lemon-like aroma, lemongrass is rich in compounds like citral, geraniol, and myrcene, which provide medicinal properties such as anti-inflammatory, antifungal, antibacterial, and antioxidant effects. Due to its versatile uses, lemongrass has become a key ingredient in natural health products, aromatherapy, and insect repellents. The extraction of essential oils from lemongrass is a critical process that determines the quality and yield of the product. Various extraction methods are employed depending on the desired end-use, with each method affecting the chemical composition and efficacy of the oil.



Extraction techniques

1. Steam distillation method.
2. Solvent extraction method.

3. Cold pressing method.
4. Supercritical fluid extraction method (SFE).

Steam Distillation Method

Steam distillation is the most commonly used method for extracting essential oils from lemongrass due to its efficiency and ability to preserve the plant's volatile compounds. The method works by using steam to separate the essential oil from the plant material, taking advantage of the oil's volatility and immiscibility in water. Here's a breakdown of the process:

Preparation of Plant Material: Fresh or partially dried lemongrass leaves and stalks are chopped into small pieces to maximize the surface area for better oil release during distillation. The plant material is then placed in the distillation chamber.

Generation of Steam: Steam is generated by boiling water in a separate container (boiler). This steam is introduced into the distillation chamber containing the lemongrass. As the steam passes through the plant material, it heats the cells, causing them to rupture and release the essential oil.

Vaporization and Collection: The heat from the steam vaporizes both the essential oil and water-soluble compounds in the lemongrass. The steam carrying the oil vapour then passes through a condenser, where it cools down and condenses back into liquid form.

Separation of Oil and Water: The condensed liquid, consisting of both water and essential oil, is collected in a separator, typically called a Florentine flask. Since essential oils are lighter than water and immiscible, the oil floats on top of the water, allowing for easy separation. The oil is then collected, while the water (often called hydrosol) can be reused or discarded.

Advantages of Steam Distillation:

Preservation of Heat-Sensitive Compounds: Since the steam is typically at a lower temperature than direct boiling, this method prevents the degradation of the essential oil's heat-sensitive compounds.

Cost-Effective and Scalable: Steam distillation is relatively simple to set up and scale for both small and large production systems, making it widely used in the commercial production of essential oils.

High Purity of Oil: The process yields pure essential oil without the need for chemical solvents, making the product suitable for therapeutic, cosmetic, and food-grade applications.

Factors Influencing Oil Quality:

Steam Temperature and Pressure: The temperature and pressure of the steam must be carefully controlled to ensure optimal extraction without damaging the oil. Too high a temperature can cause degradation of volatile compounds, while too low a temperature may result in incomplete extraction.

Duration of Distillation: The length of the distillation process also affects the oil yield and quality. If the process is too short, not all oil will be extracted; if too long, some desirable compounds may be lost.

Yield and Composition:

The essential oil extracted through steam distillation from lemongrass typically contains high concentrations of citral (up to 75-85%), which is responsible for its characteristic lemony fragrance, along with other compounds like geraniol and myrcene. The overall yield is typically around 0.2-0.4% of the plant's fresh weight, depending on factors like plant maturity, harvest conditions, and distillation efficiency .

Solvent Extraction Method for Lemongrass Essential Oil

Solvent extraction is another method used for extracting essential oils from lemongrass, particularly when heat-sensitive compounds need to be preserved or when the desired oil

contains heavy or less volatile components that cannot be efficiently extracted through steam distillation. This process involves using organic solvents to dissolve the essential oils from the plant material, followed by solvent evaporation to obtain the pure oil.

Preparation of Plant Material: Fresh or dried lemongrass leaves and stalks are first chopped into small pieces to increase the surface area for extraction. In some cases, the plant material is dried before extraction to reduce moisture content, which can interfere with the efficiency of the solvent.

Mixing with Solvent: The prepared plant material is soaked in an organic solvent, such as hexane, ethanol, or petroleum ether. The solvent dissolves the essential oils and other non-volatile components from the plant. The mixture is allowed to sit for a set period to ensure complete dissolution.

Filtration and Solvent Evaporation: After the essential oils have dissolved, the mixture is filtered to remove the solid plant matter. The solvent containing the dissolved essential oil is then subjected to evaporation, usually under reduced pressure or heat. This process removes the solvent, leaving behind a concentrated extract, commonly referred to as concrete.

Separation of Essential Oil: The concrete contains essential oils along with waxes, resins, and pigments. To purify the essential oil, the concrete is dissolved in alcohol, and the waxes are separated by cooling. The alcohol is then evaporated to obtain the purified essential oil, often called an absolute.

Advantages of Solvent Extraction:

Efficient Extraction of Non-Volatile Compounds: Solvent extraction is ideal for extracting less volatile or heavier aromatic compounds that may not be easily distilled through steam distillation.

Preservation of Heat-Sensitive Compounds: Since the process does not require high temperatures, it is suitable for preserving delicate components that could degrade under the heat of steam distillation.

Higher Yields: Solvent extraction tends to yield more essential oil compared to steam distillation, as it captures a broader range of compounds from the plant.

Disadvantages:

Use of Chemical Solvents: The use of organic solvents, particularly non-food-grade options like hexane or petroleum ether, can raise concerns about the presence of residual solvent in the final product. However, food-grade solvents like ethanol are sometimes used for applications where purity is critical.

Complex Post-Processing: Additional steps, such as the removal of waxes and resins, are required to obtain the pure essential oil, which increases the complexity of the process.

Loss of Volatile Compounds: Some of the lighter, more volatile compounds can be lost during solvent evaporation, affecting the aroma and chemical profile of the essential oil.

Factors Influencing Oil Quality:

Solvent Selection: The choice of solvent significantly affects the quality of the extract. Non-polar solvents like hexane are more efficient at dissolving lipophilic (oil-loving) compounds, but may introduce contaminants. Food-grade solvents like ethanol offer a safer alternative, especially for cosmetic and food-related products.

Solvent Removal: The method and effectiveness of solvent removal impact the purity of the final oil. Any residual solvent can lower the quality and safety of the essential oil, making proper evaporation and purification critical.

Concentration of Extract: Since solvent extraction captures both volatile and non-volatile compounds, the final product may contain waxes, resins, and pigments. These can be desirable for some applications (like perfumes) but may need removal for others.

Yield and Composition: Solvent extraction typically produces a higher yield than steam distillation due to its ability to extract a broader range of compounds, including non-volatile

components. The essential oil obtained through this method is richer in aromatic compounds, though it may contain waxes and other plant lipids. The resulting product is highly fragrant and can be used in perfumes and cosmetics where a richer aroma profile is desired.

Applications:

Perfume Industry: The absolute obtained from solvent extraction is highly valued for its strong, long-lasting fragrance and is commonly used in high-end perfumes.

Cosmetics and Pharmaceuticals: Because solvent extraction can yield compounds that enhance skin care formulations (such as waxes), it is often used in beauty and medicinal products.

Aromatherapy and Flavors: When ethanol is used as the solvent, the final product is suitable for food flavoring and aromatherapy, though the presence of residual solvent is carefully monitored.

Cold Pressing Method for Lemongrass Extraction

Cold pressing is a mechanical method traditionally used for extracting essential oils, particularly from citrus fruits. However, in the case of lemongrass, it is less commonly employed because lemongrass oil is primarily stored in the plant's fibers and is not as easily released through pressure alone. Still, this method can be adapted for lemongrass when aiming to preserve delicate compounds that could be affected by heat.

Preparation of Plant Material: Fresh lemongrass stalks and leaves are washed and cut into small pieces. It is important that the plant material remains fresh and moist, as the mechanical pressing relies on the moisture content of the plant to release the oil.

Mechanical Pressing: The plant material is then subjected to mechanical pressure using a cold press machine. In this process, the material is crushed, and the pressure forces out the essential oils along with plant juices. The cold pressing technique involves no heat, preserving the integrity of heat-sensitive compounds that can be degraded at higher temperatures.

Separation of Oil from Plant Juice: After the mechanical pressing, the mixture of plant juice and essential oil is collected. Since essential oils are lighter than water, they float to the surface, allowing for separation. The oil is then decanted or skimmed off from the water-based plant juice.

Filtration: To ensure purity, the extracted oil may undergo filtration to remove any remaining plant particles. Since no heat is used, the oil is considered to be raw and retains the full spectrum of its natural compounds.

Advantages of Cold Pressing:

No Heat Degradation: Cold pressing preserves the volatile and heat-sensitive compounds in lemongrass essential oil, maintaining its natural chemical profile.

Environmentally Friendly: This method is eco-friendly, as it does not require the use of solvents or large amounts of water, and there is no chemical waste involved.

Pure, Natural Oil: The oil produced is free from chemical contamination since no solvents are used in the process, making it suitable for applications requiring pure, natural oils.

Disadvantages:

Low Yield: Cold pressing yields significantly less essential oil compared to methods like steam distillation or solvent extraction. This is because the mechanical process cannot extract as much oil from the plant material, especially when dealing with plants like lemongrass that store oil in fibrous tissues.

Less Efficient for Lemongrass: Since lemongrass does not naturally release oil easily like citrus fruits, cold pressing is less efficient and practical compared to other methods like steam distillation.

Factors Influencing Oil Quality:

Pressure Applied: The amount of pressure used during the pressing process can affect both the yield and the quality of the oil. If the pressure is too low, less oil will be extracted. Excessive pressure, however, may cause the release of undesirable compounds like plant waxes or excess moisture.

Moisture Content: The freshness and moisture content of the plant material significantly impact the efficiency of cold pressing. Drier material will yield less oil, and excessively wet material may result in a less concentrated product.

Yield and Composition:

Cold pressing generally produces lower yields compared to steam distillation or solvent extraction. The composition of the oil may differ slightly as well, as this method tends to capture more plant-based compounds, including traces of water-soluble elements. The resulting oil is rich in aromatic compounds, but the concentration of essential oils like citral may be lower due to the lower extraction efficiency.

Applications:

Cosmetic and Skincare Products: The cold-pressed oil is often used in cosmetic products because it retains its natural properties and is free from chemical residues. Its gentle extraction process makes it ideal for sensitive skin applications.

Aromatherapy: The purity and intact aromatic compounds of cold-pressed lemongrass oil make it desirable for aromatherapy, where the holistic benefits of the oil are sought.

Natural Cleaning Products: Given its natural purity, cold-pressed lemongrass oil can be used in eco-friendly cleaning solutions and insect repellents.

Supercritical Fluid Extraction (SFE) Method for Lemongrass

Supercritical fluid extraction (SFE) is an advanced and highly efficient method used for extracting essential oils from plants, including lemongrass. This technique utilizes supercritical carbon dioxide (CO₂) as a solvent to extract the essential oils. In its supercritical state, CO₂ exhibits properties of both a gas and a liquid, making it an excellent solvent for extracting volatile compounds from plant material. This method is known for producing high-purity extracts with minimal thermal degradation, which is particularly advantageous for heat-sensitive compounds in lemongrass.

Preparation of Plant Material: Fresh or dried lemongrass is cut into small pieces to maximize surface area for extraction. The plant material is placed in the extraction chamber, where the supercritical fluid will interact with it.

CO₂ Compression and Heating: Carbon dioxide is subjected to high pressure (usually above 73.8 bar) and moderate temperature (above 31°C) to enter its supercritical state. In this state, CO₂ behaves like a liquid in terms of its ability to dissolve essential oils, but it can also diffuse through solid plant material like a gas.

Extraction: The supercritical CO₂ is passed through the lemongrass plant material in the extraction chamber. The supercritical CO₂ penetrates the plant material and dissolves the essential oils and other non-polar compounds, extracting them from the plant matrix. The CO₂ acts as a solvent, selectively extracting volatile oils while leaving behind unwanted materials like chlorophyll and waxes.

Separation: The supercritical CO₂ carrying the dissolved essential oils is then depressurized in a separate chamber (separator). As the pressure is lowered, the CO₂ returns to its gaseous state, releasing the essential oil. The CO₂ can be recycled for reuse, while the pure lemongrass essential oil is collected.

Purification: Depending on the desired product, the essential oil may undergo further purification steps, although SFE typically yields very pure oil directly.

Advantages of Supercritical Fluid Extraction:

High-Purity Extraction: SFE produces extremely pure essential oil without the need for chemical solvents, making it ideal for applications that require high-quality, uncontaminated oils, such as pharmaceuticals, cosmetics, and food products.

No Thermal Degradation: The process is conducted at low temperatures, which preserves the integrity of heat-sensitive compounds in lemongrass, such as citral, geraniol, and myrcene.

Eco-Friendly and Sustainable: CO₂ is a non-toxic, non-flammable, and readily available gas that can be recycled within the system, making SFE an environmentally friendly process with minimal waste.

Selective Extraction: By adjusting the temperature and pressure, SFE can be fine-tuned to selectively extract specific components from lemongrass, allowing control over the composition of the final product.

Efficient Use of Resources: SFE extracts more active compounds from the plant material than traditional methods, often resulting in higher yields of essential oil.

Disadvantages:

High Initial Costs: The equipment required for SFE is expensive, making the initial setup cost high compared to other extraction methods such as steam distillation or solvent extraction. This limits its use to industries with the necessary capital for investment.

Complex Operation: The process requires precise control of pressure and temperature, making it more complex than simpler methods like steam distillation. Operators need specialized knowledge to run SFE systems efficiently.

Factors Influencing Oil Quality

Pressure and Temperature: The pressure and temperature of the CO₂ during extraction play a crucial role in determining the yield and composition of the oil. Higher pressures may extract more compounds, but care must be taken to avoid extracting unwanted waxes or resins.

Extraction Time: Longer extraction times can increase the yield, but if too long, it may result in the extraction of unwanted components. Optimization of extraction time is essential to maintain high oil quality.

CO₂ Flow Rate: The flow rate of CO₂ through the plant material can also affect the efficiency of extraction. A higher flow rate can result in faster extraction but may lead to incomplete extraction of all desired compounds.

Yield and Composition:

SFE produces a higher yield of lemongrass essential oil compared to steam distillation, as it extracts a broader range of volatile and non-volatile compounds. The oil obtained from SFE is highly concentrated in key active compounds such as citral (which gives lemongrass its characteristic lemon-like scent) and myrcene, but it can also include beneficial compounds that are often left behind in traditional methods.

The composition of the essential oil can be carefully controlled by adjusting the pressure and temperature of the CO₂, allowing for the extraction of specific compounds based on the desired application.

Applications:

Pharmaceutical Industry: Due to its purity and high-quality composition, lemongrass oil extracted via SFE is used in medicinal products, particularly for its antimicrobial, antifungal, and anti-inflammatory properties.

Food and Flavoring: SFE-extracted lemongrass oil is food-safe and can be used as a natural flavoring agent in beverages, sauces, and other food products.

Cosmetics and Perfumes: The high-purity oil is ideal for use in cosmetic and fragrance formulations where both quality and scent intensity are crucial.

Aromatherapy: Lemongrass oil obtained via SFE retains the full range of aromatic compounds, making it highly desirable in aromatherapy for its therapeutic benefits.

Conclusion

The extraction of lemongrass essential oil can be achieved through various methods, each with distinct advantages and limitations. Steam distillation remains the most widely used method due to its cost-effectiveness, simplicity, and ability to produce high-quality oil without chemical contamination. Solvent extraction, while yielding a higher concentration of compounds, is often more complex and may leave trace solvents, making it less desirable for applications requiring absolute purity. Cold pressing is less common for lemongrass due to its lower efficiency but offers a solvent-free and heat-free option that preserves delicate compounds. Lastly, supercritical fluid extraction (SFE) is a highly efficient, eco-friendly, and advanced technique that produces exceptionally pure oils with minimal degradation, although it requires significant capital investment. Ultimately, the choice of extraction method depends on factors like the desired oil quality, yield, cost, and the specific application of the oil. For high-purity products in industries like pharmaceuticals, cosmetics, and food, SFE and steam distillation are preferred.

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