

Review

A Review on Volatile (Essential) Oils: Chemistry, Extraction Methods, and Industrial Applications

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Abstract:

Volatile oils, also known as essential oils, are naturally occurring secondary metabolites produced by aromatic and medicinal plants. Although they constitute less than 5% of total plant composition, they possess significant biological and commercial value due to their characteristic aroma and diverse pharmacological activities. These oils are composed mainly of terpenes, terpenoids, and aromatic compounds and are distributed in various plant parts such as flowers, leaves, bark, seeds, fruits, and wood. Volatile oils exhibit distinct physical, chemical, and organoleptic properties, including high volatility, strong odor, optical activity, and solubility in organic solvents. They demonstrate a wide range of biological activities such as antimicrobial, antioxidant, anti-inflammatory, antiviral, and insecticidal effects, making them important in pharmaceutical, cosmetic, food, and aromatherapy industries. Various extraction techniques, including steam distillation, hydrodistillation, expression, solvent extraction, enfleurage, and supercritical CO₂ extraction, are employed based on the nature of plant material and desired oil quality. Each method influences the yield, purity, and stability of the extracted oil.

Keywords: Volatile oils, Essential oils, Terpenes, Steam distillation, Supercritical CO₂ extraction, Pharmacological activities, Industrial applications

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Introduction Of Volatile Oils

Volatile oils is a secondary metabolite synthesized by medicinal and aromatic plants. It represents less than 5% of the total plant composition. Over 3000 types of volatile oils have been identified, but only 300 were found to be economical [1, 2].

Volatile oils is volatile, generally colorless, and liquid at room temperature. It is highly soluble in organic solvents, alcohol, and fixed oils but sparingly soluble in water. It has very high optical activity, a variable refractive index, and

sometimes a distinctive taste. In addition, volatile oils have a characteristic odor, that is responsible for the fragrance specific to the aromatic plant. Chemically volatile oils components can be divided into terpene compounds and aromatic compounds. It is a mixture of bioactive chemical components such as terpenoids, terpenes, and phenolic compounds. They are made up of terpene compounds, acids, alcohols, esters, aldehydes, ketone epoxides, sulfides, and amines. They are synthesized by the majority of plant organs, in particular flowers, buds, leaves, seeds,

stems, and fruits. These volatile oils can be stored in epidermal cells, cavities, and the secretory cells of glandular trichomes. Volatile oils recent advances, new perspectives and applications volatile oils are known for their biological activity, notably their antioxidant, antifungal, antimicrobial, antiviral, antiparasitic, antimycotic, and insecticidal properties [3, 4].

Several extraction techniques are used; Hydro-distillation and steam extraction are the oldest, simplest, and most commonly used methods. Other extraction methods can also be used: cold pressing, especially applied to rose. Volatile oils extraction method generally depends on the botanical material used. It is one of the main factors determining volatile oils quality. An inappropriate extraction procedure can damage or alter the chemical composition of volatile oils. This results in a loss of bio-activity and natural characteristics. In the most serious cases, this is accompanied by discoloration, an unpleasant odor or flavor, and physical changes such as increased viscosity [5].

The principle of volatile oils extraction is relatively straightforward. However, the process chosen can have a significant effect on the yield and quality of the distillate obtained. Various processes have therefore been developed to obtain maximum yields of volatile oils with a chemical state as close as possible to their native structure. According to the European Pharmacopeia, a volatile oils can be obtained by steam distillation, distillation, or a mechanical process. Other processes include supercritical CO₂ extraction, volatile organic solvent extraction, microwave extraction, and ultrasonic extraction. The aim of this chapter is to present an overview of the various extraction methods [6].

Properties Of Volatile Oils

Volatile oils exhibit a number of characteristic physical, chemical, and organoleptic properties which help in their identification, purity testing, and standardization.

Physical Properties:[7].

1. State and Appearance: Volatile oils are generally colorless or pale yellow when freshly distilled. However, they may darken on storage due to oxidation and resin formation.
2. Odor and Taste: They usually possess a strong, pleasant or pungent aromatic odor. Their taste may be spicy, cooling,

pungent, irritant, or bitter depending on the chemical components.

3. Volatility: Volatile oils evaporate readily when exposed to air, especially at room temperature, without leaving a greasy stain. This distinguishes them from fixed (non-volatile) oils.
4. Solubility
 - Insoluble in water, but impart aromatic flavor to water (e.g., rose water).
 - Soluble in organic solvents such as alcohol, ether, chloroform, and fixed oils.
5. Boiling Point: Usually high, ranging between 150°C to 250°C. Therefore, they are commonly extracted by steam distillation, which avoids decomposition.
6. Specific Gravity: Most volatile oils are lighter than water (specific gravity < 1), hence they float. Exception: Clove oil and Cinnamon oil are heavier than water.
7. Refractive Index: They have high refractive index due to aromatic ring structures. This property helps in purity testing.
8. Optical Activity: Some volatile oils may rotate plane-polarized light, which serves as a characteristic identification test.

Chemical Properties:

1. Susceptibility to Oxidation: On exposure to light, air, and heat, volatile oils undergo oxidation and may form resins and peroxides, reducing their medicinal and aromatic value.
2. Combustibility: Many volatile oils are highly flammable and should be stored away from ignition sources.
3. Formation of Resin and Polymerization: Prolonged storage leads to thickening and resinification due to polymerization of unsaturated compounds.
4. Reaction with Alkalies: Some volatile oils containing phenolic components (e.g., eugenol in clove oil) form salts with alkali.
5. Ability to Form Emulsions: Volatile oils can be dispersed in water with the help of emulsifying agents. This is useful in pharmaceutical formulations like mouthwashes and liniments.

Organoleptic Properties (Sensory Evaluation):

Table 1. Organoleptic Properties of volatile oil

Parameter	Description
Color	Colorless to pale yellow when fresh; may turn yellowish-brown on aging due to oxidation and resin formation.
Odor	Strong, characteristic, aromatic odor specific to the plant source.
Taste	Pungent, spicy, cooling, or irritant depending on chemical composition (e.g., menthol gives cooling sensation).
Texture (Feel)	Non-greasy, smooth, and volatile; evaporates quickly without leaving an oily stain.

Organoleptic evaluation helps in rapid identification of crude drugs containing volatile oils.

Source of Volatile Oils [8].

Volatile oils are widely distributed in the plant kingdom and occur in various parts of the plant. Their presence is associated with specialized secretory structures such as oil glands, glandular trichomes, secretory ducts, resin canals, and lysigenous cavities. The location and concentration of the volatile oil differ from plant to plant and influence extraction efficiency.



Fig.1: Volatile oils

Volatile oils are obtained from the following plant parts:

Flowers: Certain flowers store volatile oils in glandular trichomes present on petals or floral tissues. These oils contribute to the aroma and attract pollinators.

Table 2. Oil Extract from Flowers

Plant	Volatile Oil	Use

<i>Rosa centifolia</i> / Rose	Rose oil	Perfumery, cosmetics
<i>Lavandula officinalis</i> / Lavender	Lavender oil	Aromatherapy, sedative
<i>Jasminum grandiflorum</i> / Jasmine	Jasmine oil	Perfumes, anxiolytic

Leaves: Leaves often contain volatile oils in epidermal glands or trichomes.

Table 3. Oil Extract form Leaves

Plant	Volatile Oil	Use
<i>Mentha piperita</i> / Peppermint	Peppermint oil	Carminative, flavoring
<i>Eucalyptus globulus</i> / Eucalyptus	Eucalyptus oil	Expectorant

Bark: Oils in bark are usually found in secretory cells and resin ducts.

Table 4. Oil Extract from Bark

Plant	Volatile Oil	Use
<i>Cinnamomum zeylanicum</i> / Cinnamon	Cinnamon oil	Spice, carminative
<i>Cinnamomum camphora</i> / Camphor tree	Camphor oil	Rubefacient, stimulant

Wood: Wood commonly stores volatile oils in xylem tissue and resin canals.

Table 5. Oil Extract from Wood

Plant	Volatile Oil	Use
<i>Santalum album</i> / Sandalwood	Sandalwood oil	Perfumery, antiseptic
<i>Cedrus deodara</i> / Cedarwood	Cedarwood oil	Insect repellent, fragrance

Fruits and Peels: Fruit peels have oil glands that burst when pressed (expression method).

Table 6. Oil Extract form Fruits and Peels

Plant	Volatile Oil	Use
<i>Citrus limon</i> / Lemon	Lemon oil	Flavoring, beverage industry
<i>Citrus sinensis</i> / Orange	Orange oil	Perfume, flavoring
<i>Pimpinella anisum</i> / Anise	Anise oil	Expectorant, flavoring

Seeds: Oils are stored in oil sacs inside seeds.

Table 7. Oil Extract from Seeds

Plant	Volatile Oil	Use
<i>Foeniculum vulgare</i> / Fennel	Fennel oil	Carminative
<i>Coriandrum sativum</i> / Coriander	Coriander oil	Flavoring, digestive

Importance Of Volatile Oils [9].

Volatile oils play an important role in medicine, industry, cosmetics, food, and aromatherapy. Their characteristic fragrance and pharmacological actions make them valuable in various therapeutic and commercial applications. Many volatile oils exhibit antimicrobial, carminative, analgesic, anti-inflammatory, expectorant, and antiseptic properties. Therefore, they are widely used in traditional as well as modern herbal medicine.

1. **Pharmaceutical Formulations**

Volatile oils are used as flavoring agents, preservatives, and active ingredients in pharmaceutical preparations such as syrups, inhalants, liniments, balms, and ointments.

2. **Aromatherapy and Mental Wellness**

The fragrance of volatile oils has significant psychological and emotional effects. Oils like lavender and sandalwood are used to promote relaxation, reduce stress, and improve sleep.

3. **Food Industry**

Many volatile oils act as natural flavoring agents in beverages, confectioneries, bakery products, and spices due to their characteristic aroma.

4. **Cosmetic and Perfumery Industry**

Due to their long-lasting fragrance and skin benefits, volatile oils are used in the production of perfumes, soaps, hair oils, talcum powders, face creams, and lotions.

5. **Insect Repellents and Disinfectants**

Some volatile oils such as neem, citronella, and eucalyptus have insect repellent and antiseptic properties and are used in mosquito repellents, room fresheners, and disinfectant solutions.

Applications Of Volatile Oils [10].

Volatile oils are volatile, aromatic compounds obtained from various parts of plants such as flowers, leaves, seeds, bark, and roots. Due to their medicinal and aromatic properties, they have

wide applications in pharmaceutical, cosmetic, food, and fragrance industries.

Table 8. Application of Volatile Oil

Volatile Oil	Botanical Source	Major Use / Application
Eucalyptus oil	<i>Eucalyptus globulus</i>	Expectorant in cough and cold preparations; inhalations
Clove oil	<i>Syzygium aromaticum</i>	Analgesic and antiseptic in dentistry (eugenol)
Peppermint oil	<i>Mentha piperita</i>	Carminative; relieves indigestion and flatulence
Cinnamon oil	<i>Cinnamomum zeylanicum</i>	Carminative and spice; flavoring agent
Lavender oil	<i>Lavandula officinalis</i>	Sedative; used in aromatherapy and perfumes
Lemon oil	<i>Citrus limon</i>	Flavoring in drinks and confectionery
Tea tree oil	<i>Melaleuca alternifolia</i>	Antibacterial; used in skin-care and acne products
Citronella oil	<i>Cymbopogon nardus</i>	Mosquito repellent and room freshener

Techniques Of Extraction Of Volatile Oil [11].

Extraction of volatile oils is carried out to obtain pure aromatic constituents from different parts of the plant such as leaves, flowers, bark, seeds, roots, and peels. The method selected depends on plant part, heat sensitivity, oil content, and commercial feasibility. The major techniques are:

Steam Distillation: [12,13].

Introduction:

Steam extraction (Figure 1) is a widely used and official method for extracting essential oils from plants. This method accounts for 93% of essential oil extractions and can take anywhere from 1 to 10 hours depending on factors such as extraction time, temperature, pressure, and type of material. In this extraction system, plant material is exposed to a This method is suitable for plants that contain volatile oils stored in glands or secretory tissues, which release their contents when subjected to heat and moisture.

Principle:

Volatile oils are immiscible with water. When water (or steam) is passed through the plant material, both water and the volatile oil co-distill.

A mixture of steam and oil vapor forms, which boils at a temperature lower than the boiling point of the volatile oil alone. This allows extraction without decomposition of heat-sensitive components.

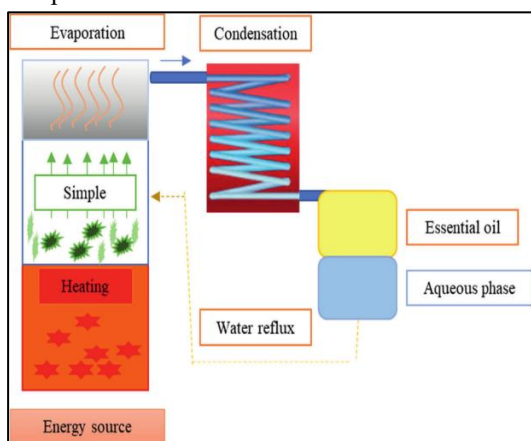


Fig.2: Steam distillation

Procedure:

1. The plant material is cleaned and then placed in the distillation still.
2. Steam generated from a boiler is passed through the plant material.
3. Steam ruptures oil glands, causing volatile oils to evaporate along with water vapor.
4. The mixture of oil vapor and steam is passed into a condenser, where it cools and returns to liquid form.
5. The condensed mixture flows into an oil separator (also called Florentine separator).
6. Because volatile oils and water usually differ in density, the oil floats or sinks and can be separated easily.
7. The separated essential oil is collected, filtered, and stored in airtight amber-colored bottles to prevent oxidation.

Advantages:

1. Prevents Decomposition of Oils:
Since the extraction occurs at lower temperatures, heat-sensitive volatile oils are protected from degradation.
2. No Residual Solvent Contamination:
The process does not require chemical solvents, resulting in pure and natural oils without residue.
3. Simple and Economical Method:
Requires basic apparatus and low maintenance, making it cost-effective and easy to operate.

Disadvantages:

1. Not Suitable for All Plant Materials:
Some plants or oils may degrade or are not efficiently extracted by steam distillation.
2. High Energy Consumption:
Continuous heating of water to produce steam requires significant energy.
3. Longer Extraction Time:
The process may be time-consuming, especially for materials with low oil content.

Examples of oils obtained by steam distillation:

- Eucalyptus oil
- Peppermint oil
- Clove oil
- Fennel oil
- Cinnamon leaf oil

Hydrodistillation (Water Distillation): [14-16].

Introduction:

Hydro-distillation, also known as Water Distillation, is one of the oldest methods used to extract volatile oils from plant materials. It is commonly applied to dry, hard, or tough plant parts such as roots, bark, wood, and dried flowers, which may be difficult to penetrate using steam alone.

In this method, the plant material is immersed in water, and the mixture is boiled. The volatile oil vaporizes along with steam and is later condensed and separated.

Principle:

The plant material is boiled directly in water. When the temperature rises, the volatile oil evaporates along with water vapor. The vapor containing oil and steam is then condensed and the oil is separated due to the difference in density and immiscibility with water. Since the oil is co-distilled with water, it distills at a temperature lower than its actual boiling point, reducing the risk of decomposition.

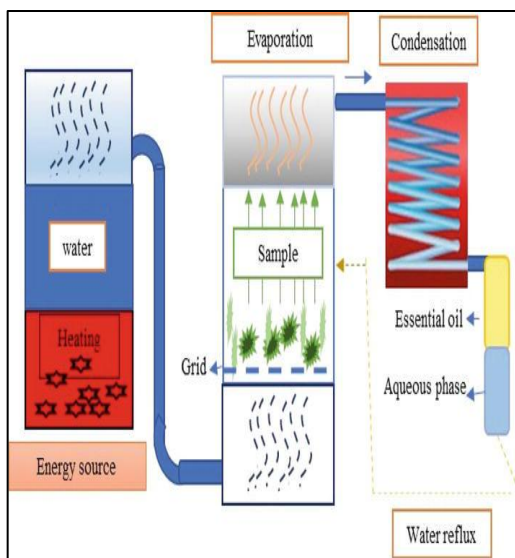


Fig.3: Hydro-distillation (Water distillation)

Procedure:

1. The plant material is placed in a distillation vessel, and enough water is added to completely immerse the material.
2. The vessel is heated, and water is boiled.
3. The volatile oil vaporizes with the steam released.
4. The steam containing volatile oil is passed into a condenser, where it is cooled and converted into liquid form.
5. The condensed mixture collects in an oil separator.
6. Due to differences in density, the oil separates from the water layer.
 - o Some oils float (like clove oil)
 - o Some sink (like cinnamon bark oil)
7. The separated oil is collected, filtered, and stored in airtight amber bottles to prevent oxidation and evaporation.

Advantages:

- Prevents decomposition of heat-sensitive oils.
- Does not require chemical solvents.
- Produces natural and pure essential oils.
- Simple and economical technique.

Disadvantages:

- Time-consuming process.
- Requires large volume of water and heat.
- Not suitable for materials that swell or become sticky in water.
- Some oils may undergo slight hydrolysis.

Examples of oils extracted by hydro-

distillation:

- Clove oil
- Cinnamon bark oil
- Turpentine oil
- Pine oil
- Cajeput oil

Expression Method (Cold Expression / Mechanical Pressing): [17]

Introduction:

The Expression Method is a mechanical extraction technique used mainly for obtaining volatile oils from the peels of citrus fruits such as lemon, orange, bergamot, and lime. These oils are highly sensitive to heat, and therefore steam distillation may destroy their aroma or alter chemical composition. In this method, the oil glands present in the peel are physically ruptured using pressure, and the released oil is collected without the use of heat or solvents. This ensures that the natural fragrance and freshness of the oil are preserved.

Principle:

Volatile oils present in oil glands of citrus peels are released when the peel is mechanically pressed or ruptured. Since no heat is applied, the extracted oil retains its natural aroma and chemical profile. Oil is separated from moisture and impurities by filtering and centrifugation.

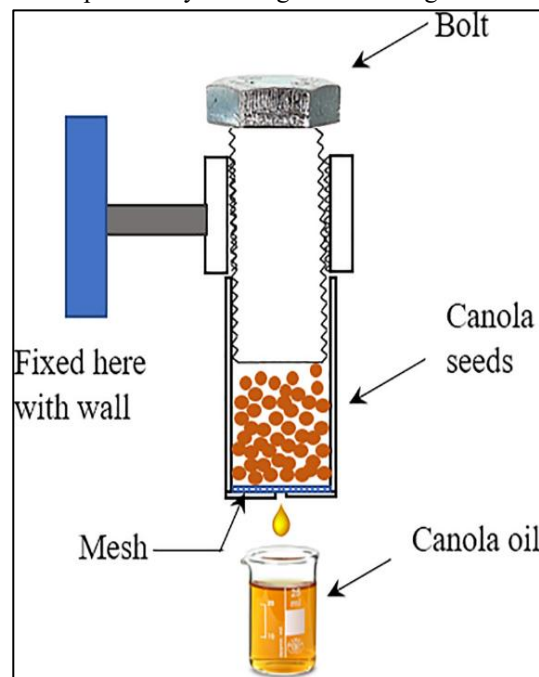


Fig.4: Expression method (Cold expression / Mechanical pressing)

Procedure:

1. Fresh citrus fruits are washed

- thoroughly.
2. The outer peel containing oil glands is removed or abraded.
 3. The peel is mechanically pressed or rolled to rupture oil glands and release oil.
 4. The resulting mixture of oil + fruit juice + water is collected.
 5. The mixture is subjected to centrifugation to separate oil from water and peel debris.
 6. The separated oil is filtered and collected in dark glass containers to prevent oxidation.

Advantages:

- No heat, so oils retain natural aroma and are not decomposed.
- Produces high-quality pure oils.
- Simple and does not require complicated equipment.

Disadvantages:

- Applicable mainly to citrus fruits only.
- Yield may be lower than some other extraction methods.
- Requires fresh plant material, cannot be done with dried peels.

Examples of oils obtained by expression method:

- Lemon oil (*Citrus limon*)
- Orange oil (*Citrus aurantium*)
- Bergamot oil (*Citrus bergamia*)
- Grapefruit oil (*Citrus paradisi*).

Solvent Extraction Method: [18].

(Also known as Volatile Solvent Extraction or Enfleurage / Extraction with Organic Solvents)

Introduction:

Solvent Extraction is used to obtain volatile oils from delicate and heat-sensitive flowers such as jasmine, rose, violet, and tuberose, which cannot withstand the high temperatures of steam distillation. In this method, non-polar organic solvents (e.g., petroleum ether, hexane, benzene) are used to dissolve the volatile oils present in the plant material. After extraction, the solvent is evaporated, leaving behind a wax-like aromatic material called concrete, which is further purified to obtain absolute oil. This method preserves the natural fragrance and purity of the oil, making it highly valuable in perfumery and cosmetic industries. The produced Volatile oil contains a small amount of solvent residue, making it

unsuitable for food applications. However, if alcohol is used as the solvent, it is considered “food grade” and safe for consumption. This method is commonly used in the perfume industry.

Principle:

Volatile oils are soluble in non-polar organic solvents.

When the plant material is treated with an organic solvent:

- Oil and other fat-soluble components dissolve in the solvent
- After filtration and evaporation of solvent → Concentrated oil (concrete) remains
- Treatment of concrete with alcohol removes waxes and impurities → absolute oil is obtained.

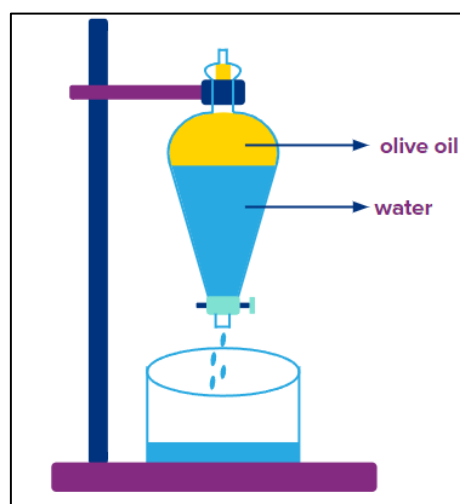


Fig.5: Solvent Extraction Method

Procedure:

1. Fresh flowers are placed inside a rotating drum or extractor.
2. A volatile organic solvent (like hexane) is added to the drum.
3. The solvent dissolves volatile oils, pigments, and waxes from the flowers.
4. The solution obtained is filtered to remove plant residue.
5. The solvent is evaporated under reduced pressure, leaving behind a semi-solid fragrant mass called concrete.
6. The concrete is washed with alcohol, which selectively dissolves the oil but leaves behind wax.
7. Alcohol is then evaporated, and the remaining material is called absolute oil (pure fragrance oil).

Advantages:

- Suitable for heat-sensitive and delicate flowers.
- Produces high-quality aromatic oils used in perfumery.
- Gives higher yield compared to distillation methods.
- No decomposition of oil due to low-temperature extraction.

Disadvantages:

- Residual traces of solvents may remain in the final product.
- Solvents used may be toxic and require careful handling.
- More expensive and requires specialized equipment.
- Not economical for bulk essential oil production.

Examples of oils obtained by solvent extraction:

- Jasmine oil
- Rose oil
- Violet oil
- Tuberose oil.

Enfleurage Method: [19].

Introduction:

Enfleurage is a traditional and gentle method used to extract volatile oils from very delicate and highly fragrant flowers such as jasmine, tuberose, violet, and gardenia. These flowers are so sensitive that the aroma gets destroyed when exposed to heat, therefore steam distillation and boiling methods are unsuitable.

Enfleurage uses fats (animal or vegetable) to absorb the fragrance of flowers at room temperature. Although this method is slow and expensive, it produces high-quality fragrance oils used in luxury perfumes.

Principle:

Certain plant flowers continuously release aromatic compounds which are soluble in fats at room temperature.

When these flowers are placed on a layer of purified fat, the fat gradually absorbs the volatile oil from the flowers.

Later, the fat containing oil (pomade) is treated with alcohol, which extracts the aromatic compounds and leaves the fat behind. When alcohol evaporates, pure essential oil (absolute) is obtained.

Procedure:

1. A glass frame (called chassis) is coated

with a thin layer of purified odorless fat.

2. Freshly harvested flowers are spread over the fat layer.
3. The flowers are left in contact with the fat for 24–48 hours until the fragrance is absorbed.
4. Once the flowers wilt and lose aroma, they are replaced with fresh flowers.
5. This process is repeated for several cycles until the fat becomes saturated with fragrance.
6. The fragrant fat (called pomade) is collected.
7. Pomade is then washed with alcohol, which dissolves the essential oil.
8. Alcohol is finally evaporated to obtain absolute oil.

Advantages:

- Ideal for very delicate flowers that lose fragrance in heat.
- Maintains natural aroma and high purity.
- Gentle and non-destructive method.

Disadvantages:

- Time-consuming and labor-intensive.
- Very expensive compared to other extraction methods.
- Requires large amounts of fresh flowers.
- Not suitable for large-scale commercial production today.

Examples of essential oils obtained by enfleurage:

- Jasmine oil
- Tuberose oil
- Violet oil
- Gardenia oil.

Supercritical CO₂ Extraction: [20,21]

Introduction:

Supercritical CO₂ Extraction is a modern and advanced technique used for extracting volatile oils from plant materials using carbon dioxide (CO₂) in its supercritical state. A substance becomes supercritical when it is subjected to a temperature and pressure above its critical point, where it behaves like both a gas and a liquid. For CO₂, the critical temperature is 31.1°C and critical pressure is 73.8 atm. In this state, CO₂ has:

- Gas-like property → It can penetrate plant tissues easily
- Liquid-like property → It can dissolve essential oils effectively

This method produces high-purity oils, free from

organic solvent residues and without heat-induced degradation, making it highly suitable for pharmaceutical, cosmetic, and food industries.

Principle:

Generally, the principle of supercritical fluid extraction process involves the use and recycling fluid in repeated steps of compression/decompression. The supercritical state of CO₂ can be achieved by highly compressing and heating this fluid. Then, it passes through the raw plant material to load volatile matter and plant extracts. The process is followed by decompression steps, where the mixture of CO₂ and plant extracts are routed to two separators where the fluid is gradually decompressed to separate the obtained extracts from the CO₂. The CO₂ is released from second separator and recycled into storage tank, and no solvent residue remains in the final product since CO₂ easily reverts to a gas under normal atmospheric pressure and temperature.

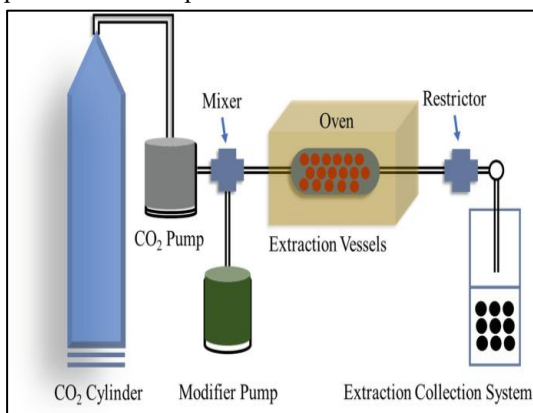


Fig.6: Supercritical CO₂ Extraction

Procedure:

1. Plant material (flowers, leaves, seeds, etc.) is dried and crushed.
2. It is placed in the extraction chamber.
3. CO₂ gas is pumped into the chamber and compressed to supercritical state ($\geq 31^\circ\text{C}$ and $\geq 73 \text{ atm}$).
4. Supercritical CO₂ passes through the plant material, dissolving volatile oils.
5. The CO₂ containing dissolved oil is transferred to a separator vessel.
6. Pressure in the separator is reduced.
7. CO₂ evaporates and essential oil is deposited.
8. CO₂ is recycled back for reuse.
9. Collected essential oil is filtered and stored.

Advantages:

- No heat, so ideal for heat-sensitive oils.

- No solvent residue → produces high purity oils.
- CO₂ is non-toxic, non-flammable, eco-friendly, and reusable.
- Selective extraction is possible by adjusting temperature and pressure.
- High yield and fragrance retention.

Disadvantages:

- Expensive equipment and high initial investment.
- Requires technical expertise to operate.
- Not economical for very low-cost oils or small-scale use.

Examples of oils extracted by supercritical CO₂ method:

- Ginger oil
- Clove oil
- Peppermint oil
- Cardamom oil
- Turmeric oil
- Black pepper oil.

Factors Affecting Extraction Of Essential Oils [22,23]

The efficiency, quality, and yield of essential oil extraction depend on several factors related to plant material, extraction conditions, and technique used. The major factors are:

Nature of Plant Material

- Different plant parts (flowers, leaves, seeds, bark) contain different amounts and types of oil.
- For example, peels of citrus fruits have high oil content, while wood and roots contain less and require longer extraction.

Stage of Plant Growth and Harvesting Time

- The age of the plant and season influence oil composition.
- Oils are usually maximum:
 - Flowers → at full bloom
 - Leaves → before flowering
 - Seeds → at full maturity

Drying and Moisture Content

- Fresh plants may contain high moisture, which may dilute oil and reduce yield.
- Controlled drying at low temperature preserves the volatile components.
- Over-drying causes loss of aroma compounds.

Particle Size of Material

- Smaller particles increase surface area

and improve extraction efficiency.

- However, too fine powder may block steam flow during steam distillation.

Temperature

- Essential oils are heat-sensitive.
- High temperature may cause decomposition or oxidation.
- Controlled heating is necessary, especially in steam distillation.

Pressure

- Higher pressure in distillation can help release oil faster.
- But excess pressure can damage delicate aroma compounds.

pH of Extraction Medium

- Some oils are stable only in slightly acidic conditions.
- Alkaline conditions can destroy phenolic and aldehyde components.

Duration of Extraction

- Insufficient time → low yield
- Excessive time → thermal degradation and resin formation

Solvent Selection (in Solvent Extraction & CO₂ Extraction)

- Solvent must:
 - Selectively dissolve oil
 - Be non-toxic
 - Be easily removable
- Example:
 - Hexane used in solvent extraction
 - Supercritical CO₂ used for high-purity oils

Storage Conditions

- Exposure to sunlight, oxygen, and heat leads to:
 - Oxidation
 - Rancidity
 - Loss of aroma
- Oils must be stored:
 - In air-tight, amber-colored bottles
 - Away from heat and moisture.

Conclusion

Volatile oils are valuable natural products obtained from various parts of plants and are widely used in pharmacy, perfumery, cosmetics, food, and aromatherapy. Several extraction methods such as hydro distillation, expression, solvent extraction, enfleurage, and supercritical

CO₂ extraction are employed depending on the nature of plant material and desired oil quality. Each method has its own advantages and limitations, which influence the yield, purity, cost, and suitability of the oil obtained. Modern techniques like supercritical CO₂ extraction offer high purity and minimal thermal degradation, while traditional methods remain economical and widely applicable. Therefore, proper selection and optimization of extraction method is important to ensure maximum yield, quality, and therapeutic value of the volatile oils.

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