Plant Archives Vol. 21, Supplement 1, 2021 pp. 2027-2033 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
doi link : https://doi.org/10.51470/PLANTARCHIVES.2021.v21.S1.331

ESSENTIAL OILS, COMPONENTS AND THEIR APPLICATIONS: A REVIEW

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ABSTRACT

Essential oils are complex volatile compounds and their bioactivities have been known and utilized since ancient times in food preservation, perfumery, flavouring and medicine. Essential oils are acceptable because of their unique antibacterial, antifungal, antiviral and antioxidant properties. This review paper focuses on essential oils, its components, extraction methods and their applications. The advances and other applications of essential oils in food, cosmetic and pharmacological industries and the biological effects of essential oils are also conferred.

***Keywords*:** Essential oils, volatiles, applications, activity, extraction.

1. Introduction

Essential oils are volatile and aromatic oily liquids which are extracted from plant materials (leaves, root, flowers, peels, bark, seeds, twigs etc.) and are made up of different chemical compounds. Plants produce essential oils to protect themselves from inevitable factors like sunlight, pollution and malnutrition and they produce unique scents to attract insects for pollination (Burt *et al*., 2004). Essential oils are often referred to as life force of plants. The essential oils do not contain any chemicals but only contains the essence of the plant. For centuries, these have been used in cosmetics, food, perfumery and medicine industries. At first essential oils were used as medicines but later they were known for their aroma and flavour applications. Essential oils are usually colourless when fresh but with time they may oxidize which may result in change of colour. Thus, essential oils should be stored preferably in amber glass containers (Rao *et al*., 2007). There are 3000 essential oils known while only 300 are used for commercial purpose. Essential oils have numerous characteristics including antibacterial, antiparasitic, antioxygenic, insecticidal properties (Rassem *et al*., 2016). Essential oils support the well-being of body and mind. It also helps in balancing and generating positive thoughts.

2. Essential oils

Essential oils are liquids extracted from potentially beneficial plants. These are used for natural health practices which include aromatherapy and naturopathy. Pure essential oils are used as an alternative for synthetic products. Each oil contains a unique chemical makeup which provides numerous benefits to the body and mind.

2.1. Definition

Essential oils are highly volatile substances isolated from odorous plants. Alkaloids, coumarines, anthraquinones, fats are among its major components. As defined by Shilcher and Heganuer (1979) "Essential oils are formed in the cytoplasm and are generally present in between cells in the form of tiny droplets. They may consist of fragrant substances or may have both fragrant and non aromatic substances, having volatility and aroma on its own (Sonwa, 2000). As given by ISO in document ISO 923502- "essential oils are products obtained from natural raw material either by distillation or from the epicarp of citrus fruits by dry distillation or any mechanical process" (Schmidt, 2000).

2.2. History

Back in the 16th Century Paracelsus von Hohenheim from Switzerland gave the name of the drug Quita essential from which the term Essential oil was coined (Wissal Dhifi *et al*., 2016). The usage of essential oil has its origin from Egypt, China and India. India since time immemorial considers spices as an alternative health remedy. The beginning of essential oil production dated back to two thousand years with the modern technologies emerging in Arab during the 9th century (Tajkarimi *et al*., 2010). Otto Walach worked in the identification and classification of essential oils especially in the field of terpenes which was then followed by Rezicka (Sonwa, 2000). The production of essential oils during 12th century was done by hydro-distillation. Before this, the more primitive distillation was used by the Romans and Greek. This method has been practiced until the 9th century. In the 13th century, Villanova confirmed working and adopting therapeutic views of oil technology. Aroma therapy gained its importance in the late 20th century (Sundaresan *et al*., 2019). Late 19th century led to the synthesis of coumarine, heliotropin, vanillin and ionone which further gave rise to the era of perfumery. Thus the volatility of essential oils is of utmost importance (Sonwa, 2000).

2.3. Classification

Essential oils can be classified based on various factors like methods of extraction, chemical composition, aroma, etc.

Classification based on extraction methods and chemical compositions are discussed below.

2.3.1. Based on chemical composition

Essential oils are composed of various chemicals. Hydrocarbon with only hydrogen and oxygen are present in citrus and pine. Coriander, tea and peppermint, consist of hydroxyl group attached to terpene structure. Citronella, lemon myrtle and lemon balm have terpenoids with a carbonyl group and hydrogen attached to it. Aldehyde group attached to benzene ring are generally present in cinnamon, bitter almond and cumin. Pennyroyal, Thuja, Sage and Euclyptus Radiata have a carbonyl group bonded to two carbon atoms. Thyme and oregano contain a hydroxyl group attached to benzene ring. Euclyptus, wormseed, cajeput have two or more carbons bridged with oxygen. Lavender, winter green, clary sage comes under ester. Aniseed, clove, tarragon, and myrtle leaf have phenyl propane in it. Elecempane and arnica comes under sesquiterpene lactones while sesquiterpenes are present in German chamomile and yarrow (Richard *et al*., 2019). The classification is as follows:-

1. Terpene Hydrocarbons: These consist of arranged chains of carbon and hydrogen which may be allycyclic, acyclic or aromatic. A terpene consists of several isoprene units in which a single terpene unit is a combination of two isoprene units. Monoterpenes(C10) and sesquiterpenes(c15) of general formula (C5H8)n are present in essential oils, while diterpenes, triterpenes and tetraterpenes are present in a very low concentration.
2. Oxygenated Compounds: The contain C, H, O and are mainly derived from terpenes, therefore are termed as terpenoids. They are as follows:-

- Phenol – Ugenol, Carbacrol, Thymol etc comes under this category
- Alcohols – It is sub-divided into monoterpene alcohol and sesquiterpene alcohol. Borneol, lavenduol, isopulegol etc comes under monoterpene alcohol, while the latter consist of elemol, santalol, nerolidol etc.
- Aldehydes – Cinnamaldehyde, Benzaldehyde, Citral etc.
- Ketones – Carbone, fenchone, camphor, thujone, menthone etc.
- Esters – Linalyl Acetate, Geralyl acetate etc.
- Oxides – Bisabolone oxide, linalool oxide etc.
- Lactones – Bergaptene, Psoralen etc.
- Ethers – Anephole, myristicil etc (Phakawat *et al*., 2014; Richard *et al*., 2019)

2.3.2. Based on extraction methods

Various extraction methods are used to extract the essential oils from different parts of several plants. The method of extraction usually depends on the botanical constituents which are the liquefied version of a plant. For the determination of the quality of essential oils, the method of extraction is a vital factor. If inappropriate methods are used for extraction then there is loss of biological activity (Phakawat *et al*., 2014).

2.3.2.1. Steam distillation

The maximum number of essential oils is produced by steam distillation. Through this method of extraction, 93% of oil is extracted and the rest 7% are further extracted by other methods (Masango, 2005). Steam distillation is a separation process of temperature sensitive and water insoluble materials like oil, resins, hydrocarbons, etc., which may decompose at their boiling point (Božović *et al*., 2017). Plant materials are placed in a chamber which is present above the steam source. Only the steam is allowed to pass through the plant material not the boiling water. The steam softens the cells of the plant and helps the EO to escape in vaporized form. The heat of the system should be maintained so as to prevent the damage of plant material. The EO forms tiny droplets and converges into the condenser for cooling along with steam. After cooling, the mixture forms a bilayer with oil being less dense forming the upper layer and water being more dense the below layer. These are then separated by an oil separator or any appropriate method or instrument (Božović *et al*., 2017; Tongnuanchan *et al*., 2014).

2.3.2.2. Water distillation

Water distillation is also called hydro distillation and is used for the extraction of essential oils from plant materials like flower and wood which are not damaged by boiling. This method is used to isolate the water insoluble products with high boiling point. This method involves complete immersion of plant material into water. Water prevents the damage of plant material due to overheating by acting as a barrier (Ahmet *et al*., 2018).

Complete immersion of plant material in water is then followed by boiling. The essential oil in vapour form is then condensed and due to density difference the oil is separated from the water. The advantage of this technique is that the required material can be distilled at a temperature below 100 °C (Phakawat *et al*., 2014).

2.3.2.3. Microwave assisted hydro distillation

Microwave assisted extraction is an extraction method which uses microwaves (radiation) where extraction time is less and extraction rate is higher along with low cost for operation (Golmakani *et al*., 2008).

The dried plant material along with solvent (water) is put in a flat bottom flask and placed inside the microwave oven which is adjusted according to the condenser. As the heating begins the vapours pass through the neck of the tube and reaches the condenser where it cools down and the essential oil was recovered. The water is removed from the essential oil by drying it in anhydrous sodium sulfate (Cardoso *et al*., 2013).

2.3.2.4. Maceration

Macerated oils are also termed as infused oils. In maceration method, carrier oils (oil obtained from seeds, nuts or kernels of a plant such as coconut oil or vegetable oil) are used as solvents to extract the therapeutic properties from the botanical material. Macerated oil is more ideal than distilled oil because it captures more of the plant's essence. The plant material should be dry so as to prevent rancidity. Plant material is ground into coarse powder and is placed in a closed container. The solvent is added and the mixture is left for a week with occasional shaking. After a week, the filteration process takes place where the liquid is collected ant the solid residue is pressed to recover any remaining liquid (Achat *et al*., 2012).

2.3.2.5. Enfleurage

Enfleurage is not a common method used for extraction but one of the oldest methods. It uses fat for the extraction

process. There are two methods of enfleurage process: hot and cold enfleurage. In cold enfleurage method, vegetable or animal fat is spread in glass plates in a frame and let to set. The fresh flower petals or the whole flowers are placed on top of the fat and then pressed in. the flowers are inside for nearly a week and the depleted flowers are replaced. The scent of flowers is seeped into the fat. The process is repeated until desired saturation of fat. The final product is called enfleurage pomade which includes the fat and the fragrance oil. The oil is separated from the fat by washing this mixture with alcohol. As the alcohol evaporates, the absolute oil is stored. In hot enfleurage method, the only difference is that the fat is heated after the flowers are added (Siswati *et al*., 2017; Prapassorn *et al*., 2009)

2.3.2.6. Cold-press extraction

Cold press extraction method is done on farm with simple mechanical devices and this method does not yield more oil as compared to other methods. The meal by-product contains more oil content and thus is palatable to livestock (Heidi *et al*., 2016).

The plant materials (commonly fruits in this method) are placed in a device called screw pressing device where the fruit is mechanically pierced to rupture the oil sacs of the fruit. The fruit is pressed to extract the juice and oil totally. This liquid mixture is then centrifuged to remove the solid particles and to separate the oil and water (Thavanapong *et al*., 2010).

2.3.2.7. Solvent extraction

Solvent extraction method is preferred for delicate plant materials which are not heat tolerable. Food grade solvents like hexane and ethanol are used to extract the essential oil. When the plant material is treated with the solvent, there is a waxy aromatic compound formation which is called concrete. This compound is then mixed with absolute alcohol where the oil is extracted and distilled at low temperature (Tongnuanchan *et al*., 2014; Dunford *et al*., 2003; Schaneberg *et al*., 2002).

2.3.2.8. Supercritical fluid extraction

In supercritical extraction instead of liquid solvents, CO_2 is used as solvent. In this extraction process the temperature of process ranges less than other distillation processes. Carbondioxide becomes liquid due to high pressure but still remains in gaseous phase (carbondioxide is now supercritical). In this state, the carbondioxide is added to the plant material and it acts as a solvent. The essential oil is dissolved into the liquid carbondioxide. This fluid is then evaporated again into gaseous state leaving back the essential oil (Yaqoob *et al*., 2020; Bozan *et al*., 2002; Clifford *et al*., 1994; Thavanapong *et al*., 2010; Tongnuanchan *et al*., 2014).

2.4. Types of Essential oils

Essential oils are obtained from different plants. Essential oils have been of great importance and have different compounds which differ in composition from oil to oil (Hamid *et al*., 2011). Various types of essential oils are discussed in table 1.

Table 1: Types of essential oils (Siddique, 2017)

Essential Oil	Plant and family	Compounds
Clary Sage	*Salvia saclarea Linn.* Lamiaceae	Linalool, linalyl acetate, alpha terpineol, germacrene D, and geranyl
Eucalyptus	*Eucalyptus globules Labil* Myrataceae	Geranic, citronelol, gerianol, linalool, citronellyl formatecitral, myrtenol, terpineol
Lavender	*Lavandula officinalis Chaix.* Lamiaceae	Camphor, terpinen-4-ol, linalool, linaly acetate, beta ocimene and 1,8-cineole
Lemon	*Citrus limon Linn.* Rutaceae	• Terpenes, D-limonene, L-limonene- 90% • Phellandrene, pinene and sesquiterpene- in traces
Peppermint	*Mentha piperita Linn*. Lamiaceae	Cavacrol, menthol, carvine, methyl acetate, limonene and menthone
Roman chamomile	*Anthemis nobilis Linn.* Asteraceae	Angelic acid,tiglic acid and 2-methylbutanoic acid
Rosemary	*Rosmarinus offcinalis Linn.* Lamiaceae	Resin, tannic acid, bornyl acetate, borneol, camphor, myrtle, cineol, pinene, camphene
Tea tree	*Melaleuca alternifolia Cheel* Myrtaceae	Terpinen-4-ol, cineole, alpha-sabine
Ylang Ylang	*Cananga odorata Hook. F. and Thoms* Annonaceae	Geranyl acetate, linalool, geraniol, farnesol, benzyl acetate, geranial, methyl chavicol, beta caryophyllene, eugenol, pinene and farnesene

3. Biological effects of essential oils

Essential oils have been subjected to various pharmacological studies and tests to evaluate their effects against biological factors. These oils showed strong defence mechanism against pathogenic strains. Most important biological effects of essential oils are discussed below.

3.1. Antibacterial effects

Bacterial infections have known to be life-threatening to human life since early times. Use of higher doses of anti-bacterial agents and increased multi-drug resistance has led to severity in the diseases caused by bacteria. This has led the researchers to explore a new method against bacterial strains (Raut *et al*., 2014). In regard to this, essential oils and their chemical constituents are reported to have the potential for bacterial inhibition. The antibacterial activity of essential oils is known for their effects in inhibiting the bacterial growth or destroying the bacterial cells. The effectiveness of essential oil works differently against different target bacterial strains depending on their structures. For example, sandalwood and vetiver oils possess inhibitory actions against gram- positive bacteria but fails in the inhibition of gram- negative bacterial strains (Hammer *et al*., 2011; Raut *et al*., 2014). The essential oils of clove, pimento, oregano, rosemary, thyme and cinnamon possess strong anti-bacterial effects against *Salmonella typhi, Staphylococcus aureus and Pseudomonas aeruginosa* (Conner, 1993).

3.2. Antifungal effects

Essential oils and their chemical compositions have been used against a wide range of fungal pathogens. The essential oils of fennel, lemon grass, basil, oregano, thyme, rosemary and citrus possess considerable antifungal effects (Fu *et al*., 2007). Essential oils obtained from spices were known to work against fungal infections, especially oils from garlic and clove work againt *Candida acutus, C. albicans, C. apicola, C. catenulata, C. inconspicua, C. tropicalis and Saccharomyces cerevisiae* (Arora *et al*., 1999). The phenolic compounds namely thymol and carvacrol, which are the main constituents in thyme and oregano are known for disruption of fungal cell membranes (Ultee *et al*., 2001).

3.3. Antiviral effects

Viral diseases are a major threat to human health with only limited drugs working against many viruses. This led to the research of plant-based and bioactive compounds as a new source for antiviral drugs. Many essential oils possess antiviral properties against DNA and RNA viruses, which includes *herpes simplex virus type 1 (HSV-1) and type 2 (HSV-2), dengue virus type 2, Junin virus, influenza virus adenovirus type 3, poliovirus and coxsackievirus B1* (Allahverdiyev *et al*., 2004; Raut *et al*., 2014; Reichling *et al*., 2009). Essential oils extracted from clove and oregano exhibits antiviral effects against nonenveloped RNA and DNA viruses such as adenovirus *type 3, poliovirus and coxsackievirus B1* (Reichling *et al*., 2009; Aj *et al*., 1994). These essential oils which are plant-based could be used against viral infections and also as alternatives for synthetic antiviral drugs.

3.4. Anti -inflammatory effects

Many toxic chemical compounds, physical injury and infectious microorganisms cause a physiological response known as inflammation (Salud *et al*., 2011). The Anti-inflammatory activity helps eliminate aggressive agents, tissue injury and other inflammatory responses (Cardia *et al*., 2018). Compounds present in essential oils responsible for anti-inflammatory properties are namely: monoterpenes, sesquiterepenes, carvacrol, camphor, limonene, linalool, 1,8-Cineole, thujanol, thymol, menthol, carvone linalyl acetate, geraniol acetate, eugenol acetate and bornyl acetate (Salud *et al*., 2011; Djilani *et al*., 2012). Essential oils with Anti-inflammatory effects include oils extracted from eucalyptus, rosemary, lavender, mille folia, pine, clove and myrrh. Essential oils are used in mixed formulation for a better anti inflammatory effect (Maria, 2010).

3.5. Anti-oxidant properties

Antioxidants are substances that can prevent or slower the damage of cells caused by free radicals and unstable molecules, that the body produces as a reaction to environmental and other pressures. Terpene is the main component of the essential oils extracted from medicinal plants, which is considered as a natural anti-oxidant (Miguel, 2010). The essential oil of basil, cinnamon, clove, nutmeg, oregano, and thyme possesses antioxidant properties due to the presence of terpenes (Sari *et al*., 2006). Thymol and carvacrol are responsible for the antioxidant activity of essential oils of *Thymus spathulifolius and Origanum vulgare ssp*. and essential oil of *Melissa officinalis* (its main constituents are neral, geranial, citronellal, isomenthone, and menthone) shows free radical scavenging activity (Mimica *et al*., 2003). In addition, isomenthone and menthone present in the essential oils of *Mentha longifolia and Mentha piperita* shows antioxidant effects, while in the *Mentha aquatica*, the 1,8-cineole is responsible for this activity (Kim *et al*., 2004). Antioxidant capacity in the essential oil of *Melaleuca alternifolia* is due to α-terpinene, γ-terpinene, and α-terpinolene compounds and the β-caryophyllene in the essential oil of *Marrubium peregrinum* is the one which presents the greater antioxidant activity.

4. Health benefits

For a very long time, essential oils have been utilized for health and medicinal purposes which includes detoxification, antiviral therapy, antidepressant and many more. Each essential oil extracted from different plant species possesses great physical, mental and emotional health benefits. Aromatherapy is the prime utilization of essential oils in pharmaceutics. In an investigation, aroma massage was given to the ladies with hypertension where its impact was demonstrated extremely solid on the systolic circulatory strain (SBP), diastolic pulse (DBP) and in rest quality and subsequently presumes that fragrance rub is useful to improve the personal satisfaction on everyday schedule (Niki, 2010). The essential oil of lavender causes the spasmolytic activity in the contraction caused because of the calcium chloride. The fundamental part answerable for its action is 1, 8-cineole. Consequently, it principally goes about as calming drug. In one of the exploration it is discovered that balm oil is demonstrated successful for the treatment against disturbance in individuals experiencing dementia. Neroli oil demonstrated extremely viable for post cardiovascular medical procedure, as per the exploration foot rub was given which keeps enduring mental impact (Yaqoob *et al*., 2020).

Essential oil is utilized in vaginal infection like *candida albicans*. For some vaginal diseases, tea tree oil utilized on

tampon is viable. Essential oils are ingested legitimately into the surrounding tissue, and thus it is utilized for the treatment of gynaecological or urinary conditions through vaginal routes. Sandalwood oil was used to treat urinary contaminations and an ointment containing tea tree oil is being utilized against haemorrhoids (Singh, 2008).

5. Applications of essential oils

Essential oils are aromatic essences extracted from natural sources and their applications are extended in pharmaceutical, food applications, perfumery, sanitary and beauty products. The essential oils are utilized depending upon the source, quality and extraction methods.

5.1. Cosmetic industry

The usage of essential oils in the cosmetic and perfumery products are of great significance from the monetary perspective. The cosmetics market is oriented towards health and well-being and thus the usage of essential oils in products have become prevalent for their therapeutic properties. Added aroma is an added benefit to the product as consumers prefer products with pleasant aroma rather than normal products. Salvia, lavender and thyme species are profoundly devoured to create these fragrant yields. Addition of essential oils in products is not just good for the skin but also consists of regenerating or relaxing properties.

5.2. Pharmaceutics and therapeutics

Essential oils are used in pharmaceutics for their potential as therapeutics (Edris, 2007; Lawless, 2013). This is especially the occurrence of the essential oils from peppermint *(Menthapiperit*a), sage *(Salvia officinalis),* anise *(P. anisum),* eucalyptus *(E. globulus),* clove *(S. aromaticum),* and tea tree *(M. alternifolia).* These oils are used as an expectorant for treating bronchitis and hack (eucalyptus basic oil), as antibacterial specialists (sage, clove and tea tree oil), as a decongestant of the respiratory tract (peppermint oil), and as a carminative (anise oil). Also, clove oil is used in dentistry for its antimicrobial and pain killing properties while tea tree oil is used in the field of dermatology (antiacne drug) as it has antimicrobial properties against Gram-positive microorganisms (Lawless, 2009). In pharmaceutics, essential oils are utilized to improve sensory attributes of drugs. The most notable application of essential oils is using it along with carrier oil after diluting it to a certain concentration. They can similarly be taken in by breathing after addition of few drops in steaming water. Also, they can be utilized as analgesics, balms, packs and creams. Oral intake of essential oils through encapsulation or any other techniques has been successful for getting the helpful impact of essences (Boehm *et al*., 2012). They can likewise be utilized as extracts like in tea which is viewed as a more precise portion while preventing undesirable effects. In any case, it is possible that the harm of essential oils may be higher when taken by this technique (Karlsen, 2010).

5.3. Agro food industry

Essential oils are used in wide range of food products. Apart from being devoured as a flavoring material, they are used in agriculture and food industry for their antimicrobial, antiviral, antifungal, insecticidal, nematocidal and anticancer properties (Adorjan *et al*., 2010; Adlard, 2016). Because of these reasons, their utilization as additives in food is indicated. Though essential oils have antibacterial and antioxidative properties, their use requires a detailed study about the effectiveness (Hyldgaard *et al*., 2013).

There is a trending interest in maintaining the quality and safety of the food products by adapting to new techniques. Use of essential oils in food products as an additive is one such techniques.

To prevent food from being infested by pests there is use of chemicals which cause harm to humans and thus the use of compounds extracted from natural sources are necessary. Essential oils are obtained from natural sources and it has proved to produce desired results.

Essential oils have helped in the control of microbial growth for sustaining quality and shelf life of food products by being the active ingredient of packaging (Day, 1989). The consumer's interest in minimally processed food has increased the usage of packaging with bioactive properties (Sadaka *et al*., 2014).

Essential oils are active components of food packaging materials. Edible coatings are being developed presently and are made up of complex carbohydrates, lipids and proteins. These compounds are mechanically strong but have poor conductivity of water, which is why sodium caseinate is added to improve the water barrier properties of the film (Audic *et al*., 2015). The films are suitable for food preservation because of their sensory attributes and also contain nutritional properties (Fabra *et al*., 2008). Essential oils like ginger and cinnamon oils are added for improvisation (Atarés *et al*., 2010).

6. Conclusions

This review summarizes about essential oils, its components, extraction methods and their applications. Essential oils can be exploited in various fields. Essential oils extracted from new sources with other bioactivities should be further researched. Developments of essential oils depend on the potential of the bioactive compounds present in it. The use of essential oils (in the films and edible coatings for preservation, perfumes in the cosmetic industry, herbal and drug enhancers in pharmaceutical industry) along with other plant extract formulations will serve as a tool to understand the benefits of essential oils in preservation and safety. As approved by FDA, essential oils are considered GRAS, which extends the application of essential oils in small or large quantities depending on the effectiveness of the bioactive compounds which improves the product quality and safety without any loss of nutrition and sensory attributes.

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