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The Therapeutic Benefits of Essential Oils

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1. Introduction

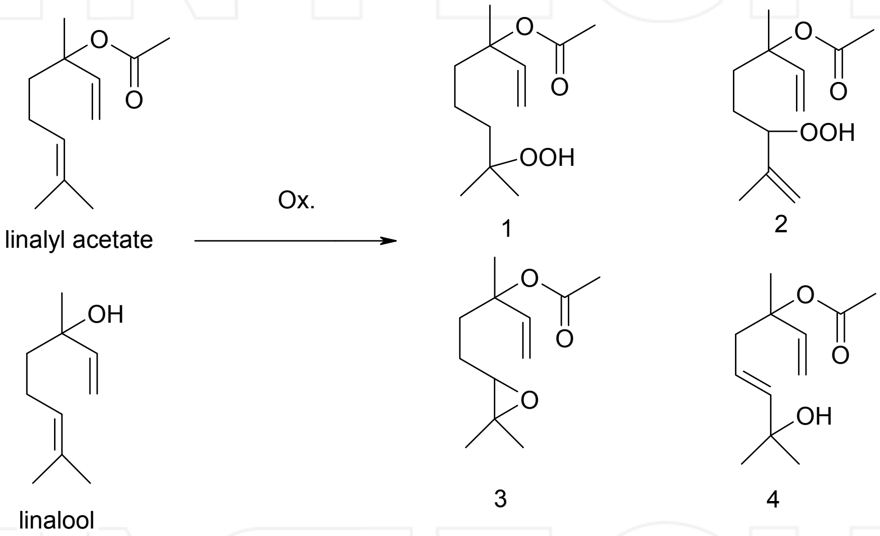
Since ancient times, essential oils are recognized for their medicinal value and they are very interesting and powerful natural plant products. They continue to be of paramount importance until the present day. Essential oils have been used as perfumes, flavors for foods and beverages, or to heal both body and mind for thousands of years (Baris et al., 2006; Margaris et al., 1982; Tisserand, 1997; Wei & Shibamoto 2010). Record findings in Mesopotamia, China, India, Persia and ancient Egypt show their uses for many treatments in various forms. For example, in the ancient Egypt, the population extracted oils by infusion. Later; Greeks and Romans used distillation and thus gave aromatic plants an additional value. With the advent of Islamic civilization, extraction techniques have been further refined. In the era of the Renaissance, Europeans have taken over the task and with the development of science the composition and the nature of essential oils have been well established and studied (Burt, 2004; Peeyush et al., 2011; Steven, 2010; Suaib et al., 2007). Nowadays, peppermint, lavender, geranium, eucalyptus, rose, bergamot, sandalwood and chamomile essential oils are the most frequently traded ones.

2. Definition and localization of essential oils

Essential oils (also called volatile or ethereal oils, because they evaporate when exposed to heat in contrast to fixed oils) are odorous and volatile compounds found only in 10% of the plant kingdom and are stored in plants in special brittle secretory structures, such as glands, secretory hairs, secretory ducts, secretory cavities or resin ducts (Ahmadi et al., 2002; Bezić et al., 2009; Ciccarelli et al., 2008; Gershenzon et al., 1994; Liolios et al., 2010; Morone-Fortunato et al., 2010; Sangwan et al., 2001; Wagner et al., 1996). The total essential oil content of plants is generally very low and rarely exceeds 1% (Bowles, 2003), but in some cases, for example clove (*Syzygium aromaticum*) and nutmeg (*Myristica fragrans*), it reaches more than 10%. Essential oils are hydrophobic, are soluble in alcohol, non polar or weakly polar solvents, waxes and oils, but only slightly soluble in water and most are colourless or pale yellow, with exception of the blue essential oil of chamomile (*Matricaria chamomilla*) and most are liquid and of lower density than water (sassafras, vetiver, cinnamon and clove essential oils being exceptions) (Gupta et al., 2010; Martín et al., 2010). Due to their molecular structures (presence of olefenic double bonds and functional groups such as hydroxyl, aldehyde, ester); essential oils are readily oxidizable by light, heat and air (Skold et al., 2006; Skold et al., 2008). Some examples of oxidations are illustrated in figure 1.

β-caryophyllene caryophyllene oxide

Fig. 1. a. Oxidation (ox.) of β-caryophyllene by air at room temperature.



1: 7-hydroper-oxy-3,7-dimethylocta-1,5-diene-3-yl acetate
2: 3,6-hydroperoxy-3,7-dimethylocta-1,7-diene-3-yl acetate
3: 6,7-epoxy-3,7-dimethyl-1-octene-3-yl acetate
4:7-hydroxy-3,7-dimethylocta-1,5-diene-3-yl acetate

Fig. 1.b. Oxidation (ox.) of linalyl acetate and linalool by air at room temperature.

3. Extraction of essential oils

Oils contained within plant cells are liberated through heat and pressure from various parts of the plant matter; for example, the leaves, flowers, fruit, grass, roots, wood, bark, gums and blossom. The extraction of essential oils from plant material can be achieved by various methods, of which hydro-distillation, steam and steam/water distillation are the most common method of extraction (Bowles, 2003; Margaris et al., 1982; Surburg & Panten, 2006). Other methods include solvent extraction, aqueous infusion, cold or hot pressing, effleurage, supercritical fluid extraction and phytonic process (Da Porto et al., 2009; Hunter, 2009; Lahlou, 2004; Martínez, 2008; Pourmortazavi & Hajimirsadeghi, 2007; Surburg & Panten, 2006). This later process has been newly developed; it uses refrigerant hydrofluorocarbons solvents at low temperatures (below room temperature), resulting in good quality of the extracted oils. Thus, the chemical composition of the oil, both quantitative and qualitative, differs according to the extraction technique. For example, hydro-distillation and steam-distillation methods yield oils rich in terpene hydrocarbons. In contrast, the super-critical extracted oils contained a higher percentage of oxygenated compounds (Donelian et al., 2009; Eikani et al., 2007; Reverchon, 1997; Wenqiang et al., 2007).

Essential oils are highly complex mixtures of volatile compounds, and many contain about 20 to 60 individual compounds, albeit some may contain more than 100 different components (Miguel, 2010; Sell, 2006; Skaltsa et al., 2003; Thormar, 2011), such as jasmine, lemon and cinnamon essential oils.

The major volatile constituents are hydrocarbons (e.g. pinene, limonene, bisabolene), alcohols (e.g. linalol, santalol), acids (e.g. benzoic acid, geranic acid), aldehydes (e.g. citral), cyclic aldehydes (e.g. cuminal), ketones (e.g. camphor), lactones (e.g. bergaptene), phenols (e.g. eugenol), phenolic ethers (e.g. anethole), oxides (e.g. 1,8 cineole) and esters (e.g. geranyl acetate) (Deans, 1992). All these compounds may be classified into two main categories: terpenoids and phenylpropanoids (Andrade et al., 2011; De Sousa, 2011; Griffin et al., 1999; Lis-Balchin, 1997; Sangwan et al., 2001) or also into hydrocarbons and oxygenated compounds (Akhila, 2006; Halm, 2008; Hunter, 2009; Margaris et al. 1982; Pourmortazavi and Hajimirsadeghi, 2007; Shibamoto, 2010). This latter classification seems less complex, and for the current book chapter, we have adopted it. The fragrance and chemical composition of essential oils can vary according to the geo-climatic location and growing conditions (soil type, climate, altitude and amount of water available), season (for example before or after flowering), and time of day when harvesting is achieved, etc (Andrade et al., 2011; Deans et al., 1992; Margaris et al., 1982; Pengelly, 2004; Sangwan et al., 2001). In addition, there is another important factor that influences the chemical composition of essential oils, namely the genetic composition of the plant. Therefore, all these biotope factors (genetic and epigenetic) influence the biochemical synthesis of essential oils in a given plant. Thus, the same species of plant can produce a similar essential oil, however with different chemical composition, resulting in different therapeutic activities. These variations in chemical composition led to the notion of chemotypes. The chemotype is generally defined as a distinct population within the same species (plant or microorganism) that produces different chemical profiles for a particular class of secondary metabolites. Some examples of various chemotypes are given in Table 1:

Plant	Chemotype 1	Chemotype 2	Chemotype 3
Thyme (*Thymus vulgaris L.*)	Thymol	Thujanol	Linalool
Peppermint (*Mentha piperita L.*)	Menthol	Carvone	Limonene.
Rosemary (*Rosmarinus officinalis L.*)	Camphor	1,8 cineole	Verbenone
Dill (*Anethum graveolens L.*)	Carvone	Limonene	Phellandrene
Lavender (*Lavandula angustifolia Mill.*)	Linalool	Linalyl acetate	β-Caryophyllene

Table 1. Main chemotypes of some aromatic plants

4. Trade of essential oils

The knowledge of composition of essential oils and their therapeutic properties have contributed to the development of their cultivation and markets. Although only 100 species are well known for their essential oils, there are over 2000 plant species distributed over 60 families such as *Lamiaceae*, *Umbelliferae* and *Compositae* which can biosynthesize essential oils. They are about 3,000 essential oils, out of which approximately 300 are commercially important and are traded in the world market (Baylac and Racine, 2003; Burt, 2004; Delamare et al., 2007; Sivropoulou et al., 1995; 1996; 1997).

Essential oils constitute a major group of agro-based industrial products and they find applications in various types of industries, such as food products, drinks, perfumes, pharmaceuticals and cosmetics (Anwar et al., 2009a; 2009b; Burt, 2004; Celiktas et al., 2007; Hammer et al., 2008; Hay & Svoboda, 1993; Hussain et al., 2008; Teixeira da Silva, 2004).

The world production and consumption of essential oils is increasing very fast (Lawless, 1995). Despite their high costs (due to the large quantity of plant material required), essential oil production has been increasing. The estimates of world production of essential oils vary from 40,000 to 60,000 tonnes per annum and represent a market of approximately 700 million US $ (Verlet, 1994).

The predominately produced essential oils for industry purposes are from orange, cornmint, eucalyptus, citronella, peppermint, and lemon (Hunter, 2009) but the more commonly domestically used ones include lavender, chamomile, peppermint, tea tree oil, eucalyptus, geranium, jasmine, rose, lemon, orange, rosemary, frankincense, and sandalwood. The countries that dominate the essential oils market worldwide are Brazil, China, USA, Indonesia, India and Mexico. The major consumers are the USA, EU (especially Germany, United Kingdom and France) and Japan.

5. Bioavailability of essential oils

The term bioavailability, one of the principal pharmacokinetic properties of drugs, is used to describe the fraction of an administered dose of unchanged drug that reaches the systemic circulation and can be used for a specific function and/or stored. By definition, when a drug is administered intravenously, its bioavailability is 100%. However, when a drug is administered via other routes (such as oral), it has to pass absorption and metabolic barriers, before it reaches the general circulation system, and its bioavailability is prone to decrease (due to gastro-intestinal metabolism, incomplete absorption or first-pass metabolism). Bioavailability is measured by pharmacokinetic analysis of blood samples taken from the systemic circulation and reflects the fraction of the drug reaching the systemic circulation. If a compound is poorly absorbed or extensively metabolised beforehand, only a limited fraction of the dose administered will reach the systemic circulation. Thus, in order to achieve a high bioavailability, the compound must be of sufficiently high absorption and of low renal clearance (measurement of the renal or other organ excretion ability).

Various factors can affect bioavailability such as biochemical, physiological, physicochemical interactions; habitual mix of the diet; individual characteristics (life-stage and life-style) as well as the genotype. In the case of essential oils, the comprehension of their bioavailability by studying their absorption, distribution, metabolism and excretion in the human body is necessary. Unfortunately, there exists only limited data on the bioavailability of essential oils, and most studies are based on animal models.

All findings confirm that most essential oils are rapidly absorbed after dermal, oral, or pulmonary administration and cross the blood-brain barrier and interact with receptors in the central nervous system, and then affect relevant biological functions such as relaxation, sleep, digestion etc. .....

Most essential oil components are metabolized and either eliminated by the kidneys in the form of polar compounds following limited phase I enzyme metabolism by conjugation with glucuronate or sulfate, or exhaled via the lungs as CO_2. For example, after oral administration of (-)-menthol, 35% of the original menthol content was excreted renally as menthol glucuronide (Bronaugh et al., 1990; Buchbauer, 1993; Hotchkiss et al., 1990; Jirovetz et al., 1992; Kohlert et al., 2000).

The same happens with thymol, carvacrol, limonene and eugenol. After their oral administration, sulphate and glucuronide forms have been detected in urine and in plasma, respectively (Buchbauer et al., 1993; Guénette et al., 2007; Michiels et al., 2008). The fast metabolism and short half-life of active compounds has led to the belief that there is a minimum risk of accumulation in body tissues (Kohlert et al., 2002).

6. Therapeutic benefits of essential oils

The feeding with aromatic herbs, spices and some dietary supplements can supply the body with essential oils. There are a lot of specific dietary sources of essential oils, such as example orange and citrus peel, caraway, dill; cherry, spearmint, caraway, spearmint, black pepper and lemongrass. Thus, human exposure to essential oils through the diet or environment is widespread. However, only little information is available on the estimation of essential oil intake. In most cases, essential oils can be absorbed from the food matrix or as pure products and cross the blood brain barrier easily. This later property is due to the lipophilic character of volatile compounds and their small size.

The action of essential oils begins by entering the human body via three possible different ways including direct absorption through inhalation, ingestion or diffusion through the skin tissue.

6.1 Absorption through the skin

Essential oil compounds are fat soluble, and thus they have the ability to permeate the membranes of the skin before being captured by the micro-circulation and drained into the systemic circulation, which reaches all targets organs (Adorjan & Buchbauer, 2010; Baser & Buchbauer, 2010).

6.2 Inhalation

Another way by which essential oils enter the body is inhalation. Due to their volatility, they can be inhaled easily through the respiratory tract and lungs, which can distribute them into the bloodstream (Margaris et al., 1982; Moss et al, 2003). In general, the respiratory tract offers the most rapid way of entry followed by the dermal pathway.

6.3 Ingestion

Oral ingestion of essential oils needs attention due to the potential toxicity of some oils. Ingested essential oil compounds and/or their metabolites may then be absorbed and delivered to the rest of the body by the bloodstream and then distributed to parts of the body. Once essential oil molecules are in body, they interrelate with physiological functions by three distinct modes of action:

- Biochemical (pharmacological): Interacting in the bloodstream and interacting chemically with hormones and enzymes such as farnesene.
- Physiological: By acting (for example phytohormones) on specific physiological function. For example, the essential oil of fennel contains a form of estrogen-like compounds that may be effective for female problems such as lactation and menstruation.
- Psychological: by inhalation, the olfactory area of the brain (limbic system) undergoes an action triggered by the essential oil molecules and then, chemical and neurotransmitter messengers provide changes in the mental and emotional behavior of the person (Buchbauer, 1993; Johnson, 2011; Shibamoto et al, 2010). Lavender and lemon essential oils are examples for their sedative and relaxant properties.

Biological activity of essential oils may be due to one of the compounds or due to the entire mixture. In the following, we present effects of different classes of compounds present in essential oils together with their major properties and we give some examples of essential oils and their potential therapeutic activities.

7. Classes of essential oil compounds and their biological activities

7.1 Hydrocarbons

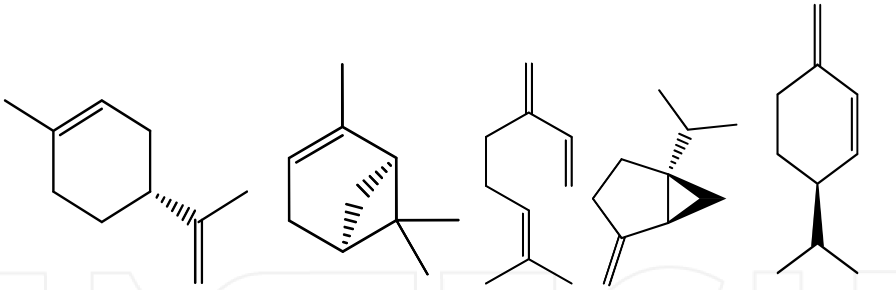
The majority of essential oils fall into this category; these contain molecules of hydrogen and carbon only and are classified into terpenes (monoterpenes: C10, sesquiterpenes: C15, and diterpenes: C20). These hydrocarbons may be acyclic, alicyclic (monocyclic, bicyclic or tricyclic) or aromatic. Limonene, myrcene, p-menthane, α-pinene, β-pinene, α-sabinene, p-cymene, myrcene, α–phellandrene, thujane, fenchane, farnesene, azulene, cadinene and sabinene are some examples of this family of products. These compounds have been associated with various therapeutic activities (Table 2). Some structures of these compounds are given in figure 2.

7.2 Esters

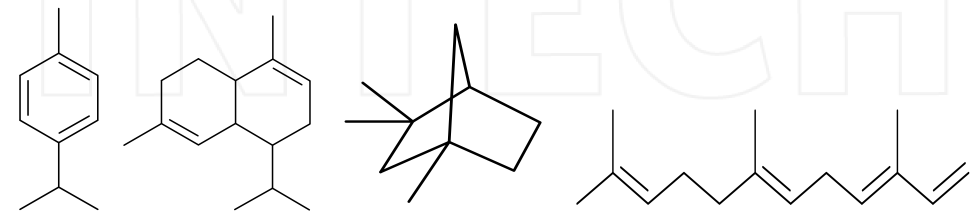
Esters are sweet smelling and give a pleasant smell to the oils and are very commonly found in a large number of essential oils. They include for example, linalyl acetate, geraniol acetate, eugenol acetate and bornyl acetate (Figure 3). Esters are anti-inflammatory, spasmolytic, sedative, and antifungal (Table 2).

7.3 Oxides

Oxides or cyclic ethers are the strongest odorants, and by far the most known oxide is 1,8-cineole, as it is the most omnipresent one in essential oils. Other examples of oxides are bisabolone oxide, linalool oxide, sclareol oxide and ascaridole (Figure 4). Their therapeutic benefits are expectorant and stimulant of nervous system (Table 2).

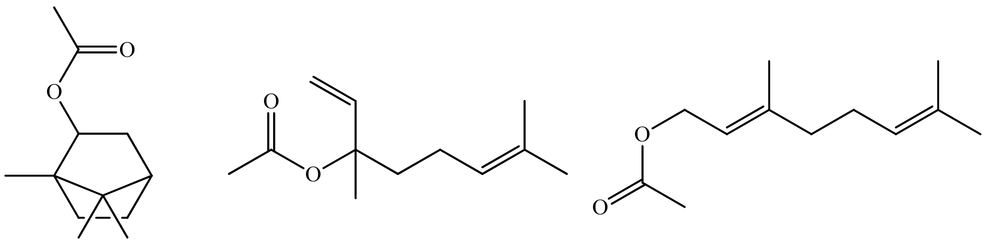


(+)-limonene (-)-α-pinene myrcene sabinene β−phellandrene



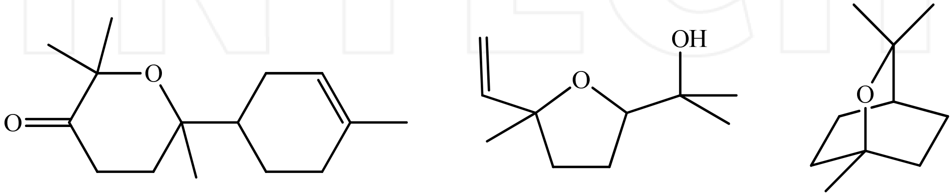
p-Cymene Cadinene Fenchane Farnesene

Fig. 2. Structures of some hydrocarbons commonly found in essential oils.



bornyl acetate linalyl acetate geranyl acetate

Fig. 3. Structures of some esters commonly found in essential oils.



bisabolone oxide linalool oxide 1,8-cineole

Fig. 4. Structures of some oxides commonly found in essential oils.

Class of compounds	Example	Bioactivities	Literature
Hydrocarbons	Limonene, myrcene, pinene, pinene, sabinene, cymene, myrcene, phellandrene.	Stimulant, antiviral, antitumour, decongestant, antibacterial, hepatoprotective	Ozbek, 2003; Pengelly, 2004; Bowles, 2003; Svoboda & Hampson, 1999; Deans et al., 1992; Griffin et al., 1999; Edris, 2007; Baser & Buchbauer, 2010
Esters	linalyl acetate, geraniol acetate, eugenol acetate, bornyl acetate	spasmolytic, sedative, antifungal, anaesthetic, anti-inflammatory.	Pengelly, 2004; De Sousa et al., 2011; Sugawara et al., 1998; Peana et al., 2002 ; Ghelardini et al., 1999; De Sousa, 2011.
Oxides	bisabolone oxide, linalool oxide, sclareol oxide, ascaridole	anti-inflammatory, Expectorant, stimulant	Pengelly, 2004; Ghelardini et al., 2001; De Sousa, 2011.
Lactones	nepetalactone, bergaptene, costuslactone, dihydronepetalactone, alantrolactone.	Antimicrobial; antiviral; Antipyretic, sedative, hypotensive; analgesic	Pengelly, 2004; De Sousa, 2011; Miceli et al., 2005 ; Gomes et al., 2009.
Alcohols	linalol, menthol, borneol, santalol, nerol, citronellol, geraniol	Antimicrobial, antiseptic, tonifying, balancing, spasmolytic, anaesthetic; anti-inflammatory.	Pengelly, 2004; Sugawara et al., 1998; De Sousa, 2011; Ghelardini et al., 1999; Peana et al., 2002.
Phenols	thymol, eugenol, carvacrol, chavicol	antimicrobial,spasmolytic, anaesthetic, irritant, immune stimulating	Pengelly, 2004; Ghelardini et al., 1999; De Sousa, 2011.
Aldehydes	citral, myrtenal, cuminaldehyde, citronellal, cinnamaldehyde, benzaldehyde	Antiviral, antimicrobial, tonic, vasodilators, hypotensive, calming, antipyretic, sedative, spasmolytic	Dorman & Deans, 2000; Pengelly, 2004;
Ketones	carvone, menthone, pulegone, fenchone, camphor, thujone, verbenone	mucolytic, cell regenerating, sedative, antiviral, neurotoxic, analgesic, digestive, spasmolytic	Pengelly, 2004; De Sousa et al. 2008; De Sousa, 2011; Gali-Muhtassib et al., 2000

Table 2. Different classes of essential oils compounds and their bioactivities.

7.4 Lactones

Lactones are of relatively high molecular weight and are usually found in pressed oils. Some examples of lactones are nepetalactone, bergaptene, costuslactone, dihydronepetalactone, alantrolactone, epinepetalactone, aesculatine, citroptene, and psoralen (Figure 5). They may be used for antipyretic, sedative and hypotensive purposes, but their contraindication is allergy, especially such involving the skin (Table 2).

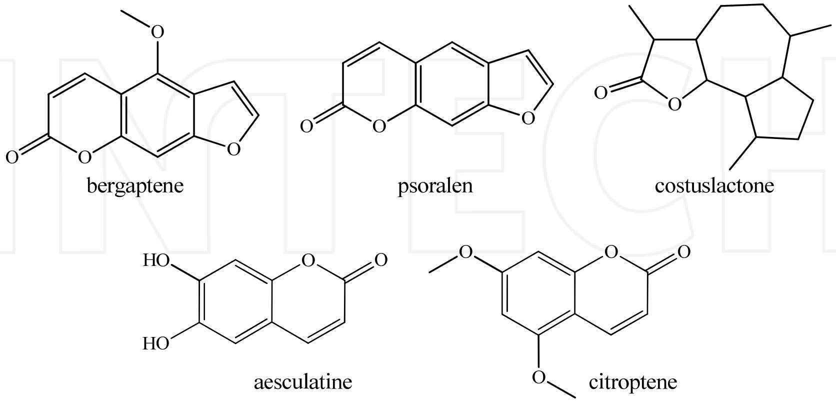


Fig. 5. Structures of some lactones commonly found in essential oils.

7.5 Alcohols

In addition to their pleasant fragrance, alcohols are the most therapeutically beneficial of essential oil components with no reported contraindications. They are antimicrobial, antiseptic, tonifying, balancing and spasmolytic (Table 2). Examples of essential oil alcohols are linalol, menthol, borneol, santalol, nerol, citronellol and geraniol (Figure 6).

7.6 Phenols

These aromatic components are among the most reactive, potentially toxic and irritant, especially for the skin and the mucous membranes. Their properties are similar to alcohols but more pronounced. They possess antimicrobial, rubefacient properties, stimulate the immune and nervous systems and may reduce cholesterol (Table 2). Phenols are often found as crystals at room temperature, and the most common ones are thymol, eugenol, carvacrol and chavicol (Figure 7).

7.7 Aldehydes

Aldehydes are common essential oil components that are unstable and oxidize easily. Many aldehydes are mucous membrane irritants and are skin sensitizers. They have characteristically sweet, pleasant fruity odors and are found in some of our most well known culinary herbs such as cumin and cinnamon. Therapeutically, certain aldehydes have been described as: antiviral, antimicrobial, tonic, vasodilators, hypotensive, calming, antipyretic and spasmolytic (Table 2). Common examples of aldehydes in essential oils include citral (geranial and neral), myrtenal, cuminaldehyde, citronellal, cinnamaldehyde and benzaldehyde (Figure 8).

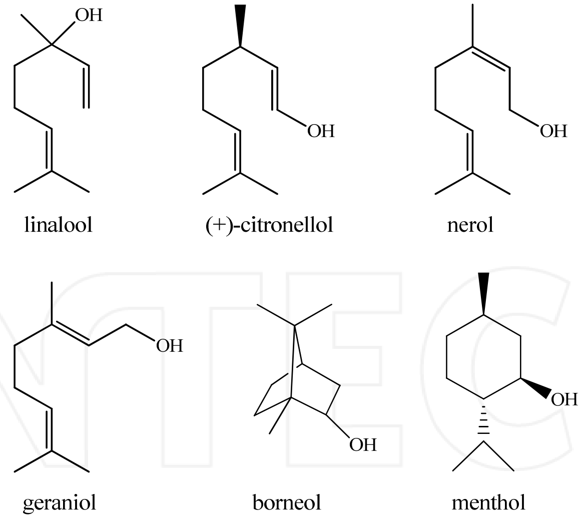


Fig. 6. Structures of some alcohols commonly found in essential oils.

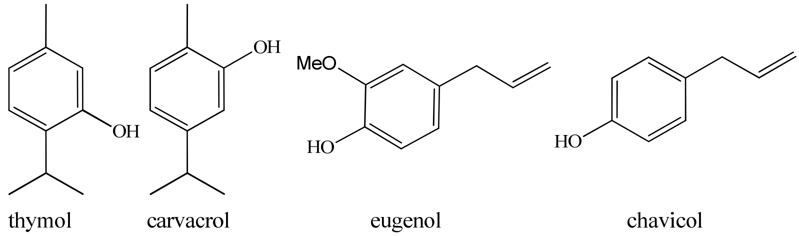


Fig. 7. Structures of some phenols commonly found in essential oils.

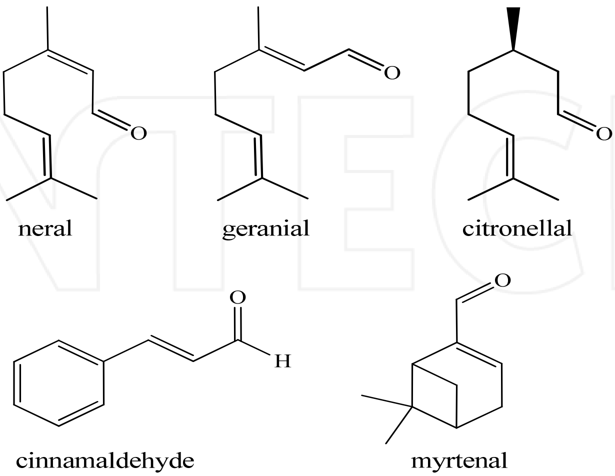


Fig. 8. Structures of some aldehydes commonly found in essential oils.

7.8 Ketones

Ketones are not very common in the majority of essential oils; they are relatively stable molecules and are not particularly important as fragrances or flavor substances. In some cases, ketones are neurotoxic and abortifacients such as camphor and thujone (Gali-Muhtassib et al., 2000) but have some therapeutic effects. They may be mucolytic, cell regenerating; sedative, antiviral, analgesic and digestive (Table 2). Due to their stability, ketones are not easily metabolized by the liver. Common examples of ketones found in essential oils include carvone, menthone, pulegone, fenchone, camphor, thujone and verbenone (Figure 9).

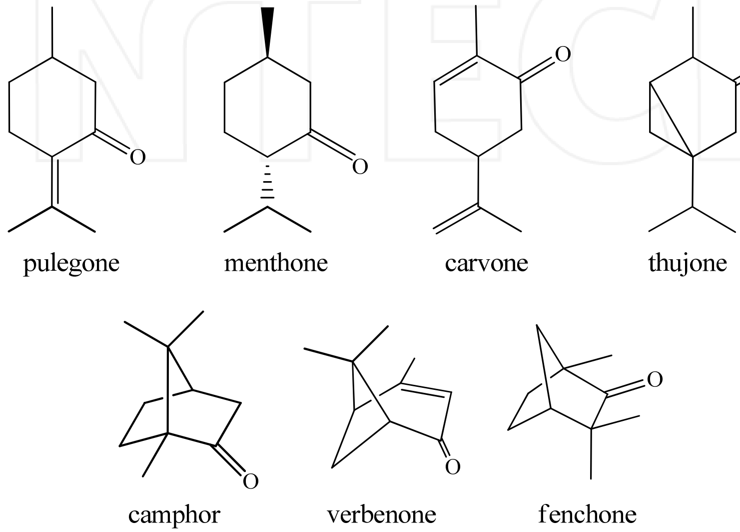


Fig. 9. Structures of some ketones commonly encountered in essential oils.

In Table 2; the different classes of these compounds are summarized with their bioactivities based on various biological studies cited in literature.

8. Mechanism of the biological activities of essential oils

So far, there is no study that can give us a clear idea and be accurate on the mode of action of the essential oils. Given the complexity of their chemical composition, everything suggests that this mode of action is complex, and it is difficult to identify the molecular pathway of action. It is very likely that each of the constituents of the essential oils has its own mechanism of action.

8.1 Antibacterial and antifungal action

Because of the variability of amounts and profiles of the components of essential oils, it is likely that their antimicrobial activity is not due to a single mechanism, but to several sites of action at the cellular level. Then, different modes of action are involved in the antimicrobial activity of essential oils.

One of the possibilities for action is the generation of irreversible damage to the membrane of bacterial cells, that induce material losses (cytoplasmic), leakage of ions, loss of energy substrate (glucose, ATP), leading directly to the lysis of bacteria (cytolysis) and therefore to its death. Another possibility of action is inhibition of production of amylase and protease which stop the toxin production, electron flow and result in coagulation of the cell content (Bakkali et al., 2008; Burt 2004; Di Pasqua et al., 2007; Hammer et al., 2008).

Antifungal actions are quite similar to those described for bacteria. However, two additional phenomena inhibiting the action of yeast are worth mentioning: the establishment of a pH gradient across the cytoplasmic membrane and the blocking of energy production of yeasts which involve the disruption of the bacterial membrane.

8.2 Antiviral activity

The complex mixture of essential oils usually shows a higher antiviral activity than individual compounds (due probably to synergism phenomena); with exception of β-caryophyllene which is the most famous antiviral compounds found in many different essential oils from different plant families. Different mechanisms of antiviral activity of different essential oils and their constituents seem to be present. 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 interfere with the virus envelope by inhibiting specific processes in the viral replication cycle or by masking viral components, which are necessary for adsorption or entry into host cells, thus, they prevent the cell-to-cell virus diffusion (Saddi et al., 2007).

9. Therapeutic properties of some essential Oils

9.1 Chamomille essential oil (*Matricaria chamomilla*):

9.1.1 Main active compounds: Bisabolol and chamazulene (Cemek et al.; 2008; Kamatou & Viljoen, 2010).

9.1.2 Properties: anti-inflammatory, anti-allergic, anti-pruritic, healing, decongestive (decongest the skin) and antispasmodic (Bnouham, 2010; Tolouee et al., 2010, Alves et al., 2010; Mckay & Blumberg, 2006).

9.2 Anise essential oil (*Pimpinella anisum*):

9.2.1 Main active compound: Anethole (Andrade et al., 2011; Mata et al., 2007;)

9.2.2 Proprieties: antispasmodic, emmenagogue, stomachic, carminative, diuretic, general cardiac stimulant. (Jaiswal et al., 2009; Muchtaridi et al., 2010; Nerio et al., 2010; Tabanca et al., 2006).

9.3 Nutmeg essential oil (*Myristica fragrans*):

9.3.1 Main active compounds: Sabinene, 4-terpineol and myristicin (Muchtaridi et al., 2010).

9.3.2 Properties: Antimicrobial, pesticidal activity, general tonic, brain and circulatory, hepatoprotective, aphrodisiac, Stimulating the digestive, carminative and digestive systems Analgesic, Emmenagogue, Antiseptic, anti-parasitic (Sankarikutty & Narayanan, 1993; Spricigo et al., 1999; Tomaino et al., 2005).

9.4 Cedar essential oil (*Cedrus libani*):

9.4.1 Main active compound: Limonene (Cetin et al., 2009).

9.4.2 Properties: Larvicidal, Lymphotonic, draining powerful diuretic, Regenerative blood, Healing, astringent, Scalp Tonic, Antifungal, Anti-mosquito and anti-moth Decongestant and antiseptic respiratory Relaxing and comforting (Dharmagadda et al., 2005; Kizil et al., 2002; Loizzo et al., 2008; Svoboda et al., 1999)

9.5 Dill essential oil (*Anethum graveolens*):

9.5.1 Main active compound: Carvone (Lazutka et al., 2001; Kishore et al.,1993)

9.5.2 Properties: Antispasmodic in gastrointestinal disorders, fluidity of bronchial secretions. (Bakkali et al., 2008; Edris, 2007; Jirovetz et al., 2003; Sridhar et al., 2003.)

9.6 Garlic essential oil (*Allium sativum*):

9.6.1 Main active compound: Diallylle disulfide (Kendler, 1987; Thomson & Ali, 2003)

9.6.2 Properties: Protects and maintains the cardiovascular system, hypoglycemic, Regulates blood pressure vermifuge, antimicrobial, antiviral, anti-fungal and anti-parasitic, insecticidal and larvicidal, antioxidant (Klevenhusen et al., 2011; Lazarević et al., 2011; Lau et al., 1983; Park & Shin, 2005)

9.7 Clove essential oil (*Syzygium aromaticus*):

9.7.1 Main active compound: Eugenol and eugenyle acetate (Silva & Fernandes, 2010; Fichi et al., 2007)

9.7.2 Properties: Antiviral, antimicrobial, antifungal, general stimulating, hypertensive aphrodisiac, light stomachic, carminative, anesthetic. (de Paoli et al., 2007; Koba et al., 2011; Machado et al., 2011; Politeo et al., 2010).

9.8 Cinnamon essential oil (*Cinnamomum cassia*):

9.8.1 Main active compound: Cinnamaldehyde (Hseini & Kahouadji, 2007; Vyawahare et al., 2009).

9.8.2 Properties: Powerful, antibacterial, antiviral, antifungal and parasiticide, uterine tonic, anticoagulant, insecticide. (Cheng et al., 2004; Geng et al., 2011; Unlu *et al.*, 2010).

9.9 Sweet orange essential oil (*Citrus sinensis*):

9.9.1. Main active compound: Limonene (Hosni et al., 2010; Viudamartos et al., 2008)

9.9.2. Properties: Antiseptic, sedative, stomachic, carminative, tonic, excellent food flavoring (Anagnostopoulou et al., 2006; Ezeonu et al., 2001; Singh et al., 2010).

9.10. Eucalyptus essential oil (*Eucalyptus globulus*):

9.10.1. Main active compound: 1,8-cineole (Nerio et al., 2009; Vilela et al., 2009)

9.10.2. Properties: Anticatarrhale, expectorant and mucolytic, antimicrobial, Antiviral (Ben-Arye et al., 2011; Ben Hadj et al., 2011; Caballero-Gallardo et al., 2011; Gende et al., 2010).

9.11. Peppermint essential oil (*Mentha piperita*):

9.11.1. Main active compound: menthol and menthone (Sala, 2011; Alexopoulos et al., 2011).

9.11.2. Properties: Tonic and stimulant, decongestant, anesthetic and analgesic antipruritic, refreshing, antimicrobial, anti-inflammatory, expectorant, mucolytic, emmenagogue (De Sousa, 2011; Kumar et al., 2011; Sabzghabaee et al., 2011; Singh et al., 2011).

9.12. Lavender essential oil (*Lavandula officinalis*):

9.12.1. Main active compound: Linalol and linalyle acétate (Hajhashemi et al., 2003; Lee et al., 2011).

9.12.2. Properties: antispasmodic, sedative, relaxing, analgesic, anti-inflammatory, antimicrobial (Kloucek et al., 2011; Pohlit et al., 2011; Woronuk et al., 2011; Zuzarte et al., 2011).

9.13. Tea tree essential oil (*Melaleuca alternifolia*):

9.13.1. Main active compound: Terpinène-1-ol-4. (Van Vuuren et al., 2009 ; Hammer et al., 2008)

9.13.2. Properties: Antimicrobial, antiviral, antiasthenic, neurotonic, lymphatic, decongestant, radioprotective, antispasmodic (Garozzo et al., 2009; Lobo et al., 2011; Mickienė et al., 2011).

9.14. Lemon essential oil (*Citrus limonum*):

9.14.1. Main active compound: limonene (Fisher & Phillips, 2008; Kim et al., 2003)

9.14.2. Properties: Strengthen natural immunity, metabolism regulator, tonic nervous system, antimicrobial, antiviral, digestive tonic carminative and purgative (Koul et al., 2008; Pavela *et al.,* 2005; Pavela et al., 2008; Ponce et al., 2004).

10. Conclusion

According to literature, we can say that the essential oils and their components have many uses, both in pharmacology and in food. In addition, they are endowed with interesting biological activities and have a therapeutic potential. For example, essential oils exhibit antimicrobial activities, antiviral activities with broad spectrum, and may be useful as natural remedies and it seems that essential oils can be used as a suitable therapy for many pathologies. In the cosmetic and in the food industry, essential oils uses are an integral part, as they may play different roles. Therefore, economic importance of essential oils is indisputable. It appears therefore imperative to preserve our natural, diverse flora and support its protection in order to keep this inexhaustible source of molecules destined for multiple targets.

11. References

Adorjan, B. & Buchbauer, G. (2010). Biological properties of essential oils: an updated review. *Flavour Fragr. J.*, Vol.25, pp. 407-426.

Ahmadi, L.; Mirza, M. & Shahmir, F. (2002). The volatile constituents of Artemisia marschaliana Sprengel and its secretory elements. *Flavour Fragr. J.*, Vol.17, pp. 141-143.

Akhila, A. (2006). *Essential Oil-Bearing Grasses, The genus Cymbopogon; Medicinal and Aromatic Plants-Industrial Profiles*, CRC Press, New York.

Alexopoulos, A.; Kimbaris, A.C.; Plessas, S.; Mantzourani, I.; Theodoridou, I.; Stavropoulou, E.; Polissiou, M.G. & Bezirtzoglou, E. (2011). Antibacterial activities of essential oils from eight Greek aromatic plants against clinical isolates of *Staphylococcus aureus. Anaerobe in press.*

Alves, A.M.H.; Gonçalves, J.C.R.; Cruz, J.S. & Araújo, D.A.M. (2010). Evaluation of the sesquiterpene (−)-α-bisabolol as a novel peripheral nervous blocker. *Neuroscience Letters*, Vol.472, pp.11-15.

Anagnostopoulou, M.A.; Kefalas, P.; Papageorgiou, V.P.; Assimopoulou, A.N. & Boskou, B. (2006). Radical scavenging activity of various extracts and fractions of sweet orange peel (*Citrus sinensis*). *Food Chemistry*, Vol.94, pp.19-25.

Gali-Muhtasib, H. ; Hilan, C. & Khater, C. (2000). Traditional uses of *Salvia libanotica* (East Mediterranean sage) and the effects of its essential oils. *Journal of Ethnopharmacology*, Vol. 71 (2000) pp. 513–520.

Andrade, E.H.A.; Alves, C.N.; Guimarães, E.F.; Carreira, L.M.M. & Maia, J.G.S. (2011). Variability in essential oil composition of *Piper dilatatum* L.C. Rich. *Biochem. Syst. Ecol.*, Vol.39, pp.669-675.

Anwar, F.; Ali, M.; Hussain, A.I.; & Shahid, M. (2009). Antioxidant and antimicrobial activities of essential oils and extracts of fennel (*Foeniculum vulgare* Mill.) seeds from Pakistan. *Flavour Fragr. J.*, Vol.24, pp.170-176.

Anwar, F.; Hussain, A.I.; Sherazi, S.T.H. & Bhanger, M.I. (2009). Changes in composition and antioxidant and antimicrobial activities of essential oil of fennel (*Foeniculum vulgare* Mill.) fruit at different stages of maturity. *Journal of Herbs, Spices and Medicinals Plants,* Vol.15, pp.1-16.

Bakkali, F.; Averbeck, S.; Averbeck, D.; & Idaomar, M. (2008). Biological effects of essential oils. *Food and Chemical Toxicology*, Vol.46, pp.446-475.

Baris, O.; Güllüce, M.; Sahin, F.; Ozer, H.; Kılıc, H.; Ozkan, H.; Sökmen, M. and Ozbek, T. (2006). Biological activities of the essential oil and methanol extract of *Achillea biebersteini* Afan Afan (Asteraceae). *Turkish J. Biol.*, Vol.30, pp.65-73.

Baser, K.H.C. & Buchbauer, G. (2010). *Handbook of essential oils: Science, Technology, and Applications*, CRC Press NW.

Baylac, S. & Racine, P. (2003). Inhibition of 5-lipoxygenase by essential oils and other natural fragrant extracts. *International Journal of Aromatherapy,* Vol.13, pp.138-142.

Ben Hadj Ahmed, S.; Sghaier, R.M.; Guesmi, F.; Kaabi, B.; Mejri, M.; Attia, H.; Laouini, D.; Smaali, I. (2011). Evaluation of antileishmanial, cytotoxic and antioxidant activities of essential oils extracted from plants issued from the leishmaniasis-endemic region of Sned (Tunisia). *Natural Product Research*, Vol.25, pp. 1195-1201.

Ben-Arye, E.; Dudai, N.; Eini, A.; Torem, M.; Schiff, E. & Rakover, Y. (2011). Treatment of Upper Respiratory Tract Infections in Primary Care: A Randomized Study Using Aromatic Herbs. *Evidence-Based Complementary and Alternative Medicine*, Vol.2011, Article ID 690346, 7 pages.

Bezić, N.; Šamanić, I.; Dunkić, V.; Besendorfer, V. & Puizina, J. (2009). Essential Oil Composition and Internal Transcribed Spacer (ITS) Sequence Variability of Four South-Croatian *Satureja* Species (Lamiaceae). *Molecules*, Vol.14, pp. 925-938.

Bnouham, M. (2010). Medicinal Plants with Potential Galactagogue Activity Used in the Moroccan Pharmacopoeia. *Journal of Complementary and Integrative Medicine*. Vol.7, Iss. 1, Article 52.

Bowles, E.J. (2003). *The Chemistry of Aromatherapeutic Oils*; 3rd Edition Griffin Press.

Bronaugh, R.L.; Wester, R.C.; Bucks, D.; Maibach, H.I.; & Sarason, R. (1990). *In vivo* percutaneous absorption of fragrance ingredients in rhesus monkeys and humans. *Food and Chemical Toxicology*, Vol.28, pp. 369-374.

Buchbauer, G. (1993). Molecular interaction: biological effects and modes of action of essential oils. *International Journal of Aromatherapy,* Vol.5, pp. 11-14.

Buchbauer, G.; Jirovetz, L.; Jager, W.; Plank, C. & Dietrich, H. (1993). Fragrance compounds and essential oils with sedative effects upon inhalation. *J. Pharm. Sci.*, Vol.82, pp. 660-664.

Burt, S. (2004). Essential oils: their antibacterial properties and potential applications in foods. *International Journal of Food Microbiology*, Vol.94, pp. 223-253.

Caballero-Gallardo, K.; Olivero-Verbel, J. & Stashenko, E.E. (2011). Repellent Activity of Essential Oils and Some of Their Individual Constituents against *Tribolium castaneum* Herbst. *J. Agric. Food Chem.*, Vol.59, pp. 1690-1696.

Celiktas, O. Y.; Kocabas, E. E. H.; Bedir, E.; Sukan, F. V.; Ozek, T. & Baser, K.H.C. (2007). Antimicrobial activities of methanol extracts and essential oils of *Rosmarinus officinalis*, depending on location and seasonal variations. *Food Chemistry,* Vol.100, pp. 553-559.

Cemek, M.; Kaga, S.; Simsek, N.; Buyukokuroglu, M.E. & Konuk, M. (2008). Antihyperglycemic and antioxidative potential of *Matricaria chamomilla* L. in streptozotocin-induced diabetic rats. *J. Nat. Med.* Vol.62, pp. 284-293.

Cetin, H.; Kurt, Y.; Isik, K. & Yanikoglu, A. (2009). Larvicidal effect of *Cedrus libani* seed oils on mosquito *Culex pipiens. Pharmaceutical Biology*, Vol.47, pp. 665-668.

Cheng, S.S.; Liu, J.Y.; Tsai, K.H.; Chen, W.J. & Chang, S.T. (2004). Chemical composition and mosquito larvicidal activity of essential oils from leaves of different *Cinnamomum osmophloeum* provenances. *J. Agric. Food Chem.*, Vol.52, pp. 4395-4400.

Ciccarelli, D.; Garbari, F. & Pagni, A.M. (2008). The flower of *Myrtus communis* (Myrtaceae): Secretory structures, unicellular papillae, and their ecological role. *Flora*, Vol.203, pp. 85-93.

Da Porto, C.; Decorti, D. & Kikic, I. (2009). Flavour compounds of *Lavandula angustifolia* L. to use in food manufacturing: Comparison of three different extraction methods. *Food Chemistry*, Vol.112, pp. 1072-1078.

de Paoli, S.; Giani, T.S.; Presta, G.A.; Pereira, M.O.; da Fonseca, A.D.; Brandão-Neto, J.; Medeiros, A.D.; Santos-Filho, S.D. & Bernardo-Filho, M. (2007). Effects of Clove (*Caryophyllus aromaticus* L.) on the Labeling of Blood Constituents with Technetium-99m and on the Morphology of Red Blood Cells. *Brazilian archives of biology and technology,* Vol.50, pp. 175-182.

De Sousa, D.P. (2011). Analgesic-like Activity of Essential Oils Constituents. *Molecules*, Vol.16, pp. 2233-2252.

De Sousa, D.P.; Júnior, G.A.S.; Andrade, L.N. & Batista, J.S. (2011). Spasmolytic Activity of Chiral Monoterpene Esters. *Rec. Nat. Prod.*, Vol.5, pp. 117-122.

De Sousa, D.P.; Júnior, G.A.; Andrade, L.N.; Calasans, F.R.; Nunes, X.P.; Barbosa-Filho, J.M. & Batista, J.S. (2008). Structure and spasmolytic activity relationships of analogues found in many aromatic plants. *Z. Naturforsch. C.* Vol.63, pp. 808-812.

Deans, S. G.; Svoboda, K.P.; Gundidza, M. & Brechany, E.Y. (1992). Essential oil profiles of several temperate and tropical aromatic plants: their antimicrobial and antioxidant activities. *Acta Hortic.*, Vol.306, pp. 229-232.

Delamare, A.P.L.; Moschen-Pistorello, I.T.; Artico, L.; Atti-Serafini, L.; Echeverrigaray, S. (2007). Antibacterial activity of the essential oils of *Salvia officinalis* L. and *Salvia triloba* L. cultivated in South Brazil. *Food chemistry*, Vol.100, pp. 603-608.

Dharmagadda, V.S.S.; Naik, S.N.; Mittal, P.K.; Vasudevan, P. (2005). Larvicidal activity of *Tagetes patula* essential oil against three mosquito species. *Bioresource Technology*, Vol.96, pp. 1235-1240.

Di Pasqua, R.; Betts, G.; Hoskins, N.; Edwards, M.; Ercolini, D.; Mauriello, G. (2007). Membrane toxicity of antimicrobial compounds from essential oils. *J. Agric. Food Chem.*, Vol.55, pp. 4863-4870.

Donelian, A.; Carlson, L.H.C.; Lopes, T.J. & Machado, R.A.F. (2009). Comparison of extraction of patchouli (*Pogostemon cablin*) essential oil with supercritical CO2 and by steam distillation. *The Journal of Supercritical Fluids*, Vol.48, pp. 15-20.

Dorman, H.J.D. & Deans, S.G. (2000). Antimicrobial agents from plants: antibacterial activity of plant volatile oils. *Journal of Applied Microbiology*, Vol.88, pp. 308-316.

Edris, A.E. (2007). Pharmaceutical and Therapeutic Potentials of Essential Oils and Their Individual Volatile Constituents. *Phytotheray Research*, Vol.21, pp.308-323.

Eikani, M. H.; Golmohammad, F. & Rowshanzamir, S. (2007). Subcritical water extraction of essential oils from coriander seeds (*Coriandrum sativum* L.). *Journal of Food Engineering*, Vol.80, pp. 735-740.

Ezeonu, F.C.; Chidume, G.I. & Udedi, S.C. (2001). Insecticidal properties of volatile extracts of orange peels. *Bioresource Technology*, Vol.76, pp. 273-274.

Fichi, G.; Flamini G.; Giovanelli, F.; Otranto, D. & Perrucci, S. (2007). Efficacy of an essential oil of *Eugenia caryophyllata* against *Psoroptes cuniculi. Experimental Parasitology*, Vol.115, pp. 168-172.

Fisher, K. & Phillips, C. (2008). Potential antimicrobial uses of essential oils in food: is citrus the answer. *Trends in Food Science & Technology*, Vol.19, pp. 156-164.

Gali-Muhtasib, H.; Hilan, C. & Khater, C. (2000). Traditional uses of *Salvia libanotica* (East Mediterranean sage) and the effects of its essential oils. *Journal of Ethnopharmacology*, Vol.71, pp. 513-520.

Garozzo, A.; Timpanaro, R.; Bisignano, B.; Furneri, P.M.; Bisignano, G. & Castro, A. (2009). *In vitro* antiviral activity of *Melaleuca alternifolia. Letters in Applied Microbiology*, Vol.49, pp. 806-808.

Gende, L.; Maggi, M.; Van Baren, C.; Di Leo Lira, A.; Bandoni, A.; Fritz, R. & Eguaras, M. (2010). Antimicrobial and miticide activities of *Eucalyptus globulus* essential oils obtained from different Argentine regions. *Spanish Journal of Agricultural Research*, Vol.8, pp. 642-650.

Geng, S.; Cui, Z.; Huang, X.; Chen, Y.; Xu, D. & Xiong, P. (2011). Variations in essential oil yield and composition during *Cinnamomum cassia* bark growth. *Industrial Crops and Products*, Vol.33, pp. 248-252.

Gershenzon, J. (1994). Metabolic costs of terpenoid accumulation in higher plants. *Journal of Chemical Ecology,* Vol.20, pp. 1281-1328.

Ghelardini, C.; Galeotti, N. & Mazzanti, G. (1999). Local anaesthetic activity of the essential oil of *Lavandula angustifolia*. *Planta Medica,* Vol.65, pp. 700–703.

Ghelardini, C.; Galeotti, N. & Mazzanti, G. (2001). Local anaesthetic activity of monoterpenes and phenylpropanes of essential oils. *Planta Medica,* Vol.67, pp. 564–566.

Gomes, N.G.M; Campos, M.G.; Órfão, J.M.C. & Ribeiro, C.A.F. (2009). Plants with neurobiological activity as potential targets for drug discovery. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, Vol.33, pp. 1372-1389.

Griffin, S.G.; Wyllie, S.G.; Markham, J.L. & Leach, D.N. (1999). The role of structure and molecular properties of terpenoids in determining their antimicrobial activity. *Flavour and Fragrance Journal,* Vol.14, pp. 322-332.

Guénette, S.A.; Ross, A.; Marier, J.F. ; Beaudry, F. & Vacho, P. (2007). Pharmacokinetics of eugenol and its effects on thermal hypersensitivity in rats. *Eur. J. Pharmacol.*, Vol.562, pp. 60-67.

Gupta, V.; Mittal, P.; Bansal, P.; Khokra, S.L. & Kaushik, D. (2010). Pharmacological Potential of *Matricaria recutita. International Journal of Pharmaceutical Sciences and Drug Research*, Vol.2, pp. 12-16.

Hajhashemi, V.; Ghannadi, A. & Sharif, B. (2003). Anti-inflammatory and analgesic properties of the leaf extracts and essential oil of *Lavandula angustifolia* Mill. *Journal of Ethnopharmacology*, Vol.89, pp. 67-71.

Halm, M.A. (2008). Essential Oils for Management of Symptoms in Critically Ill Patients. *Am. J. Crit. Care,* Vol.17, pp. 160-163.

Hammer, K.A.; Carson, C.F.; Dunstan, J.A.; Hale, J.; Lehmann, H.; Robinson, C.J.; Prescott, S.L. & Riley, T.V. (2008). Antimicrobial and anti-inflammatory activity of five *Taxandria fragrans* oils *in vitro. Microbiology and immunology,* Vol.52, pp. 522-530.

Hay, R.K.M. & Svoboda, K.P. (1993). Botany. In Volatile oil crops: their biology, biochemistry and production, Hay, R.K.M. and Waterman, P.G. (eds.), Longman Scientific & Technical, Harlow, pp. 5-22.

Hosni, K.; Zahed, N.; Chrif, R.; Abid, I.; Medfei, W.; Kallel, M.; Ben Brahim, N. & Sebei, H. (2010). Composition of peel essential oils from four selected *Tunisian Citrus* species: Evidence for the genotypic influence. *Food Chemistry*, Vol.123, pp. 1098-1104.

Hotchkiss, S.A.; Chidgey, M.; Rose, S. & Caldwell, J. (1990). Percutaneous absorption of benzyl acetate through rat skin in vitro. Validation of an in vitro model against in vivo data. *Food and Chemical Toxicology,* Vol.28, pp. 443-447.

Hseini, S. & Kahouadji, A. (2007). Étude ethnobotanique de la flore médicinale dans la région de Rabat (Maroc occidental); LAZAROA Vol.28, pp.79-93.

Hunter, M. (2009). Essential oils: Art, Agriculture, Science, Industry and Entrepreneurship. Nova Science Publishers, Inc., New York.

Hussain, A.I.; Anwar, F.; Sherazi, S.T.H.; Przybylski, R. (2008). Chemical composition, antioxidant and antimicrobial activities of basil (*Ocimum basilicum*) essential oils depends on seasonal variations. *Food Chem.*, Vol.108, pp. 986-995.

Jaiswal, P.; Kumar, P.; Singh, V.K. & Singh, D.K. (2009). Biological Effects of *Myristica fragrans*. *Annual Review of Biomedical Sciences*, Vol.11, pp. 21-29.

Jirovetz, L.; Buchbauer, G.; Jager, W.; Woidich, A. & Nikiforov, A. (1992) Analysis of fragrance compounds in blood samples of mice by gas chromatography, mass spectrometry, GCFTIR and GCAES after inhalation of sandalwood oil. *Biomedical Chromatography,* Vol.6, pp. 133-134.

Jirovetz, L.; Buchbauer, G.; Stoyanova, A.S.; Georgiev, E.V. & Damianova, S.T. (2003). Composition, quality control, and antimicrobial activity of the essential oil of long-time stored dill (*Anethum graveolens* L.) seeds from Bulgaria. *J. Agric. Food Chem.*, Vol.51, pp. 3854-3857.

Johnson, A.J. (2011). Cognitive Facilitation Following Intentional Odor Exposure. *Sensors*, Vol.11, pp. 5469-5488.

Kamatou, G.P.P. & Viljoen A.M. (2010). A Review of the Application and Pharmacological Properties of α-Bisabolol and α-Bisabolol-Rich Oils. *J. Am. Oil Chem. Soc.*, Vol. 87, pp. 1–7.

Kendler, B.S. (1987). Garlic (*Allium sativum*) and onion (*Allium cepa*): a review of their relationship to cardiovascular disease. *Preventive Medicine*, Vol.16, pp. 670-685.

Kim, E.H.; Kim, H.K. & Ahn, Y.J. (1993). Acaricidal Activity of Plant Essential Oils against *Tyrophagus putrescentiae* (Acari: Acaridae). *Journal of Asia-Pacific Entomology*, Vol.6, pp.77-82.

Kishore, N.; Mishra, A.K. & Chansouria, J.P.N. (1993). Fungitoxicity of essential oils against dermatophytes. *Mycoses*, Vol.36, pp. 211-215.

Kizil, M.; Kizil, G.; Yavuz, M. & Aytekin, C. (2002). Antimicrobial activity of resins obtained from the roots and stems of *Cedrus libani* and *Abies Cilicia*. *Applied Biochemistry and Microbiology*, Vol.38, pp. 144-146.

Klevenhusen, F.; Zeitz, J.O.; Duval, S.; Kreuzer, M. & Soliva, C.R. (2011). Garlic oil and its principal component diallyl disulfide fail to mitigate methane, but improve digestibility in sheep. *Animal Feed Science and Technology*, Vol.166-167, pp. 356-363.

Kloucek, P.; Smid, J.; Frankova, A.; Kokoska, L.; Valterova, I. & Pavela, R. (2011). Fast screening method for assessment of antimicrobial activity of essential oils in vapor phase. *Food Research International,* Article in Press.

Koba, K.; Nenonene, A.Y.; Raynaud, C.; Chaumont, J.P. & Sanda, K. (2011). Antibacterial Activities of the Buds Essential Oil of *Syzygium aromaticum* (L.) 42 Merr. & Perry from Togo. *Journal of Biologically Active Products from Nature*, Vol.1, pp. 42-51.

Kohlert, C.; Schindler, G.; Marz, R.W.; Abel, G.; Brinkhaus, B.; Derendorf, H.; Grafe, E.U. & Veit, M. (2002). Systemic availability and pharmacokinetics of thymol in humans. *J. Clin. Pharmacol.* Vol.42, pp. 731-737.

Kohlert, C.; van Rensen I.; Marz, R.; Schindler, G.; Graefe, E.U. & Veit, M. (2000). Bioavailability and pharmacokinetics of natural volatile terpenes in animals and humans. *Planta Medica*, Vol. 66, pp. 495-505.

Koul O., Walia S., Dhaliwal G.S. (2008). Essential Oils as Green Pesticides: Potential and Constraints. *Biopestic. Int.,* 2008, Vol.4, pp. 63-84.

Kumar, P.; Mishra, S.; Malik, A.; Satya, S. (2011). Insecticidal properties of *Mentha* species. *Industrial Crops and Products*, Vol.34, pp. 802-817.

Lahlou, M. (2004). Methods to Study the Phytochemistry and Bioactivity of Essential Oils. *Phytother. Res.*, Vol.18, pp. 435-448.

Lau, B.H.S.; Adetumbi, M.A. & Sanchez, A. (1983). *Allium sativum* (garlic) and atherosclerosis. *Nutrition Research* Vol.3, pp. 119-128.

Lawless, J. (1995). The illustrated encyclopedia of essential oils: the complete illustrated guide to the use of oils in aromatherapy and herbalism. Shaftesbury, Dorset, UK: Element.

Lazarević, J.S.; Đorđević, A.S.; Zlatković, B.K.; Radulović, N.S. & Palić, R.M. (2011). Chemical composition and antioxidant and antimicrobial activities of essential oil of *Allium sphaerocephalon* L. subsp. *sphaerocephalon* (Liliaceae) inflorescences. *Journal of the Science of Food and Agriculture* Vol.91, pp. 322-329.

Lazutka, J.R; Mierauskiene J.; Slapsyte, G. & Dedonyte, V. (2001). Genotoxicity of dill (*Anethum graveolens* L.), peppermint (*Mentha piperita* L.) and pine (*Pinus sylvestris* L.) essential oils in human lymphocytes and *Drosophila melanogaster*. *Food Chem. Toxicol.* Vol.39, pp.485-492.

Lee, Y.L.; Wu, Y.; Tsang, W.H.; Leung, A.Y. & Cheung, W.M. (2011). A Systematic Review on the Anxiolytic Effects of Aromatherapy in People with Anxiety Symptoms. *The Journal of Alternative and Complementary Medicine*. Vol.17, pp. 101-108.

Liolios, C.C.; Graikou, K.; Skaltsa, E. & Chinou, I. (2010). Dittany of Crete: A botanical and ethnopharmacological. *Journal of Ethnopharmacology*, Vol.131, pp. 229-241.

Lis-Balchin, M. (1997). Essential oils and 'aromatherapy': their modern role in healing. *The Journal of the Royal Society for the Promotion of Health*, Vol.117, pp. 324-329.

Lobo, R.; Prabhu, K.; Shirwaikar, A.; Shirwaikar, A. & Ballal, M. (2011). Formulation and Evaluation of Antiseptic Activity of the Herbal Cream Containing *Curcuma longa* and Tea Tree Oil. *Journal of Biologically Active Products from Nature,* Vol.1, pp. 27-32.

Loizzo, M.R.; Saab, A.; Tundis, R.; Statti, G.A.; Lampronti, I.H.; Menichini, F.; Gambari, R.; Cinatl, J. & Doerr, H.W. (2008). Phytochemical analysis and in vitro evaluation of the biological activity against herpes simplex virus type 1 (HSV-1) of *Cedrus libani* A. Rich. *Phytomedicine*, Vol.15, pp. 79-83.

Machado, M.; Dinis, A.M.; Salgueiro, L.; Custódio; J.B.A.; Cavaleiro, C. & Sousa, M.C. (2011). Anti-Giardia activity of *Syzygium aromaticum* essential oil and eugenol: Effects on growth, viability, adherence and ultrastructure. *Experimental Parasitology*, Vol.127, pp. 732-739.

Margaris, N.; Koedam A. & Vokou, D. (1982). Aromatic Plants: basic and applied aspects. The Hague, London, Boston, Martinus Nijhoff Publishers.

Martín, A.; Varona, S.; Navarrete, A. & Cocero, M.J. (2010). Encapsulation and Co-Precipitation Processes with Supercritical Fluids: Applications with Essential Oils. *The Open Chemical Engineering Journal*, Vol. 4, pp. 31-41.

Martínez, J.L. (2008). Supercritical Fluid Extraction of Nutraceuticals and Bioactive Compounds, CRC Press, NW.

Mata, A.T.; Proenc, C.; Ferreira, A.R.; Serralheiro, M.L.M., Nogueira, J.M.F. & Araujo M.E.M. (2007). Antioxidant and antiacetylcholinesterase activities of five plants used as Portuguese food spices. *Food Chemistry*, Vol.103, pp. 778-786.

McKay, D.L. & Blumberg, J.B. (2006). A Review of the bioactivity and potential health benefits of chamomile tea (*Matricaria recutita* L.). *Phytotherapy Research*, Vol.20, pp. 519–530.

Miceli, N.; Taviano, M.F.; Giuffrida D.; Trovato, A.; Tzakou, O. & Galati E.M. (2005). Anti-inflammatory activity of extract and fractions from *Nepeta sibthorpii* Bentham. *Journal of Ethnopharmacology*, Vol.97, pp. 261-266.

Michiels, J.; Missotten, J.; Dierick, N.; Fremaut, D.; Maene, P. & De Smet, S. (2008). In vitro degradation and in vivo passage kinetics of carvacrol, thymol, eugenol and transcinnnamaldehyde along the gastrointestinal tract of piglets. *J Sci Food Agric*. Vol.88, pp. 2371-2381.

Mickienė, R.; Bakutis, B. & Baliukonienė, V. (2011). Antimicrobial activity of two essential oils. *Ann. Agric. Environ. Med.*, Vol.18, pp. 139-144.

Miguel, M.G. (2010). Antioxidant and Anti-Inflammatory Activities of Essential Oils. *Molecules*, Vol.15, pp. 9252-9287.

Morone-Fortunato, I.; Montemurro, C.; Ruta, C.; Perrini, R.; Sabetta, W.; Blanco, A.; Lorusso, E. & Avato, P. (2010). Essential oils, genetic relationships and in vitro establishment of *Helichrysum italicum* (Roth) G. Don ssp. *italicum* from wild Mediterranean germplasm. *Industrial Crops and Products,* Vol.32, pp. 639-649.

Moss, M.; Cook, J.; Wesnes, K. & Duckett, P. (2003). Aromas of rosemary and lavender essential oils differentially affect cognition and mood in healthy adults. *International Journal of Neuroscience,* Vol.113, pp. 15-38.

Muchtaridi; Subarnas, A.; Apriyantono, A. & Mustarichien R. (2010). Identification of Compounds in the Essential Oil of Nutmeg Seeds (*Myristica fragrans* Houtt.) That Inhibit Locomotor Activity in Mice. *Int. J. Mol. Sci.*, Vol.11, pp. 4771-4781.

Nerio, L.S.; Olivero-Verbel, J. & Stashenko, E.E. (2009). Repellent activity of essential oils from seven aromatic plants grown in Colombia against *Sitophilus zeamais* Motschulsky (*Coleoptera*). *Journal of Stored Products Research,* Vol.45, pp. 212-214.

Nerio, L.S.; Olivero-Verbel, J. & Stashenko, E. (2010). Repellent activity of essential oils. *Bioresource Technology*, Vol.101, pp. 372-378.

Ozbek, H.; Ugras, S.; Dulger, H.; Bayram, I.; Tuncer, I.; Ozturk, G. & Öztürk, A. (2003). Hepatoprotective effect of *F. vulgare* essential oil. *Fitoterapia*, Vol.74, pp. 317-319.

Park, I.K. & Shin, S.C. (2005). Fumigant activity of plant essential oils and components from garlic (*Allium sativum*) and clove bud (*Eugenia caryophyllata*) oils against the Japanese termite (*Reticulitermes speratus* Kolbe). *J. Agric. Food Chem.*, Vol.53, pp. 4388-4392.

Pavela, R. (2008). Insecticidal properties of several essential oils on the house fly (*Musca domestica* L.). *Phytotherapy Research*, Vol.22, pp. 274-278.

Pavela, R.; (2005). Insecticidal activity of some essential oils against larvae of *Spodoptera littoralis*. *Fitoterapia*, Vol.76, pp. 691-696.

Peana, A.T.; D'Aquila, P.S.; Panin, F.; Serra; G.; Pippia, P. & Moretti, M.D.L. (2002). Anti-inflammatory activity of linalool and linalyl acetate constituents of essential oils. *Phytomedicine*, Vol.9, pp. 721-726.

Peeyush, K.; Sapna, M.; Anushree, M. & Santosh, S. (2011). Insecticidal properties of *Mentha* species. *Industrial Crops and Products,* Vol.34, pp. 802-817.

Pengelly, A. (2004). The Constituents of Medicinal Plants; Allen & Unwin.

Pohlit, A.M.; Lopes, N.P.; Gama, R.A.; Tadei, W.P. & Neto, V.F.D. (2011). Patent Literature on Mosquito Repellent Inventions which Contain Plant Essential Oils. *Planta Med.* Vol.77, pp. 598-617.

Politeo, O.; Jukic, M. & Milos, M. (2010). Comparison of chemical composition and antioxidant activity of glycosidically bound and free volatiles from clove (*Eugenia caryophyllata* Thunb.). *Journal of Food Biochemistry*, Vol.34, pp. 129-141.

Ponce, A.G.; del Valle, C.E. & Roura, S.I. (2004). Natural essential oils as reducing agents of peroxidase activity in leafy vegetables. *Lebensmittel-Wissenschaft und-Technologie*, Vol.37, pp. 199-204.

Pourmortazavi, S.M. & Hajimirsadeghi, S.S. (2007). Supercritical fluid extraction in plant essential and volatile oil analysis. *Journal of Chromatography A*, Vol.1163, pp. 2-24.

Reverchon, E. (1997). Supercritical fluid extraction and fractionation of essential oils and related products. *J. Supercrit. Fluids*, Vol.10, pp. 1-37.

Sabzghabaee, A.M.; Nili, F.; Ghannadi, A.; Eizadi-Mood, N.; Maryam Anvari M. (2011). Role of menthol in treatment of candidial napkin dermatitis. *World Journal of Pediatrics*, Vol.7, pp. 167-170.

Saddi, M.; A. Sanna, F.; Cottiglia, L.; Chisu, L.; Casu, L.; Bonsignore, A.; De Logu, A. (2007). *Ann. Clin. Microbiol. Antimicrob.* Vol.6, pp. 1-10.

Sala, H.; (2011). Aromatherapy: Current and Emerging Applications. *Alternative and Complementary Therapies*, vol.17, pp. 26-31.

Sangwan, N.S.; Farooqi, A.H.A.; Shabih, F.; Sangwan, R.S. (2001). Regulation of essential oil production in plants. *Plant Growth Regulation*, Vol.34, pp.3-21.

Sankarikutty, B. & Narayanan, C.S. (1993), Essential Oils Isolation and Production; Encyclopedia of Food Sciences and Nutrition Academic Press. (Second Edition). pp. 2185-2189.

Sell, C.S. (2006). The Chemistry of Fragrance. From Perfumer to Consumer. 2nd edition. *The Royal Society of Chemistry*. Cambridge. 329 p.

Shibamoto, K.; Mochizuki, M. & Kusuhara, M. (2010). Aroma Therapy in Anti-Aging Medicine. *Anti-Aging Medicine*, Vol.7, pp. 55-59.

Silva, N.C.C. & Fernandes, J.A. (2010). Biological properties of medicinal plants: a review of their antimicrobial activity. *The Journal of Venomous Animals and Toxins including Tropical Diseases*, Vol.16, pp. 402-413.

Singh, P.; Shukla, R.; Prakash, B.; Kumar, A.; Singh, S.; Kumar, P.; Mishra, P.K. & Dubey, N.K. (2010). Chemical profile, antifungal, antiaflatoxigenic and antioxidant activity of *Citrus maxima* Burm. and *Citrus sinensis* (L.) Osbeck essential oils and their cyclic monoterpene, dl-limonene; *Food and Chemical Toxicology*, Vol.48, pp. 1734-1740.

Singh, R.; Shushni, M.A.M. & Belkheir, A. (2011). Antibacterial and antioxidant activities of *Mentha piperita* L; *Arabian Journal of Chemistry*, in press.

Sivropoulou, A.; Kokkini, S.; Lanaras, T. & Arsenakis, M. (1995). Antimicrobial activity of mint essential oils. *J. Agric. Food Chem.* Vol.43, pp. 2384-2388.

Sivropoulou, A.; Nikolau, C.; Papanikolau, E.; Kokkini, S.; Lanaras, T. & Arsenakis, M. (1997). Antimicrobial, cytotoxic, and antiviral activities of *Salvia fruticosa* essential oil. *Journal of Agricultural & Food Chemistry* Vol.45, pp.3197-3201.

Sivropoulou, A.; Papanikolaou, E.; Nikolau, C.; Kokkini, S.; Lanaras, T. & Arsenakis, M. (1996). Antimicrobial and cytotoxic activities of *origanum* essential oils. *J. Agric. Food Chem.* Vol.44, pp. 1202-1205.

Skaltsa, H.D.; Demetzos, C.; Lazari, D. & Sokovic, M. (2003). Essential oil analysis and antimicrobial activity of eight *Stachys* species from Greece. *Phytochemistry*, Vol.64, pp.743-752.

Skold, M.; Karlberg, A.T.; Matura, M. & Borje, A. (2006). The fragrance chemical β-caryophyllene—air oxidation and skin sensitization. *Food and Chemical Toxicology*, Vol.44, pp. 538–545.

Skold, M.; Hagvall, L. & Karlberg, A.T. (2008). Autoxidation of linalyl acetate, the main compound of lavender oil, creates potent contact allergens. *Contact Dermatitis,* Vol.58, pp. 9-14.

Spricigo, C.B.; Pinto, L.T.; Bolzan, A. & Novais, A.F. (1999). Extraction of essential oil and lipids from nutmeg by liquid carbon dioxide; *The Journal of Supercritical Fluids,* Vol.15, pp. 253-259.

Sridhar, S.R.; Rajagopal, R.V.; Rajavel, R.; Masilamani, S. & Narasimhan, S. (2003). Antifungal activity of some essential oils. *J. Agric. Food Chem*., Vol. 51, pp. 7596-7599.

Steven, B.K. (2010). Traditional Medicine: A global perspective. Edited by Steven B. K.; Pharmaceutical Press.

Suaib, L.; Dwivedi, G.R.; Darokar, M.P.; Kaira, A. & Khanuja, S.P.S. (2007). Potential of rosemary oil to be used in drug-resistant infection. *Alternative therapies,* Vol.13, pp. 54-59.

Sugawara, Y.; Hara, C.; Tamura, K., Fujii, T.; Nakamura, K.; Masujima, T. & Aoki, T. (1998). Sedative effect on humans of inhalation of essential oil of linalool: Sensory evaluation and physiological measurements using optically active linalools. *Analytica Chimica Acta* Vol.365, pp. 293-299.

Surburg, H. & Panten J. (2006). Common Fragrance and Flavor Materials. Preparation, Properties and Uses. 5th Ed. WILEY-VCH, Weinheim.

Svoboda, K.; Hampson, J. & Hunter, T. (1999). Secretory tissues: Storage and chemical variation of essential oils in secretory tissues of higher plants and their bioactivity. *International Journal of Aromatherapy*, Vol.9, pp. 124-131.

Tabanca, N.; Demirci, B.; Ozek, T.; Kirimer, N.; Baser, K.H.C.; Bedir, E.; Khan, I.A. & Wedge, D.E. (2006). Gas chromatographic–mass spectrometric analysis of essential oils from *Pimpinella* species gathered from Central and Northern Turkey. *Journal of Chromatography A*, Vol.1117, pp. 194-205.

Teixeira da Silva, J.A. (2004). Mining the essential oils of the Anthemideae. *African Journal of Biotechnology,* Vol.3, pp. 706-720.

Thomson, M. & Ali, M. (2003). Garlic [*Allium sativum*]: a review of its potential use as an anti-cancer agent. *Current Cancer Drug Targets*, Vol.3, pp. 67-81.

Thormar, H. (2011). Lipids and Essential Oils as Antimicrobial Agents; John Wiley & Sons; Chichester.

Tisserand, R. B. (1997). In The Art of Aromatherapy; Healing Arts Press: Rochester, VT.

Tolouee, M.; Alinezhad, S.; Saberi, R.; Eslamifar, A.; Zad, S.J.; Jaimand, K.; Taeb, J.; Rezaee, M.B.; Kawachi, M.; Ghahfarokhi, M.S. & Abyaneh, M.R. (2010). Effect of *Matricaria chamomilla* L. flower essential oil on the growth and ultrastructure of *Aspergillus nigervan* Tieghem. *International Journal of Food Microbiology,* Vol.139, pp. 127-133.

Tomaino, A.; Cimino, F.; Zimbalatti, V.; Venuti, V.; Sulfaro, V.; De Pasquale, A. & Saija, A. (2005). Influence of heating on antioxidant activity and the chemical composition of some spice essential oils. *Food Chemistry,* Vol.89, pp. 549-554.

Unlu, M.; Ergene, E.; Unlu, G.V.; Zeytinoglu, H.S. & Vural, N. (2010). Composition, antimicrobial activity and in vitro cytotoxicity of essential oil from *Cinnamomum zeylanicum* Blume (Lauraceae). *Food and Chemical Toxicology*, Vol.48, pp. 3274-3280.

Van Vuuren, S.F.; Suliman, S. & Viljoen, A.M. (2009). The antimicrobial activity of four commercial essential oils in combination with conventional antimicrobials. *Letters in Applied Microbiology*, Vol.48, pp. 440-446.

Verlet, N. (1994). Huiles essentielles: production mondiale, échanges internationaux et évolution des prix. *Res. Mediterranea Magazine,* Vol.1, pp. 4-9.

Vilela, G.R.; de Almeida, G.S.; Moraes, M.H.D.; Brito, J.D.; Da Silva, M.F.; Silva, S.C.; De Stefano Piedade, S.M.; Calori-Domingues, M.A. & Da Gloria, E.M. (2009). Activity of essential oil and its major compound, 1,8-cineole, from *Eucalyptus globulus Labill*., against the storage fungi *Aspergillus flavus* Link and *Aspergillus parasiticus* Speare. *Journal of Stored Products Research*, Vol.45, pp. 108-111.

Viudamartos, M.; RuizNavajas, Y.; Fernándezlópez, J. & Pérezalvarez, J. (2008). Antifungal activity of lemon (*Citrus lemon* L.), mandarin (*Citrus reticulata* L.), grapefruit (*Citrus paradisi* L.) and orange (*Citrus sinensis* L.) essential oils. *Food Control*, Vol.19, pp. 1130-1138.

Vyawahare, N.S.; Deshmukh, V.V.; Gadkari, M.R. & Kagathara, V.G. (2009). Plants with Antiulcer Activity. *Phcog Rev*., Vol.3, pp. 118-125.

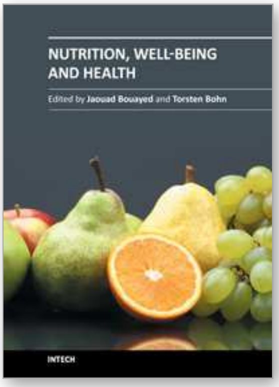
Wagner, G.J. (1996). Secreting glandular trichomes: More than just hairs. *Plant Physiol.* Vol.96, pp. 675-679.

Wei, A. & Shibamoto, T. (2010). Antioxidant/Lipoxygenase Inhibitory Activities and Chemical Compositions of Selected Essential Oil. *J. Agric. Food Chem*. Vol.58, pp. 7218-7225.

Wenqiang, G.; Shufen, L.; Ruixiang, Y.; Shaokun, T. & Can, Q. (2007). Comparison of essential oils of clove buds extracted with supercritical carbon dioxide and other three traditional extraction methods Chemistry of essential oils. *Food Chemistry,* Vol.101, pp.1558-1564.

Woronuk, G.; Demissie, Z.; Rheault, M. & Mahmoud, S. (2011). Biosynthesis and Therapeutic Properties of *Lavandula* Essential Oil Constituents. *Planta Med.,* Vol.77, pp. 7-15.

Zuzarte, M.; Gonçalves, M.J.; Cavaleiro, C.; Canhoto, J.; Vale-Silva, L.; Silva, M.J.; Pinto, E. & Salgueir, L. (2011). Chemical composition and antifungal activity of the essential oils of *Lavandula viridis* L'Hér. *Journal of Medical Microbiology,* Vol.60, pp. 612-618.



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