Chapter

Pharmaceutical and Therapeutic Potentials of Essential Oils

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Abstract

It is a common perspective that medicinal plants have played and continue to perform an undeniably major role in the lives of people worldwide. Essential oils are the key constituents of medicinal herbs and their biological activities have been discovered since ancient times and are enormously utilised in multiple industries. The essential oils possess important biological properties like antibacterial, antioxidant, antiviral, insecticidal, etc. Because of these unique features they are more acceptable and are utilised in various fields throughout the world. In the cosmetics industry they play an important role in the development of perfumes while in the food industry they have been used as food preservatives. Essential oil components are interestingly utilised for pharmaceutical applications. The most investigated properties are anti-oxidant, anti-inflammatory, antimicrobial, wound-healing, anxiolytic activities etc. The current thrust area is evaluation for aromatherapy and anti-cancer, as it is noted that essential oils reported in plants may prevent, inhibit, or even reverse formation of cancerous cells. The aim of this chapter is to provide a concise and comprehensive overview on the therapeutic and pharmaceutical potential of essential oils in the current scenario.

Keywords: essential oil, therapeutic use, pharmaceutical potential

1. Introduction

The plants are the main source of food, clothing and shelter. Besides, different materials derived from plants are utilised in treatment against numerous ailments. Due to detrimental effects of synthetic medicines, the herb derived medicines are undergoing revival because of their safe application. Aromatic plants are the source of essential oils, which are volatile substances having essence and properties of the source plant.

The essential oils have been extracted from 60 families of plants from different parts of the world and around 3000 diverse essential oils have been recognised so far. Out of these around 300 are utilised monetarily in the seasoning and scents advertised [1]. The essential oils can be produced in all parts of a plant, mainly by leaves, flowers and stems (Peppermint, Lavender), fruits (Anise), bark (Cinnamon), seeds (Nutmeg). Plants store these components in the glandular cells or pockets which release them with aroma when squeezed or pressed [2]. Essential oil can be extracted by conventional methods: steam distillation, water and steam distillation. However,

the cold or hot pressing, aqueous infusion, solvent extraction, effleurage or the other methods used for extraction of essential oils [3]. Bowles [4] reported that in some cases essential oil content may reach above 10% viz. Nutmeg (*Myristica fragrans*) and clove (*Syzygium aromaticum*) but in general the essential oil content rarely exceeds 1%. Essential oils possess physical properties as they are commonly hydrophobic in nature depicting slight solubility in water, although solubility in non- polar solvents varies, from highly soluble in waxes, alcohol and other weakly polar solvents. Further, the essential oils are commonly pale yellow or colourless but Chamomile (*Matricaria chamomilla*) essential oil is blue in colour. Moreover, they exist mainly in liquid state showing lower density than water except Sassafras, Cinnamon and Clove essential oil which are denser than water. [5, 6]. The principle chemical components are monoterpenes, sesquiterpenes, oxygenated derivatives, aromatic and aliphatic compounds. The complex mixtures of chemical compounds generally comprise of terpenoids, alcohols, ethers, asters, ketones and aldehydes in differential concentrations.

The pharmaceutical and therapeutic properties of plants are attributed to the essential oils and are related to their chemical composition [1]. All over the world researchers have established various pharmaceutical and therapeutic properties of the essential oils from time to time [7–9]. Extensive work has been carried out to utilise essential oils for the cure of multiple infectious diseases through pharmaceutical remedies. Scientific investigations have established that qualitatively 100% pure essential oil free from impurities have the potential to relieve chronic pain, elevate moods, recover defective cells and treat life threatening diseases, common in the world. The broad therapeutic prospective of the plant derived, essential oils have grab attention of the researchers all around to visualise their anti-cancer properties because of the fact that their mode of action is quite diverse than the classic cytotoxic chemotherapeutic agents [10]. Besides, one fascinating feature is their potential as medicines in aroma based therapies or as carriers for drug delivery. In the recent past the aim of essential oils have alternately shifted from culinary use to pharmaceutical and therapeutic use, yet in addition to their application in the fabrication of fragrances and beauty care products [11].

In the current scenario essential oils are gaining importance day by day, reason for this being they are mostly utilised in beverages, food industries, cosmetics and Fragrances industries for making valuable perfumes, beautifying agents, soaps, shampoos or cleaning gel. Also the significant contribution of essential oils is their utilisation in the Agro-food businesses for increasing the sensorial characters of food items [12]. The purpose of this chapter is to make an effort to bring the remedial and pharmaceutical significance of essential oils in light. For this purpose the recent research carried out throughout the world by various researchers has been included in this chapter.

2. Chemical composition of the essential oil

The chemical composition of essential oils varies plant to plant, the constituents of essential oils are generally volatile and non-volatile in nature therefore are widely categorised into volatile and non-volatile types. Further, the volatile fractions of aromatic oils are chemically constituted by the mono and sesquiterpene components and several oxygenated derivatives along with alcohols, aliphatic aldehydes, and esters, while as the non-volatile fractions are chemically constituted by the carotenoids, fatty acids, flavonoids and waxes [13].

The chemical composition of essential oils is determined by gas chromatography-mass spectrometry (GC-MS). This method is simple, efficient and gives fast results. Further, it is a broadly used analytical technique for the determination of essential oils constituents. A GC-MS provides a valid profile of the essential oil components and serves as the fingerprint of any particular batch of essential oil. The peculiar properties of the oils can be reflected from its chemical composition and GC-MS is a reliable technique to indicate the purity of essential oils in most cases [14]. The components of essential oils are delineated below.

2.1 Classes of essential oil compounds and their biological activities

2.1.1 Hydrocarbon

The largest group of composites present in essential oils are hydrocarbons. The hydrocarbons are composed of carbon and hydrogen bits. The hydrocarbons which are found in essential oils are placed in a group called Terpenes (monoterpenes: C10, sesquiterpenes: C15, and diterpenes: C20). On the basis of physical composition the Terpenes may be ambrosial, alicyclic (monocyclic, bicyclic or tricyclic) or acyclic. The terpenes which are ingredients of essential oils are β-pinene, α-sabinene, myrcene, α-pinene, p-cymene, myrcene, α–phellandrene, pmenthane, thujane, fenchane, Limonene,, azulene, cadinene, sabineine and farnesene These composities have been associated with various remedial conditioning (**Table 1**).

2.1.2 Esters

Esters are the chemical composites constituting an organic or inorganic acid with one hydroxy group replaced by an alkyl group. The Esters are generally found

Compound	Chemical nature	Activity	References
Dodecane, phellandrene	Hydrocarbon	Antimicrobial activity	[15]
Bornanone	Terpene	Anti-inflammatory, antifungal, antimicrobial, anticancer	[15]
α- pinene, β- pinene, sabinene, myrecene, β- ocimene	Monoterpenes	Antimicrobial, antifungal, antioxidants	[16]
Eucalyptol, citronelal, eucamalol, linalool, α-terpineol	Alcohols	Antioxidant, insecticide, acaricide, herbeside	[17]
Bisabolane, elemane, germacrane, humulane, chamazulene	Sesquiterpenes	Antibacterial, antifungal, anti-inflammatory, antioxidant	[18]
Cinnanaldehyde, benzaldehyde, myrtenal	Aldehyde	Antifungal, circulatory, anti-inflammatory, cardiovascular	[19]
Geranyl acetate, bornyl acetate, linalyl acetate, eugenol acetate	Ester	Antispasmodic, antimicrobial	[20]
Pulegone, fenchone, thujone	Ketone	Antiviral, gastrointestinal, regenerating cells, analgesic	[21]
Carvacrol, tymol	Phenol	Antibacterial, strengthening immune system	[22]

Table 1.
Chemical nature of essential oil compounds and some biological activities.

composites in a vast number of the essential oils and are known for their affable smell and give sweet smell to the essential oils. The common ester bearing essential oils include linalyl acetate, geraniol acetate, eugenol acetate and bornyl acetate. Esters are anti-inflammatory, spasmolytic, dreamy, and antifungal (**Table 1**).

2.1.3 Alcohols

Alcohol containing essential oils has a affable type of fragrance. The alcohol bearing essential oils are therapeutically most profitable essential oil components with no reported contraindications. Linalool, menthol, borneol, santalol, nerol, citronellol and geraniol are some important alcohols found in the essential oils. They are known to retain antimicrobial, antiseptic, tonifying, balancing and spasmolytic parcels (**Table 1**).

2.1.4 Phenols

These are aromatic alcohols which are chemically veritably reactive, slightly poisonous and induce irritation to the skin and the mucous membranes. They exist as crystals at room temperature. The important essential oils containing phenol s are thymol, eugenol, carvacrol and chavicol. The essential oils containing phenols as their constituents possess following characteristics, antimicrobial, rubefacient properties, stimulate the immune and nervous systems and may reduce cholesterol (**Table 1**).

2.1.5 Ketones

Ketones such as carvone, menthone, pulegone, fenchone, camphor, thujone and verbenone are some common examples of ketones found in essential oils. These groups of compounds are chemically stable and lack fragrance or flavour like the other group of compounds. Besides some remidial effects, Ketones have been reported to retain neurotoxic and abortifacient effects in some cases similar as camphor and thujone [23]. These ketone bearing essential oils have been reported to be mucolytic, cell regenerating; opiate, antiviral, analgesic and digestive in nature (**Table 1**).

2.1.6 Aldehydes

Aldehydes found in essential oils include citral (geranial and neral), myrtenal, cuminaldehyde, citronellal, cinnamaldehyde and benzaldehyde. Unlike ketones aldehydes retain sweet, pleasant fruity odours and are present in common culinary herbs such as cumin and cinnamon. This group of compounds are unstable and oxidise easily, besides numerous of the aldehydes have been reported to act as mucous membrane irritants and are skin sensitizers. As far as therapeutic use is concerned, aldehydes have been reported to work as antiviral, antimicrobial, tonic, vasodilators, hypotensive, calming, antipyretic and spasmolytic (**Table 1**).

3. Mechanism of action of bioactive components of essential oils

The mode of action of essential oils varies. The mode of action depends upon chemical composition and molecular structure of the components of essential oil.

3.1 Antibacterial action

An important feature of essential oils are their hydrophobicity, which allows them to partition into lipids of the cell membrane of bacteria disrupting the structure thus making it more permeable resulting in leakage of ions and cellular molecules which cases greater loss of cell contents leading to cell death for instance trans-cinnamaldehyde can inhibit the growth of E. coli and *Salmonella typhimurium*. It has been reported that essential oils containing primarily aldehydes and phenols for example cinnamaldehyde, citral, carvacrol, eugenol andthymol are characterised by maximum antibacterial activity followed by essential oils consisting of terpene- alcohols.

3.2 Antifungal action

Antifungal actions resemble in mode of action as those described for bacteria. In case of yeast it has been reported that potential of Hydrogen (pH) gradient across the cytoplasm membrane and blockage of energy production in the cells results in disruption of fungal membranes leading to death. Antifungal effects were caused by a combination of essential oils of clove and *rosmarinus officinalis* against *C. albicans*. Trans-anthole, a major component of Anise essential oil, demonstrated anti-fungal activity against the filamentous fungus, *Mucor mucedo*. The essential oil obtained from citrus containing active component limonene has been reported to inhibit the growth of *Aspergillus niger* by causing deleterious morphological alterations that is loss of cytoplasm fungal hyphae and budding of hyphal tip [24]. Also, tea tree essential oil containing components has been reported to alter permeability as well as membrane fluidity of *Candida albicans* [25].

3.3 Antiviral activity

The essential oil of saltolinia showed antiviral activity against HSV-1 and HSV-2 by preventing cell to cell virus spread in infected cells. The oil directly inactivated virus particles thus preventing adsorption of virion to host cells. Iso-borneol, a common monoterpene alcohol, showed dual virucidal activity against HSV-1, specifically inhibited glycosylation of viral polypeptides. The antiviral activity of the essential oil is principally due to direct virucidal effects (by denaturing viral structural proteins or glycoproteins). Proposed mechanisms suggest that essential oils intrude with the virus envelope by inhibiting specific processes in the viral replication cycle or by masking viral factors, which are necessary for adsorption or entry into host cells, therefore precluding cell-to-cell virus prolixity [26]. The essential oils attained from oregano and clove have been reported to show remarkable antiviral exertion against a number of non-enveloped DNA and RNA viruses including adenovirus type-3, coxsackievirus B-1 and polio virus. Several constituents of essential oils like monoterpenes, sesquiterpenes and triterpenes have been reported to show strong antiviral activity against rhinovirus and herpes virus. The essential oil components of pogostemoncablin have been found active against H2N2 influenza-A virus [27].

3.4 Anticancer activity

The broad therapeutic prospective has gained a lot of attention throughout the world in recent times for their implicity capacity in relation to combating

cancer. According to Wu et al. [28] diallyl sulphide, diallyldisulfide composites actuated in the host cells (rats) the enzymes which play an important part in the detoxification process of hepatic phase-1 (decomposition of chemical bonds that link carcinogenic toxins to each other) and phase-2 (bonds to toxins released detoxifying enzymes similar as glutathione S- transferase). Further myristicin an allyl benzene composites found in the essential oil of nutmeg activates glutathione S- transferase in mice cells which minimise carcinogenesis induced by benzo a pyrene in the lungs of mice. Moreover it has been recently concluded that myristicin persuade apoptosis in neuroblastoma (SK-N-SH) in humans [18]. Geraniol have been reported to decrease the resistance of: cancer cells (TC 118) to 5-fluorouracil an anticancer agent. Further, geraniol enhances the inhibitory effect of tumour growth 5-fluorouracil. Moreover the essential oil of balsam fir which contains alpha-humulene depicting high anticancer property in several cell lines and low toxicity to healthy cells [29]. In addition to this limonene an active component of citrus essential oil has been reported to show anticancer activity at the level of stomach cancer and liver cancer [30]. Chamomile essential oil containing an active component alpha-bisabolol sesquiterpene alcohol has been reported to show antigliomale activity [31].

4. Therapeutic properties of some essential oils

4.1 Chamomile essential oil (*Matricariachamomilla*)

It has been reported that Bisabolol and chamazulene are active compounds found in chamomile essential oil. The dry flowers of Chamomile have numerous properties such as anti-inflammatory, antioxidant and also possess some mild astringent properties [32–35].

4.2 Anise essential oil (*Pimpinellaanisum*)

The Anetholeis is the main active compound found in ansine essential oil. Therapeutic Properties of Anise include a cure for sleeplessness, an appetite stimulant and diuretic. In ancient times the Anise has been reported to show the carminative property (reducing flatulence) [36–38].

4.3 Nutmeg essential oil (*Myristicafragrans*)

The Main active compounds found in nutmeg essential oil are Sabinene, 4-terpineol and myristicin. The essential oil of Nutmeg has been found effective against a number of microbial agents and pests. Also, it is used as an important ingredient to cough syrups, while in some instances it acts as general tonic for brain activity and normal functioning of circulatory system [39].

4.4 Cedar essential oil (*Cedruslibani*)

Cetin et al. [40] reported that the principle active component of cedar essential oil is Limonene. The essential oil of cedar has been found to perform Antifungal and Larvicidal activity. Also, the oil is good for regeneration of blood cells and enhances the healing property [41–43].

4.5 Dill essential oil (*Anethumgraveolens*)

The Main active compound found in dill essential is Carvone and the well-established therapeutic use of essential oil reported is the Antispasmodic in gastrointestinal disorders. Moreover, it reduces the fluidity of bronchial secretions in the lungs and thus prevents various lung infections [21, 44].

4.6 Garlic essential oil (*Allium sativum*)

It has been reported that Diallylle disulphide is the main active compound found in garlic essential oil. Garlic essential oil Protects and maintains the cardiovascular system, reducing blood pressure. Also, the extracted essential oil has been reported to control the fungal infection, pest infestation and parasitic growth. Moreover, many studies have found an increase in garlic intake reduces the cancers of the upper digestive tract [45].

4.7 Clove essential oil (*Syzygiumaromaticus*)

Eugenol and eugenyl acetate are the main active compounds which constitute clove essential oil. The commonly known therapeutic property of essential oil reported is effectiveness against the tooth ache and as an analgesic for alveolar osteitis. Also, the studies have proven that essential oil obtained from clove is effective against various microbial and fungal infections [46, 47].

4.8 Cinnamon essential oil (*Cinnamomum cassia*)

Essential oil of Cinnamon is mainly constituted by the chemical Cinnamaldehyde. The cinnamon essential oil has been reported to perform enormous functions related to health. The studies have established that it lowers the plasma glucose in the diabetic patients. Also, it has been reported to lower the level of total cholesterol and triglycerides in the blood, thus preventing cardiovascular diseases [48, 49].

4.9 Sweet orange essential oil (*Citrus sinensis*)

Limonene is Main active compound found in sweet orange essential oil. It possesses. Antiseptic property in some cases but the commonly reported property of essential oil is used as an excellent flavouring ingredient in the food industry [50, 51].

4.10 Eucalyptus essential oil (*Eucalyptus globulus*)

A number of compounds has been reported in the eucalyptus essential oil but 1,8-cineole is the major constituent present in the essential oil. A number of studies have concluded that it can be used for treating cough, common cold and to mildly relieve muscular pain. Also, the essential oil is used as an insect repellent and biopesticide in many countries [52, 53].

4.11 Peppermint essential oil (*Menthapiperita*)

The major portion of essential oil contains menthol and menthone compounds, which govern the properties like treatment for irritable bowel syndrome. Also, used

topically for muscle pain, nerve pain and relief from itching in many cases. Moreover, it has been found to minimise the mucosal irritation in the digestive tract and reduce the heartburn [51, 54, 55].

4.12 Lavender essential oil (*Lavandulaofficinalis*)

Linalool and linalyl acetate are main active compounds found in lavender essential oil. The main properties of lavender essential oil includes sedative action, pan relaxing, analgesic in many cases and effective in alleviating in anxiety and sleep disturbances [56–59].

4.13 Tea tree essential oil (*Melaleucaalternifolia*)

The main active compound reported so far in the essential oil has been only Terpinène-1-ol-4. The tea tree essential oil has been used to treat coughs and colds widely. In addition, the oil is used to treat sore throats and numerous skin ailments [60–62].

4.14 Lemon essential oil (*Citrus limonum*)

Limonene is the main constituent compound found in lemon essential oil. The therapeutic Properties include enhancement of natural immunity in the human body, regulation of metabolism and a reliable nerve tonic. Besides, it has been concluded through many studies that essential oil acts as antiviral and antimicrobial [63–66].

4.15 Yarrow (*Achillea millefolium*)

The important active constituents of yarrow essential oil are Sabinene and terpineol manifesting. A number of studies have reported that the essential oil of yarrow acts as an anti-inflammatory and analgesic. Moreover, it has been found to cure many lung diseases and act as an important antiseptic agent [67, 68].

4.16 Geranium (*Pelargonium graveolens*)

The geranium essential oil consists of citronellol, geraniol, linalool and citronellylformate. The essential oil has been found to depict astringent and antiseptic properties. Also, in minor instances anti-inflammatory and antioxidant property has been observed [69].

4.17 Thyme (*Thymus vulgaris*)

Chromatographic analysis has revealed that the main active compound in essential oil is thymol followed by carvacrol, linalool etc. Thymol shows antiseptic properties and is an active ingredient of commercially prepared mouthwashes and toothpastes.

5. Conclusion

This chapter comprehensively summarises the therapeutic and pharmaceutical potential of essential oils. The essential oils possess important biological activities which lead to their application in diverse fields. The characteristic properties such

as antiviral, anti-bacterial, anti-fungal, anti-inflammatory, ant carcinogenic etc. are utilised in various industries to prepare beneficial products which have great impact on human life. The active compounds present in essential oils are thoroughly studied now a day for replacement to unsafe medications. In pharmaceutical industries the use of essential for making perfumes and other pharmaceutical products are gaining popularity. Therefore, the essential oils are receiving attention from all the corners because of their tremendous features. Thus essential oils and their constituents can arguably be studied in the future for meticulously more scientific investigations and probable applications as important components in future medical field and pharmaceutical industries.

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