Extraction of Essential oils: Eucalyptus Oil Extraction Techniques and methods.

[1]Rahul Khandge, [2]Sushank Sane, [3]Nikhil Khatri, [4]Nitin Satao
[4]Assistant Professor
Department of Chemical Engineering,
Shivajirao S Jondhale College of Engineering, Dombivli (E), 421201, University of Mumbai, India.

Abstract : Pure essential oils are concentrated oils derived from various natural plants, flowers, plants roots, seeds, resins, external tissue of plants, trees or shrubs or fruits rinds. These oils are highly recognized by humans for their beneficiary on body, skin and spirit. These oils are also used commercially due to their high end therapeutic or odoriferous properties.
Objectives:- To study extraction techniques available to extract the oils from plants and trees, to come across pros and cons of few extraction methods, selection and efficiency of a single method
Results: The technique used to extract essential oil from plants is important, because some methods use solvents which can destroy the therapeutic properties of plants and trees. There are various methods for extraction, but the quality and yield of the oil never remains the same. In this experiment, Soxhlet apparatus technique has been employed due to its mild extracting conditions and low operating cost. Steam is used as the key component to extract oils.
Conclusion:- Extraction of essential oil by various methods and Innovative techniques retards the risk of losing the essential component of plants and trees, reduce chemical risk, extraction time, acts eco-friendly and increase the quality and yield of the essential oils.

***Index Terms* – Eucalyptus oil, Steam Distillation using Soxhlet apparatus.**

I. INTRODUCTION

Mankind has been using plants and trees from thousands of years for healing and it's the same procedure that we use this essentials oils for medicinal component. These essentials oils were used for embalming process, for medicines and in few rituals. Research show that the use of essentials oils has been carried out for centuries due to its "Fragrant pharmacy" contents for biochemical effects. Essential oils are available in 300 different variety and are used by various professional practitioners, and with the perseverance of virus, bacteria, parasitic and fungal contamination in our world, essential oil provides a great medication towards our body and home from this onslaught of viruses. Our body, immune system needs a protection from foreign particles so essential oil helps us to achieve the shield against them.

Essential oils are concentrated volatile with strong aromatic compounds that are derived from plants and are easily evaporated essence that gives plants their natural scents. Every complex highly precious liquid is extracted from different species of plants. Each species of plants originates from different regions of world with particular environmental conditions and their surrounding fauna and flora. Essential oils are usually referred to as "Life Force" of plants. Unlike fatty oils essential oil are volatile, high concentrated substance extracted from flowers, stems of plants, roots, seeds, barks, resins and fruit rinds. The amount of essential oil found in a plant ranges between 0.01 % to 10% of the total, therefore tones of plants material is required for just a few hundred pounds of oil. Essential oils have antimicrobial properties and high therapeutic constituents. Due to this they are widely used in foods products, medicines and cosmetic. Essential oil cannot be replaced by synthetic compounds. Pure essential oil contains a full spectrum of compounds that cheap imitations simply cannot duplicate.

Table no: 1.1 Major Raw Material used in Extraction of Essential Oil

Leaves	Flowers	Peel	Seed	Wood
Basil	Chamomile	Bergamot	Almond	Camphor
Bay leaf	Clary Sage	Grape fruit	Anise	Cedar
Cinnamon	Clove	Lemon	Celery	Rosewood
Eucalyptus	Geranium	Lime	Cumin	Sandalwood
Lemon Grass	Hyssop	Orange	Nutmeg Oil	
Melaleuca	Jasmine	Tangerine		
Oregano	Lavender			
Patchouli	Manuka			
Peppermint	Marjoram			
Pine	Orange			
Rose marry	Rose			

Spear mint	Ylang-Ylang			
Tea Tree				
Winter Green				
Thyme				

1.1 Properties of Essential Oil: Pharmacological properties

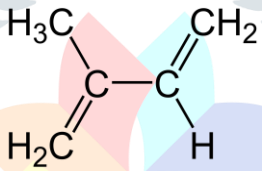
- **Antiseptic**: Essential oils consist of antiseptic properties and are stands strong against bacteria as well as an antibio-resistant strain.
- **Expectorants and diuretics:** They have the property to act as a slight local anaesthetic substance and provide relieve from sprains and other articular pains.
- **Spasmolytic and sedative:** The umbellifereae family's, Mentha and verbena species essential oil are reputed to decrease gastrointestinal spasms.
- **Others:** Cholagogue, anti-inflammatory, cicatrizing.

1.2 Chemical Constituents of Essential oil

Natural and pure essential oils are mixture of more than 200 components, usually mixtures of terpenes/phenyl propanic derivatives, in which the compound differ minimal in chemical and structural way. The are normally classified as

1. Volatile Fraction: Essential oil constituting of 90-95% of the oil in weight, containing the monoterpene and sesquiterpene hydrocarbon, as well as their oxygenated derivative along with the aliphatic aldehydes, alcohol and esters.
2. Non-volatile: essential oil that compromise of 1-10% of the oil, containing hydrocarbons, fatty acids, sterols, carotenoids, waxes and flavonoids.

1.2.1 Hydrocarbon: Essential oil have chemical compound that consist of hydrogen and carbon as their building blocks. Primary hydrocarbon found in plants, trees are isoprene having the structure as –



(Isoprene)

1.2.2 Terpenes: This usually have names ending in "ene". For example: Limonene, Pinene, Piperene, Camphene, etc. Terpenes are anti-inflammatory, antiseptic, antiviral, and bactericidal. Terpenes are further classified as monoterpenes, sesquiterpenes and diterpenes. Looking back to isoprene units under the hydrocarbon heading, when two of these isoprene unit joints head to tail, the results is monoterpene, when three joins it's a sesquiterpene and four linked isoprene units are diterpenes.

1.2.3 Alcohols

Properties: Anti-viral, anti-septic, bactericidal and germicidal.

Alcohols are Hydroxyl compounds. They exist naturally, either as a free or combined compound with a terpenes or ester. When the terpenes are attached to an oxygen and hydrogen atom the results is an alcohol. Alcohols have a very low absent toxicity reaction on the body and skin, therefore it is considered to be safe for use.

Example:

- linalool found in Ylang-Ylang and lavender.
- Geraniol in geranium and rose.
- Nerol in neroli.

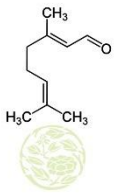
1.2.4 Aldehydes

Properties: Antifungal, Anti-inflammatory, Anti-septic, Antiviral, Bactericidal, Disinfectant, Sedative.

Medicinally essential oil that contains aldehydes are effective in treating candida and other fungal infections.

Example:

- Citral in lemon
- lemongrass and lemon balm.
- Citronellal in lemongrass, lemon balm and citrus eucalyptus.



Citral

1.2.5 Acids

Properties: Anti-inflammatory.

Organic acids in their free state are usually found in very small amount in essential oil. Plants acids acts as a component or buffer system to level the acidity.

Example:

- Cinnamic and benzoic acid in benzoin.
- Citric and lactic.

1.2.6 Ester

Ester are created by the reactions between alcohols and acids. Essential oil containing esters are used for their soothing and balancing effect. Due to the presence of alcohol, they are effective antimicrobial agents. Medicinally, esters are characterized as antifungal, sedative with a balanced action on the nervous system.

Example:

- linlyl acetate in bergamot and lavender.
- Geranyl formate in geranium.

1.2.7 Ketones

Properties: anti-catarrhal, cell proliferant, expectorant, vulnery.

Ketones often are found in plants that are usually used for upper respiratory complaints. Ketones assist flow of mucus and bring ease in congestion. Essential oils containing ketones are helpful in promoting wound healing and building the scar tissue. Ketones are generally very toxic. The highly toxic ketone is Thujone that is found in mugwort, sage, tansy, thuja and wormwood oils, furthermore toxic ketones seen in essential oils are pulegone in pennyroyal, and pinocamphone in hyssops. Few non-toxic ketones are jasmone in jasmine oil, fenchone in fennel oil, carvone in spearmint and dill oil and menthone in peppermint oil.

Example:

- fenchone in funnel, Carvone in spearmint and dill.
- Menthone in peppermint.

1.2.8 Lactones

Properties: Anti-inflammatory, Antiphlogistic, Expectorant, Febrifuge.

Lactones are effective for their anti-inflammatory action, by the role of reduction of prostaglandin synthesis and expectorant actions. Lactones have stronger expectorant action then ketones.

II. TYPES OF ESSENTIAL OILS.

The most common type of essential oil found commercially and used widely are:

- Lavender oil
- Eucalyptus oil
- Pepper mint oil
- Tea tree oil
- Jojoba oil
- Blue chamomile oil
- Rose oil
- Oregano oil
- Jasmine oil
- Neroli oil
- Lemon balm oil
- Pomegranate oil

III. METHODS OF EXTRACTING ESSENTIAL OIL

Earlier the practice of extraction used alcohol and a fermentation process. Recent methods of extracting essential oils are entering the mainstream of aromatherapy, providing new choices in oils which were offered never before. In addition of new labels of CO_2 and Super critical CO_2, along with the traditional “steam’ and ‘hydro’ distillation, ‘absolutes’, and ‘cold pressing’, a little education

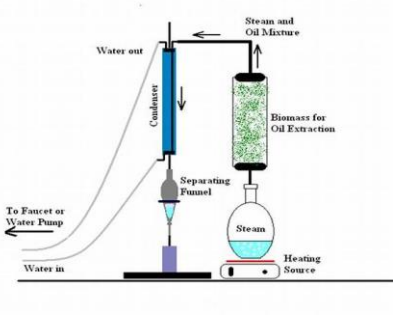
for the aromatherapy enthusiast can go a long way in essential oil selection. The method used to extract essential oil from plants or other raw material is important because some procedure includes the use of solvents that can destroy the therapeutic properties. Few plants and flowers, do not lend themselves to steam distillation because they are too delicate, or their fragrance and therapeutic essences cannot be completely released by steam distillation. Jasmine oil and rose oil particularly are delicate flowers whose oils are often found in 'absolute' form.

The value of newer methods depends greatly on the experience of the distiller, as well as the intended application of the final product. Each and every method is important, and posses its place in the making of aromatherapy-grade essential oils. Few methods available for extracting essential oils are given below:

1. **Maceration**: This method produces more of 'infused oil' instead of 'essential oil'. In this method the plant matter is soaked in vegetable oil, heated and then strained, so that at this point it can be used for massage.
2. **Cold pressing:** This method is used to extract oils from citrus rind such as lemon, orange, grapefruit and bergamot. In this method the rinds are separated from the fruit and the chopped and pressed at 120 º F (Degree Fahrenheit) to extract the oil. The results are watery mixture of essential which will be separated later.
3. **Solvent extraction:** Hydrocarbon solvent is added to the plant material to help dissolve the essential oil. The solution is filtered and concentrated by distillation, later a combination of wax and essential oil (known as concrete) remains. Pure alcohol is used to extract the oil from concentrate, and when the alcohol is evaporated, the oil is left behind. However this is not considered to be the best method for extraction because the solvent can leave a small amount of residue behind which can cause allergies and can effect immune system.
4. **Enfleurage:** An intensive and ancient way of extracting oil from flowers. Enfleurage process involves layering some amount of fat over the flower petals. After the fat absorbs the essential oil from the flower, alcohol is used to separate the essential oil and fat. The oil is later evaporated and essential oil is obtained.
5. **Hydro distillation:** Few processes become obsolete to carry out extraction n process like Hydro distillation which is used in primitive countries. There is a risk of drying off the still, or be overheated, burning the aromatics and resulting in a burnt aroma/smell of essential oil. Hydro distillation seems to be the best method for powders (i.e., spice powders, ground wood etc.) and very tough materials like roots, woods, and nuts.
6. **CO_2 & Super critical CO_2 Extraction:** This is the most modern technology of extracting essential oil. Carbon dioxide and Supercritical Carbon dioxide extraction involve the use of CO_2 as the solvent which carried the essential oil away from the raw plant material. Lower pressure CO_2 extraction involves the cooling of CO_2 between 35 °F and 55 °F, and then pumping it through the plant material at about 1000 psi. The CO_2 in this condition is condensed to a liquid.
   Supercritical extraction involves the heating of CO_2 to 87 °F and pumped it through the plant material at around 8,000 psi. Under both the conditions carbon dioxide is likened to a 'dense fog' or vapor. With the release of pressure in any of the process, the carbon dioxide escapes in its gaseous form, leaving the essential oil behind. After extraction, the properties of a good quality essential oil should be as close as possible to the essence of original plant. The key to excellent essential oil is through low pressure and low temperature processing. The high temperatures, rapid processing and the use of solvents alter the molecule structure, destroys the therapeutic value and alter the fragrance.
7. **Turbo distillation extraction:** Turbo distillation is useful for hard to extract or coarse plant material, such as bark, roots, and seeds. In the turbo extraction process, the plants soak in water and steam is circulated through this plant and water mixture. During the entire process, the same water is circulated continuously through the plant material. This method allows faster extraction of essential oil from difficult to extract plant materials.
8. **Steam Distillation:** In this process, the essence is extracted from the plant using a technique called distillation. The flowers or plants are placed on a screen, steam is passes through the area and becomes 'charged' with the essence. The steam is then passed through the condenser (a area to cool the steam). This mixture of water and essential oil is separated and bottled. As plants and flowers contains small amount of this precious oil, several hundred pounds of raw material is required to produce a single ounce.

IV. EXTRACTION OF ESSENTIAL OIL USING STEAM DISTILLATION PROCESS.

Extraction of essential oil can be done using various methods, although some are not commonly used today. Nowadays, distiller plays an important role in restoring the qualities of plant, but the final therapeutic results is not often found until and unless extraction process is performed. During extraction the qualities of oil changed to give it more value- for example, the characteristics of pure blue color German chamomile (chamazulene) is formed during steam distillation process. Looking at the current situation the extraction of essential oil through steam distillation is much in practice and commonly used. Steam distillation is a special type of distillation or separation technique for temperature sensitive materials like oils, resins, hydrocarbons, etc. which are insoluble in water and may decompose at their boiling point. The fundamental of steam distillation is that it enables a compound or mixture of compounds to be distilled at a temperature substantially below that of boiling point(s) of the individual constituent(s). Essential oil contains compound with boiling points up to 200 °C or higher temperatures. In the presence of steam or boiling water, however these substances are volatilized at a temperature close to 100 °C at atmospheric pressure.

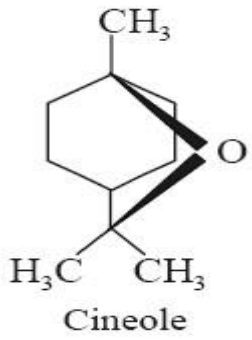


In this process, the fresh leaves of eucalyptus plant are cut into pieces less than 2x2 cm within half a day after collection and then placed into the still chamber where steam is being passed from the bottom. The essential oil (eucalyptus oil) is being carried out along with the steam from the top of the still and then sent to the condenser. In the condenser the cooling water stream is continuously supplied to cool the mixture (steam and oil). The mixture is then cooled and collected from the bottom of the condenser. The mixture is then separated using separating funnel or the water is evaporated from the mixture and the residue is pure essential oil of eucalyptus. The extraction period should be allowed to continue for a certain period of time in order to flush the oil's components from the plant, as some are easily and quick to remove while others takes time.

Major component: 1, 8-Cineole.

4.1 Physical and Chemical properties of Eucalyptus oil (Cineole)

Color	Pale yellow liquid
State	Liquid-oil
Odor	Camphoraceous odor, sweet, fruity
Taste	Pungent and Cooling taste
Boiling Point of Cineole (Eucalyptol)	176 °C – 177 °C
Density of oil	0.921 – 0.923
Solubility	1. Insoluble in water. 2. Miscible in alcohol having high concentration. 3. Miscible in oil, fats, paraffins, ether, chloroform etc.



Cineole

Chemical Name: 1, 3, 3-Trimethyl 1-2-Oxabicyclo [2. 2. 2.]-Octane or 1, 8-epoxy-p-methane.
Molecular Formula of Cineole: $C_{10}H_{18}O$
Molecular Weight: 154.25
Precaution of Storing: Eucalyptus oil and the products containing eucalyptus oil should be kept at a temperature less than 25 °C in well filled containers. It should be kept away from sunlight. Liquid products containing eucalyptus oil are good to be stored in child resistant containers.

Precautions:

1. Temperature of the extraction chamber should not be high, in order to prevent the destruction of the oil components. The same is to be true for the chamber's pressure. High temperature and pressure results in a harsh aroma, more chemical than floral and lessen the oils therapeutic effects.
2. The period of extraction must be continued to a certain period of time in order to flush all the oils components from the plant, flowers as some are released more quickly than other.

V. Advantages of Steam Distillation process

The advantage of steam distillation is that it is a comparatively cheap process it requires less capital to operate at basic level, and the properties of oil obtained by this process is highly acceptable and known. Newer methodology, such as sub critical water extraction, may eventually replace steam distillation, but so far even contenders such as CO_2 extraction, although establishing a firm market niche-have not really threatened to take over as the major preparative technique.

VI. Application of Essential oil

1. Eucalyptus oil uses have long been known to include anything regarding the respiratory system, deodorize.
2. It assists people with clear breathing. Mix with carrier oil and rub on chest to assist with clear breathing.
3. Eucalyptus oil supports overall respiratory health.
4. Soothes tired and sore muscles.
5. Eucalyptus oil contains purifying and cleansing properties.
6. If the eucalyptus oil is combined with lemon and peppermint it can be used as effective cleaning spray.
7. For jet lag, eucalyptus oil uses include waking up the body with its slightly sweet, fruity, and camphorous aroma. Use topically or aromatically.
8. Make a cooling spray, place several drops of eucalyptus oil in a spray bottle, along with peppermint oil if you'd like some extra oomph, and spritz over the body for soothing.
9. Eucalyptus oil is also used in pharmaceutical company for producing few cough syrups and lozenges.

10. Eucalyptus oil may help to address pain and inflammation, and soothe mucous membrane especially if they have been affected with conditions like allergies and asthma.

VII. Conclusion

Steam distillation is a special type of distillation (a separation process) for temperature sensitive materials like oils, resins, hydrocarbons, etc. which are insoluble in water and may decompose at their respected boiling point. The temperature of the steam must be enough to vaporize the oil present however the temperature should not be so high that it destroys the plants, flowers or burn the essential oils. The eucalyptus plant has high content of essential oil. Such eucalyptus oil, which have been used as perfume and chemical raw material for a long time. Oil content in eucalyptus is higher and can be easily extracted.

The eucalyptus oil contains more than 65% of 1, 8-Cineole. Hence the incorporation of very small amount of eucalyptus oil as cosolvent in aqueous ethanol and petrol mixture improved the water tolerance of the system, Therefore the work can be extended for the study of ternary phase equilibrium of the water ethanol and 1, 8-cineole or eucalyptus oil.

VIII. Acknowledgement

Authors acknowledge the extreme help received from the scholars whose articles are referred and included in the references of the manuscript. Authors are also grateful to authors, editors, and publisher of all those articles, journals, and books from where the literature for this article has been reviewed and discussed.

IX. Reference

1. "The Encyclopedia of Chromatography", edited by Dr. Jack Cazes of Florida Atlantic University.
2. R. Oprean; M. Tamas; R. Sandulescu; L. Roman "Essential oil analysis. I. Evaluation of essential oil composition using both GC and MS "fingerprints. J. Pharm. Biomed.
3. A.Tezel; A. Hortacsu; O. Hortacsu, "Multi-component models for seed and essential oil extraction" Supercritical Fluids.
4. "Chromatography Theory" Jack Cazes (Florida Atlantic University) and Raymond P.W. Scott (University of London).
5. R. P. W Scott "Chromatographic Detectors ", Marcel Dekker, Inc., New York.
6. "Extraction of Essential oil" from webpage of AWorldofAromatherapy.com/essential oils.
7. "Essential_Oils_Introduction" from the webpage of http://www.theherbsplace.com/index.html.
8. "Making Essential Oils - Methods of Essential Oil Extraction" from the Webpage of http://www.anandaapothecary.com/essential-oils.html.
9. "Methods of Extraction Essential Oil" from the webpage of http://www.aromathyme.com/essentialoils.html.
10. "Chemical Constituents of Essential oils" from the webpage of http://healingdeva.com/selena2.htm. http://healingdeva.com/selena3.htm.
11. "What are Essential Oils, How are Essential Oils Made, How to Make Essential Oils "from the webpage of http://www.deancoleman.com/index.htm.
12. "Essential Oil Steam Distiller "from the webpage of http://www.heartmagic.com/
13. Ammon, D.G., Barton, A.F.M. and Clarke, D.A., 1986. Eucalyptus oil as a component of petrol-ethanol fuel blends.
14. GC-Analytical Solutions "Analysis of Eucalyptus oil on Sol-GEL wax http://www.sge.com/
15. Brophy JJ, Lassak EV & Toia RF (1985) The steamvolatile leaf oil of Eucalyptus pulverulenta.Planta Medica,51:170- 171.