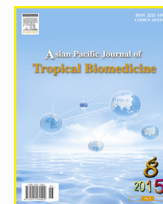




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## Essential oils used in aromatherapy: A systemic review

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## ABSTRACT

Nowadays, use of alternative and complementary therapies with mainstream medicine has gained the momentum. Aromatherapy is one of the complementary therapies which use essential oils as the major therapeutic agents to treat several diseases. The essential or volatile oils are extracted from the flowers, barks, stem, leaves, roots, fruits and other parts of the plant by various methods. It came into existence after the scientists deciphered the antiseptic and skin permeability properties of essential oils. Inhalation, local application and baths are the major methods used in aromatherapy that utilize these oils to penetrate the human skin surface with marked aura. Once the oils are in the system, they remodulate themselves and work in a friendly manner at the site of malfunction or at the affected area. This type of therapy utilizes various permutation and combinations to get relief from numerous ailments like depression, indigestion, headache, insomnia, muscular pain, respiratory problems, skin ailments, swollen joints, urine associated complications *etc.* The essential oils are found to be more beneficial when other aspects of life and diet are given due consideration. This review explores the information available in the literature regarding therapeutic, medical, cosmetic, psychological, olfactory, massage aromatherapy, safety issues and different plants used in aromatherapy. All the available information was compiled from electronic databases such as Academic Journals, Ethnobotany, Google Scholar, PubMed, Science Direct, Web of Science, and library search.

## 1. Introduction

Aromatherapy derived its name from the word aroma, which means fragrance or smell and therapy which means treatment. This therapy is a natural way of healing a person's mind, body and soul [1]. Many ancient civilizations like Egypt, China and India

have used this as a popular complementary and alternative therapy from at least 6 000 years [2,3]. Aromatherapy has established itself for the treatment of various arrays of complications and conditions. Literature survey reveals that this therapy has gained a lot of attention in the late 20th century and is very popular in the 21st century too, and due to its importance, popularity and widespread use, it is recognized as aroma science therapy [4]. The essential oils have gained their importance in therapeutic, cosmetic, aromatic, fragrant and spiritual uses [5,6]. Aromatherapy uses essential oils, as the main therapeutic agents, which are said to be highly concentrated substances extracted from flowers, leaves, stalks, fruits and roots, and also distilled from resins [7]. Essential oils are a mixture of saturated and unsaturated hydrocarbons, alcohol, aldehydes, esters, ethers, ketones, oxides phenols and terpenes, which may produce characteristic odors [8,9]. They are colorless pleasant smelling liquids with high refractive index. These oils

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are so potent and concentrated that they work on pressure points and rejuvenate. The essential oils in plants are present in different areas like, pockets and reservoirs, glandular hairs, specialized cells, or even in the intercellular spaces. Essences evaporation from the plants, shields them from bacterial attack and a warming aura due to essences protects the plant from temperature fluctuations [2]. There are various methods by which they are administered in small quantity like inhalation, massage or simple applications on the skin surface and rarely, they are taken internally [6,10]. Inhalation and the external application of these oils for the treatment of mental and physical balance are the very basics of aromatherapy. The therapy of these oils is known to relieve the stress, rejuvenate and regenerate the individual for a next day's work. Olfactory nerves from nose to the brain are the site of action for these essential oils. These oils have well proven antibacterial, antibiotic, and antiviral properties and many published reports elsewhere as well as folkloric practitioners have suggested them to be useful in many other diseases like alzheimer, cardiovascular, cancer and labor pain in pregnancy *etc* [11–15]. There is an increased trend nowadays to use this therapy in the treatment of cancer and sleep disorder [16–18]. Their organic character and to act in a supportive manner with the body, provide a feeling of well-beingness [19]. It was found that the locomotor activity of mice increased significantly by inhalation of rosemary essential oils, which are used in phytotherapy as activating and refreshing remedy for exhaustion [20].

The use of aromatherapy in holistic medicine has taken a long leap within a couple of years [21]. On reviewing the literature on this therapy, it is found that numerous studies have been carried out to study the effects of this therapy on human brain and its emotions. Its role in mood, alertness, and mental stress in healthy subjects was a topic of hot discussion among scientific community recently. Some researchers tried to investigate the effects on work ability, reaction time, and some spontaneous actions on the brain through electroencephalograph patterns and functional imaging studies [22]. This therapy was found to be superior when compared to synthetic odors. Synthetic fragrances generally contain irritants, like solvents and propellants causing irritation in some people [23–25]. According to aroma therapists, synthetic odor does not match the importance of essential oils as they are deficient in natural or vital energy; however, this has been remained a matter of debate between odor psychologists and biochemists [26].

### 1.1. How aromatherapy works

For centuries, the essential oils have found their importance as a fragrance with a curative potential on the body, mind and spirit. These aroma molecules are very potent organic plant chemicals that make the surroundings free from disease, bacteria, virus and fungus [27,28]. Their versatile character of antibacterial, antiviral, anti-inflammatory nature along with immune booster body with hormonal, glandular, emotional, circulatory, calming effect, memory and alertness enhancer, is well documented by many scientists [6,10]. Many pilot projects and studies have been conducted on humans to decipher their nature and role with disease and disorder [29]. These oils are known for their energy specific character, as their potency is not lost with time and age. The stimulation properties of these oils lay in their structure which are closely in resemblance with actual hormones [30]. The penetration potential of these

oils to reach the subcutaneous tissues is one of the important characters of this therapy. Their effects are also complex and subtle due to their complex structure and chemical properties. The mechanism of their action involves integration of essential oils into a biological signal of the receptor cells in the nose when inhaled. The signal is transmitted to limbic and hypothalamus parts of the brain via olfactory bulb. These signals cause brain to release neuro messengers like serotonin, endorphin *etc.*, to link our nervous and other body systems assuring a desired change and to provide a feeling of relief. Serotonin, endorphin and noradrenalin are released from calming oil, euphoric, and stimulating oil respectively to give expected effect on mind and body [2,31].

## 1.2. Classification of aromatherapy

### 1.2.1. Cosmetic aromatherapy

This therapy utilizes certain essential oils for skin, body, face and hair cosmetic products. These products are used for their various effects as cleansing, moisturizing, drying and toning. A healthy skin can be obtained by use of essential oils in facial products. On a personal level, cosmetic aromatherapy of full-body or foot bath will be a simple and an effective way to have an experience. Similarly, few drops of appropriate oil give a rejuvenating and revitalizing experience [32].

### 1.2.2. Massage aromatherapy

The use of grape seed, almond, or jojoba oil in pure vegetable oil during massage has been shown to have wonderful effects. This is also known as healing touch of massage therapy [33,34].

### 1.2.3. Medical aromatherapy

The founder of modern aromatherapy Rene-Maurice Gattefosse has used essential oils to massage patients during surgery, thus utilizing the medical aromatherapy knowledge of the effect of essential oils on promoting and treating clinically diagnosed medical ailments [35].

### 1.2.4. Olfactory aromatherapy

Inhalation of essential oils has given rise to olfactory aromatherapy, where simple inhalation has resulted in enhanced emotional wellness, calmness, relaxation or rejuvenation of the human body. The release of stress is welded with pleasurable scents which unlock odor memories. Essential oils are complemented to medical treatment and can never be taken as a replacement for it [36–38].

### 1.2.5. Psycho-aromatherapy

In psycho-aromatherapy, certain states of moods and emotions can be obtained by these oils giving the pleasure of relaxation, invigoration or a pleasant memory. The inhalation of the oils in this therapy is direct though the infusion in the room of a patient. Psycho-aromatherapy and aromacology, both deal with the study and effects of aroma be it natural or synthetic. Psycho-aromatherapy has limited itself with study of natural essential oils [11].

## 2. Some plants used in aromatherapy

Many plants have been reported to use in the aromatherapy due to presence of essential or volatile oils in different plants'

**Table 1**

Plants producing essential oils [105].

Essential oils	Parts of the plant
Bergamot, lemon, lime, sweet orange, tangerine, mandarin	Fruit peel
Cinnamon	Bark
Citronella, lemongrass, petitgrain, palmarosa, patchouli	Leaves
Geranium, lavender, rosemary, spike lavender	Entire plant
Ginger, vetiver	Roots
Jasmine, neroli (orange blossom), rose, ylang ylang	Flowers

materials like flowers, barks, stem, leaves, roots, fruits *etc.* Some of the plants used in aromatherapy are summarized in Table 1.

### 2.1. Clary sage

Clary sage (*Salvia sclarea* Linn.) belongs to the family of Lamiaceae (Figure 1). Purple tinted large hairy green leaves are the main source of essential oil in clary sage, perennial herb. It is different from, *Salvia officinalis* or a common sage. Further, it can be differentiated by its size of leaves which are much larger than the common one and its color is bluish white in late summer. It contains mainly linalool, linalyl acetate, alpha-terpineol, germacrene D, and geranyl [38]. The literature available on clary sage essential oil suggests its various therapeutic properties. It's a boon for women as its tonic is used for womb and uterus associated problems, and it also regulate the menstrual periods, ease tension and muscle cramps along with a seductive and aphrodisiac activity. It helps in controlling the sebum production, hence can be used for both dry and oily skin, along with acne, wrinkles and for controlling cellulite [28,39,40]. In recent studies, this oil is found to be very effective in controlling cortisol levels in women along with its antimicrobial activity [41,42].

### 2.2. Eucalyptus

Eucalyptus [*Eucalyptus globulus* Labill (*E. globulus*)] belonging to the family of Myrtaceae, is a long evergreen plant with a height up to 250 feet (Figure 2). It is known for its

**Figure 2.** *E. globulus* Labill.

constituents like cineole (70%–85%), aromadendrene limonene terpinene, cymene, phellandrene, and pinene [38,43]. Its oils have been used to regulate and activate the various systems like nervous system for neuralgia, headache and debility. The immune system boosts the immunity against measles, flu, cold and chickenpox. Leucorrhea and cystitis of genitourinary system can also be well treated with it. Throat infections, catarrh, coughs, bronchitis, asthma and sinusitis associated with respiratory system have been taken care of by oils of this plant. Moreover, skin problems like wounds, cuts, burns, herpes, lice, insect repellent and insect bites can be treated with it. Treatment of rheumatoid arthritis, muscle and joint pains and aches is well reported from the essential oils of this plant [36,44,45]. Eucalyptus oil has demonstrated its antioxidant, anti-inflammatory, anti-proliferative and antibacterial activities and researchers have proved its efficacy beyond doubt in treatment of various metabolic and infectious diseases. The results are promising and can be utilized for treatment of multifactorial diseases of various origins in humans [44,46].

### 2.3. Geranium

Geranium (*Pelargonium graveolens* L' Herit) belongs to the family of Geraniaceae (Figure 3). A perennial hairy shrub native

**Figure 1.** *Salvia sclarea* Linn.**Figure 3.** *Pelargonium graveolens* L' Herit.



of South Africa, up to one meter in height, also found and cultivated in France, Italy, Spain, Central America, Egypt, Japan and Congo is a plant of choice for essential oil. Eugenol, geranic, citronellol, geraniol, linalol (linalool), citronellyl formate, citral, myrtenol, terpineol, methone and sabinene are the chemical constituents of its essential oil [38]. One of the best natural perfume, complete in itself is geranium oil, generally used in soaps and detergents because its unique nature is never challenged with alkalinity of soaps. Hence, this oil is generally used to control the emotions in aroma therapy. It is used in dermatitis, eczema, aging skin, some fungal infections, along with anxiety and stress related problems. The oil has some anti-bacterial action and is an important ingredient for endometriosis treatment. This oil is further used for its sedative properties, nerve tonic, in throat infection, to rectify the blood disorder diabetes and for menopausal associated problems. Some reports are there about its supportive therapy in uterine and breast cancer, and it also certainly can help the patient in coping with the pain. People have used this as a flavoring agent for food stuff along with alcoholic and non alcoholic beverages. It is an effective insect repellent [47,48]. Moreover, this oil is gaining popularity as antidiabetic, anticancer, antibacterial and antimicrobial agent [49–52].

#### 2.4. Lavender

Lavender (*Lavandula officinalis* Chaix.) belonging to the family of Lamiaceae, is a beautiful herb of the garden (Figure 4). It contains camphor, terpinen-4-ol, linalool, linalyl acetate, beta-cimene and 1,8-cineole [38]. Its constituent varies in concentration and therapeutic effects with the different species. Linalool and linalyl acetate have maximum and great absorbing properties from skin during massage with a depression of central nervous system. Linalool shows sedative effects and linalyl acetate shows marked narcotic actions. These two actions may be responsible for its use in lavender pillow anxiety patients with sleep disturbance pattern, improving the feeling of well being, supporting mental alertness and suppressing aggression and anxiety [53]. Lavender oil shows its antibacterial and antifungal properties against many species of bacteria, especially when antibiotics fail to work, but the exact mechanisms are yet to be established. When talking about its use in aromatherapy, it is

well documented for the treatment of abrasions, burns, stress, headaches, in promotion of new cell growth, skin problems, painful muscles and boosting an immune system [47,48,54]. This oil is used in the treatment of primary dysmenorrheal and has shown some promising results in one of the randomized, double-blind clinical trials [55,56].

#### 2.5. Lemon

Lemon [*Citrus limon* Linn. (*C. limon*)] belongs to the family of Rutaceae (Figure 5). *C. limon* long trees grow up to the 15 feet height and bear rich scented lemon fruits all year round. Its oil constituents are abundant in the terpenes, D-limonene and L-limonene, together forming about 90 percent of the bulk of the oil. Traces of phellandrene, pinene and sesquiterpene are also present [38]. The valuable portion of the oil is the remaining 10 percent which consists of oxygenated bodies, chiefly the aldehyde citral, to which the odor of the oil is largely due and of which there is 3.5%–5% odor present in the oil. When compared to other essential oils, its constituents have antiseptic, astringent and detoxifying properties, for blemishes associated with oily skin [57]. Its oil brightens and rejuvenates dull skin. Lemon essential oil is mainly used to boost the immune system and to accelerate the white corpuscles production along with counteracting acidity and ulcers through citric acid, which helps digestion, by forming carbonates and bicarbonates of potassium and calcium [47,48]. A recently conducted double-blinded, randomized, controlled clinical trial study on aromatherapy has suggested that citrus oil is good in relieving the first stage labor pain. It is effective in controlling the nausea and vomiting along with its mood elevating properties [58–60].

#### 2.6. Peppermint

Peppermint [*Mentha piperita* Linn. (*M. piperita*)] belongs to the family of Lamiaceae (Figure 6). Till date, all the 600 kinds of mints are raised from 25 well-defined species. The two most important are peppermint (*M. piperita*) and spearmint (*Mentha spicata*). Spearmint bears the strong aroma of sweet character with a sharp menthol undertone. Its oil constituents include carvacrol, menthol, carvone, methyl acetate, limonene and menthone. The pharmacological action is due to menthol, a



Figure 4. *Lavandula officinalis* Chaix.



Figure 5. *C. limon* Linn.



Figure 6. *M. piperita* Linn.

primary constituent of peppermint oil. At least 44% free menthol is present in peppermint oil. Components are sensitive to climate, latitude and maturity of the plant. Inhalation and application of menthol on skin causes a skin reaction. It is used in many liniments dosage form to relieve pain spasms and arthritic problems. Peppermint oil is studied and documented for its antiinflammatory, analgesic, anti-infectious, antimicrobial, antiseptic, antispasmodic, astringent, digestive, carminative, fungicidal effects, nerve stimulant, vasoconstrictor, decongestant and stomachic properties.

The antispasmodic properties of oil make it a better choice during pain associated with the menstrual cycle and are also used in the treatment of irritable bowel syndrome. When superficially applied around the head and temple, it has very good action on headache. Further, itching due to various reasons like herpes blisters, ringworm infestation, scabies, poison oak, and ivy can also be relieved. It is observed that it can relieve many bacterial, fungal, and viral infections when inhaled or applied in the form of a vapor balm. Sinus and lung congestion are also known to be cleared from this oil. Much have been said and discussed about the mentha oil by many researchers for its various activities but its use in aroma therapy needs more efforts [61,62].

### 2.7. Roman chamomile

Roman chamomile (*Anthemis nobilis* Linn.) belongs to the family of Asteraceae (Figure 7). A prized plant for centuries with a potential to calm, moderate and strong emotions bears a daisy like flowers. Major constituents of Roman chamomile oil are esters of angelic acid, tiglic acid and 2-methylbutanoic acid. The freshly distilled oil has a bluish tint due to the sesquiterpenoid chamazulene. It is rich in pinocarvone, farnesol, pinene, bisabolol, cineole, pinocarveol, beta-caryophyllene, azulene, camphene and myrcene. Chamomile preparations have made inroads in the treatment of human ailments such as hay fever, inflammation, muscle spasms, menstrual disorders, insomnia, ulcers, wounds, gastrointestinal disorders, rheumatic pain, and hemorrhoids. In cosmetics and aromatherapy, it is employed for its anxiolytic properties [63,64].

Its antianxiety, stress relieving properties ease out depression, worry, and overactive mind. Its use before sleep for bath can relax both mind and body and brings on sleep, with a peaceful



Figure 7. *Anthemis nobilis* Linn.

and spiritual awareness. Headache, insomnia and menstrual disorders are known to be treated with this oil. In aromatherapy, it is extensively used to relieve the pain from physical conditions, menstrual cramps and tension with its application on lower abdomen. Psoriasis, eczema, boils, sunburn and cold sores have been treated with it along with its role in decreasing the pain associated with joints, arthritis, sprains and stings [47].

### 2.8. Rosemary

Rosemary (*Rosmarinus officinalis* Linn.) belonging to the family of Lamiaceae bears small pale blue flowers in late spring/early summer and grows up to the height of 90 cm (Figure 8). It has three varieties (silver, gold and green stripe); it's the green variety that is used for its medicinal properties. This plant is rich in bitter principle, resin, tannic acid and volatile oil. The active constituents are bornyl acetate, borneol along with other esters and, special camphor similar to that possessed by the myrtle, cineol, pinene and camphene [40]. Its oil has a marked action on the digestive system, with relieving the symptoms of indigestion, constipation and colitis. It works as liver and gall-bladder tonic. The oil also possesses some good action on the cardiovascular system. It regularizes the blood pressure and retards the hardening of arteries. In winter, it used to relieve the



Figure 8. *Rosmarinus officinalis* Linn.



rheumatic pain which aggravates due to cold. Its stimulating properties on the nervous system have found to be beneficial in hysteria and paralysis. In latest human trials, aromatherapy is an efficacious non-pharmacological therapy for dementia and may have some potential for improving cognitive function, especially in Alzheimer's disease patients, due to its free radical scavenging activity [12,65]. Excellent skin tonic properties, a soothing, positive effect on menstrual cramps, for hair growth are some of the other important properties of this oil. The other benefits of rosemary include a stimulant for the scalp encouraging hair growth and providing treatment for dandruff and greasy hair [66].

### 2.9. Tea tree

Tea tree (*Melaleuca alternifolia* Cheel) belonging to the family of Myrtaceae, with yellow or purple flower and needles like leaves is a shrub of marshy area (Figure 9). Due to its commercial value, it is cultivated on plantations. The main constituent of its oil is terpinen-4-ol, an alcoholic terpene with a clean musty aroma. The antiviral activity is due to alpha-sabine with antibacterial and antifungal effects. It is an immune booster due to terpinen-4-ol while cineole is responsible for its antiseptic character [67–70]. The tea tree itself possesses antibacterial, anti-inflammatory, antiviral, insecticidal, and immune stimulant properties. The aromatherapy utilizes the mixture of lemon, blue gum, clary sage, eucalyptus, lavender, rosemary, ginger and Scotch pine for treatment of different ailments. The oil is used in herpes, abscess, blisters acne, cold sores, burns, insect bites, dandruff and oily skin. Further, in treatment of respiratory associated problems it has been used for tuberculosis, cough, bronchitis, asthma, catarrh and whooping cough; also it is used in females for vaginitis, cystitis and pruritus treatment. Cold, fever, flu and chickenpox have called for its use [71,72]. Well defined studies have been carried out on *Melaleuca alternifolia* (tea tree) on herpes through clinical trial efforts with a promising result of this plant [73].

### 2.10. Ylang Ylang

Ylang-ylang (*Cananga odorata* Hook. F. & Thoms) belonging to the family of Annonaceae, native to Madagascar, Indonesia and Philippines is a small tree (Figure 10). Its chemical constituent includes geranyl acetate, linalol, geraniol,



Figure 9. *Melaleuca alternifolia* Cheel.



Figure 10. *Cananga odorata* Hook. F. & Thoms.

farnesol, benzyl acetate, geranial, methyl chavicol, beta-caryophyllene, eugenol, pinene and farnesene. The best property of this tree is to retard the heart beat and rapid breathing with perfect use in shock and trauma situations. It is anti-depressive in nature with euphoric properties [5], thus giving the feeling of well being. Low self-esteem and women suffering from the post-menopausal syndrome have better results on them. A pilot study involving 34 professionals from a nursing group was carried out in Portugal to verify the use of ylang ylang essential oil in relieving the anxiety and increasing the self esteem along with alteration of blood pressure and temperature. The results showed clear evidence that use of this plant led to a significant alteration in self esteem [74]. Further, its aphrodisiac properties are due to its exotic fragrance advantageous for both dry and oily skins. It is also indicated in depression, anxiety, hypertension, frigidity, stress and palpitations [75].

### 3. Essential oil safety issue

The essential oils are generally safe with minimum adverse effects. Several of these have been approved as food additives and fall in the category of generally recognized as safe by the U.S. Food and Drug Administration [76]. The most common adverse events are eye, mucous membrane and skin irritation and sensitization particularly to oils containing aldehydes and phenols. Photo toxicity of essential oil that contains furocoumarins, for example *Citrus bergamia*, is also reported. Contact sensitization is more likely to occur due to oxidation of monoterpenes, often due to inappropriate storage conditions [48]. Cross-sensitization to other essential oils and foods is also possible. Allergy from inhaled essential oils can occur; however, data about exposure levels are limited and many of the reports concern perfumes rather than aromatherapy essential oils [77]. An exceptional case of airborne contact dermatitis was reported only once in context to aromatherapy without massage [78]. The aromatherapy utilizes non defined mixtures of these essential oils without disclosing their plant sources. Allergic reactions have been reported in few instances, especially with topical administration. These oils are not free from oxidation reaction with age and are reported for the change in their chemical composition on storage for long time. Reversible prepubertal gynecomastia was reported in one study on repeated exposure to lavender and tea tree oils by topical administration [79]. There

**Table 2**

Essential oils for common problems [106–108].

Condition	Essential oils
Anxiety, agitation, stress, challenging behaviors	<i>Angelica archangelica</i> rad. (angelica) <i>Cistus ladaniferus</i> (labdanum) <i>Citrus aurantium</i> var. <i>amara</i> fol. (petitgrain bigarade), <i>Citrus aurantium</i> var. <i>amara</i> per. (orange bigarade), <i>Citrus bergamia</i> (bergamot) <i>Citrus sinensis</i> (sweet orange) <i>Cymbopogon martinii</i> (palmarosa) <i>Eucalyptus staigeriana</i> (lemon-scented ironbark), <i>Lavandula angustifolia</i> (lavender) <i>Litsea cubeba</i> (may chang) <i>Ocimum basilicum</i> (basil) <i>Origanum majorana</i> (sweet marjoram) <i>Pelargonium graveolens</i> (geranium) <i>Pogostemon patchouli</i> (patchouli) <i>Valeriana officinalis</i> (valerian)
End-of-life agitation	<i>Lavandula angustifolia</i> (lavender) <i>Santalum album</i> (sandalwood) <i>Boswellia carteri</i> (frankincense)
Fatigue	<i>Angelica archangelica</i> rad. (angelica) (nervous) <i>Cistus ladaniferus</i> (labdanum) (chronic) <i>Citrus aurantium</i> var. <i>amara</i> (neroli bigarade) <i>Citrus paradisi</i> (grapefruit) (exhaustion) <i>Coriandrum sativum</i> (coriander) (including mental) <i>Cymbopogon nardus</i> (citronella) <i>Eucalyptus radiata</i> (black peppermint) (chronic) <i>Eucalyptus smithii</i> (gully gum) <i>Juniperus communis</i> ram. (juniper twig) <i>Mentha spicata</i> (spearmint) (mental) <i>Pelargonium graveolens</i> (geranium) (nervous) <i>Pinus sylvestris</i> (Scots pine) <i>Rosmarinus officinalis</i> ct. <i>cineole</i> , ct. <i>camphor</i> , ct. <i>verbenone</i> (rosemary) <i>Salvia sclarea</i> (clary) (nervous) <i>Zingiber officinale</i> (ginger)
Insomnia	<i>Angelica archangelica</i> rad. (angelica) <i>Cananga odorata</i> (ylang ylang) <i>Chamaemelum nobile</i> (Roman chamomile) <i>Citrus aurantium</i> var. <i>amara</i> (neroli bigarade) <i>Cistus ladaniferus</i> (labdanum) <i>Citrus bergamia</i> (bergamot) <i>C. limon</i> (lemon) <i>Citrus reticulata</i> (mandarin) <i>Citrus sinensis</i> (sweet orange) <i>Cuminum cyminum</i> (cumin) <i>Juniperus communis</i> fruct. (juniper berry) <i>Lavandula angustifolia</i> (lavender) <i>Litsea cubeba</i> (may chang) <i>Melissa officinalis</i> (lemon balm) <i>Myrtus communis</i> (myrtle) <i>Ocimum basilicum</i> (basil) (nervous) <i>Origanum majorana</i> (sweet marjoram) <i>Ravensara aromatica</i> (ravensara) <i>Thymus vulgaris</i> ct. <i>geraniol</i> , ct. <i>linalool</i> (sweet thyme) <i>Valeriana officinalis</i> (valerian)

**Table 2 (continued)**

Condition	Essential oils
Mental exhaustion, burnout	<i>M. piperita</i> (peppermint) <i>Ocimum basilicum</i> (basil) <i>Helichrysum angustifolium</i> (everlasting)
Memory loss	<i>Litsea cubeba</i> (may chang) <i>M. piperita</i> (peppermint) <i>Rosmarinus officinalis</i> ct. <i>cineole</i> (rosemary)
Pain management	<i>Eucalyptus smithii</i> (gully gum) <i>Lavandula angustifolia</i> (lavender) <i>Matricaria recutita</i> (German chamomile) <i>Leptospermum scoparium</i> (manuka) <i>Origanum majorana</i> (sweet marjoram) <i>Pinus mugo</i> var. <i>pumilio</i> (dwarf pine) <i>Rosmarinus officinalis</i> ct. <i>camphor</i> (rosemary) <i>Zingiber officinale</i> (ginger)

is always a big controversy which arises when the safety of these essential is discussed. No well defined studies have proved that these essential oils are harmful. In case of some isolated studies, we have observed that these are not safe, but the majority of studies have not proved these oils if used in aromatherapy are harmful [80].

#### 4. Pharmacological actions of essential oils

Many essential oils were screened for variety of pharmacological potentials. Important pharmacological actions of essential oils are summarized in Table 2. Some of the pharmacological actions of essential oils are discussed below.

##### 4.1. Antibacterial

Many essential oils were screened for their antibacterial activity against Gram-positive and Gram-negative bacteria along with antifungal properties. These essential oils are well studied for their antibacterial properties and beyond doubt they have shown some very promising results on salmonella, staphylococci and other oral pathogens. They can be very good alternatives for antibiotics if properly and thoroughly studied for these effects of there [41,81,82]. One such oil is Basil essential oil; this oil showed a good antimicrobial potential. It has bactericidal properties against *Aeromonas*, *Hydrophila* and *Pseudomonas fluorescens* [83]. The investigation of antibacterial effects was positive to prove its potential for oral bacteria like *Fusobacterium nucleatum*, *Porphyromonas gingivalis*, *Streptococcus mutans*, *Actinobacillus actinomycetemcomitans*, and *Streptococcus sobrinus*. Manuka oil was most potent among the eucalyptus oil, rosmarinus oil, lavandula oil and tea tree oil for antibacterial potential [84]. From 15 genera of oral bacteria, 161 isolates were sensitive to *Melaleuca alternifolia* (tea tree) oil, indicating its health care properties for oral hygiene [69]. *Staphylococcus epidermis*, *Hedychium gardnerianum* and *Pittosporum undulatum* (*P. undulatum*) were susceptible to essential oils from the leaves of *P. undulatum* and *Hedychium gardnerianum* with the highest activities against *Staphylococcus aureus* and *Staphylococcus epidermis*. *P. undulatum* additionally, have good antithrombin activity also [85].

## 4.2. Antifungal

*Melaleuca alternifolia* (tea tree) oil tested positive for its all constituents for *in vitro* antifungal activity except beta-myrcene. Hammer *et al.* identified that most of the components of tea tree oil had wide range of fungicidal potential, especially against dermatophytes and filamentous fungi [68]. In one of the reports, the germinated *Aspergillus niger* conidia was more susceptible to non-germinated one. The essential oils obtained from the fresh leaves of *Melaleuca ericifolia* (*M. ericifolia*), *Melaleuca armillaris* (*M. armillaris*), *Melaleuca leucadendron* (*M. leucadendron*) and *Melaleuca styphelioides* exhibited good activity against *Aspergillus niger* [68]. Many plants like *M. piperita*, black mustard (*Brassica nigra*), *Angelica archangelica*, *Cymbopogon nardus*, *Skimmia laureola*, *Artemisia sieberi* and *Cuminum cyminum* have been tested positive for their antifungal activity. They are in the initial phase of clinical trials and if the results are as per the expectation, they will be a very good alternative for existing antifungal drugs which are not frequently used for their toxic systemic effects [86–91].

## 4.3. Antiviral

The antiviral activity evaluated by Deans and Ritchie for the essential oils of *M. ericifolia*, *M. leucadendron*, *M. armillaris* and *Melaleuca styphelioides* on kidney cells of African green monkey through plaque reduction assay on herpes simplex virus type 1, gave the remarkable results for *M. armillaris* (up to 99%) followed by *M. leucadendron* (92%) and *M. ericifolia* (91.5%) [92].

## 4.4. Anti-inflammatory

Histamine reaction of weal and flare were reduced by tea tree oil in human. The topical applications of 100% tea tree oil are able to reduce the inflammation induced by histamine diphosphate after a period of 10 min [70]. Existing data on various essential oils shows that noncytotoxic concentrations exert an anti-inflammatory action by increasing interleukin-10 production [93].

## 4.5. Anti-lice

Most of the preparation for head lice infestations contains the tea tree oil [94]. The insecticidal activity of tea tree oil is due to its anticholinesterase potential [95].

## 4.6. Anti-dandruff

In a single blind and parallel-group study, it was observed that shampoos which contain five percent tea tree oil were effective and well tolerated by patients having mild to moderate dandruff and at least 41% improvement was observed [96]. Not much have been explored on the antidandruff potential of plant products, and especially on volatile products, some efforts have been made by Anjum *et al.*, but the results are not promising [97].

## 4.7. Anti-tumor

Tea tree oil and terpinen-4-ol both were able to retard the growth of human melanoma M14 WT cells and M14 adriamicin-

resistant cells. This action was linked to apoptosis via caspase-dependent mechanism in melanoma cells. 5-Fluorouracil treatment is enhanced in human colon cancer cells if sensitized by geraniol, a component of plant essential oils [98,99]. Efforts are being made to establish the link between essential oils and their anti-tumor activity. Polypharmacological anti-tumor mode-of-action of essential oils in cardamom has some promising results to substantiate the claims [100].

## 4.8. Anti-oxidant

The essential oil from seeds of *Nigella sativa* L. is a potent antioxidant *in vitro*, with effective hydroxyl radical scavenging activity. Kanuka (*Kunzea ericoides*), Manuka (*Leptospermum scoparium*) and *Leptospermum petersonii* possess good antibacterial activity and antioxidant properties. The essential oil from the *M. armillaris* has marked antioxidant potential; it alters the parameters of superoxide dismutase, improves vitamin E and vitamin C concentrations [28]. The free radicals produced during inflammation, can induce gene mutations and posttranslational modifications of various proteins. If not, remove may turn injurious radicals to the whole system. This mechanism is generally countered by antioxidant properties of compounds. Various plants like *Thymus vulgaris*, *C. limon*, *E. globulus* and *Cupressus sempervirens* have shown their anti-inflammatory effects on animal study [46].

## 4.9. Insect/mosquito repellent action

Insect repellency/toxicity results were promising from the essential oils of *Nepeta parnassica*, on the *Culex pipiens molestus* [101].

## 4.10. Spasmodic action

Strong spasmogenic and spasmolytic activity was shown by *Kunzea ericoides* and *Leptospermum scoparium* essential oils, respectively and their various extracts when tested on isolated rat ileum. *Ferula gummosa* is much better in relaxing the contractile over-activity of the ileum which forms the very basic of gastrointestinal disorders [102].

## 4.11. Hormonal action

Geraniol, neral, geraniol, nerol and trans-anethole are well established for their stimulation of estrogenic response, when compared to eugenol which has anti-estrogenic activity. Citra *i.e.*, the combination of geraniol, nerol and eugenol were effective in replacing [<sup>3</sup>H]17 $\beta$ -estradiol from the estrogen receptors in recombinant yeast cells [103,104].

## 5. Conclusion

From above reports and study, we can conclude that aromatherapy is natural and noninvasive gift of nature for humans. It's not only the disease symptoms which are eradicated but the whole body is rejuvenated by the use of aroma. Aromatherapy regulates the physiological, spiritual and psychological upliftment for the new phase of life. This therapy is not only preventive but also can be used in the acute and chronic stages of disease. Pharmaceutical industries are trying for



environmental friendly, alternative and natural medicine for disease associated with pathogens and metabolism. There may be a possibility of enhancing the rate of reaction and bioavailability of drugs from the use of these essential oils.

If properly studied, these volatile oils may have the synergistic effect with the drugs used in the treatment of central nervous system disorder. Moreover, the time at which the plant contains the maximum amount of volatile oil with various chemical constituents also is a matter of discussion. Essential oils can be a useful non-medicinal option or can also be combined with conventional care for some health conditions, provided safety and quality issues are considered. The tilt of the scientific community towards complementary and alternative medicine has given the new hope to reduce the unwanted effects of modern medicine by these essential oils and if properly explored to their full potential, this therapy can be a boon not only to the patients but also to a common man.

### Conflict of interest statement

We declare that we have no conflict of interest.

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### References

- [1] Worwood VA. *Aromatherapy for the healthy child: more than 300 natural, non-toxic, and fragrant essential oil blends*. Novato: New World Library; 2000.
- [2] Krishna A, Tiwari R, Kumar S. Aromatherapy-an alternative health care through essential oils. *J Med Aromat Plant Sci* 2000; **22**: 798-804.
- [3] Manniche L. *Sacred luxuries: fragrance, aromatherapy and cosmetics in ancient Egypt*. New York: Cornell University Press; 1999.
- [4] Esposito ER, Bystrek MV, Klein JS. An elective course in aromatherapy science. *Am J Pharm Educ* 2014; **78**(4): 79.
- [5] Evans WC. *Trease and Evans pharmacognosy*. 4th ed. London: WB Saunders Co; 2000.
- [6] Svoboda KP, Deans SG. Biological activities of essential oils from selected aromatic plants. *Acta Hort* 1995; **390**: 203-9.
- [7] Dunning T. Aromatherapy: overview, safety and quality issues. *OA Altern Med* 2013; **1**(1): 6.
- [8] Schiller C, Schiller D. *500 formulas for aromatherapy: mixing essential oils for every use*. USA: Sterling Publications; 1994.
- [9] Wildwood C. *The encyclopedia of aromatherapy*. Rochester: Healing Arts Press; 1996.
- [10] Svoboda K, Hampson J, Hunter EA. Production and bioactivity of essential oils in secretory tissues of higher plants. In: Proceedings of World Aromatherapy II Conference of National Association for Holistic Aromatherapy (NAHA); Sep 25–28; St. Louis, Missouri, USA; 1998, p. 105-27.
- [11] Perry N, Perry E. Aromatherapy in the management of psychiatric disorders clinical and neuropharmacological perspectives. *CNS Drugs* 2006; **20**: 257-80.
- [12] Jimbo D, Kimura Y, Taniguchi M, Inoue M, Urakami K. Effect of aromatherapy on patients with Alzheimer's disease. *Psychogeriatrics* 2009; **9**: 173-9.
- [13] Smith CA, Collins CT, Crowther CA. Aromatherapy for pain management in labour. *Cochrane Database Syst Rev* 2011; <http://dx.doi.org/10.1002/14651858.CD009215>.
- [14] Shiina Y, Funabashi N, Lee K, Toyoda T, Sekine T, Honjo S, et al. Relaxation effects of lavender aromatherapy improve coronary flow velocity reserve in healthy men evaluated by transthoracic Doppler echocardiography. *Int J Cardiol* 2008; **129**: 193-7.
- [15] Lai TK, Cheung MC, Lo CK, Ng KL, Fung YH, Tong M, et al. Effectiveness of aroma massage on advanced cancer patients with constipation: a pilot study. *Complement Ther Clin Pract* 2011; **17**: 37-43.
- [16] Marchand L. Integrative and complementary therapies for patients with advanced cancer. *Ann Palliat Med* 2014; **3**(3): 160-71.
- [17] Lee SH, Kim JY, Yeo S, Kim SH, Lim S. Meta-analysis of massage therapy on cancer pain. *Integr Cancer Ther* 2015; <http://dx.doi.org/10.1177/1534735415572885>.
- [18] Hwang E, Shin S. The effects of aromatherapy on sleep improvement: a systematic literature review and meta-analysis. *J Altern Complement Med* 2015; **21**(2): 61-8.
- [19] Farooqi AHA, Sharma S. Aromatherapy-a promising holistic system. *J Med Aromat Plant Sci* 2000; **22**: 704-6.
- [20] Kovar KA, Gropper B, Friess D, Ammon HP. Blood levels of 1,8-cineole and locomotor activity of mice after inhalation and oral administration of rosemary oil. *Planta Med* 1987; **53**: 315-8.
- [21] Berwick A. *Holistic aromatherapy: balance the body and soul with essential oils*. St. Paul, MN: Llewellyn Publications; 1994.
- [22] Buchbauer G, Jirovetz L, Jager W, Plank C, Dietrich H. Fragrance compounds and essential oils with sedative effects upon inhalation. *J Pharm Sci* 1993; **82**: 660-4.
- [23] Silva-Néto RP, Peres MF, Valença MM. Odorant substances that trigger headaches in migraine patients. *Cephalalgia* 2014; **34**: 14-21.
- [24] Vethanayagam D, Vliagoftis H, Mah D, Beach J, Smith L, Moqbel R. Fragrance materials in asthma: a pilot study using a surrogate aerosol product. *J Asthma* 2013; **50**: 975-82.
- [25] Celeiro M, Guerra E, Lamas JP, Lores M, Garcia-Jares C, Llompant M. Development of a multianalyte method based on micro-matrix-solid-phase dispersion for the analysis of fragrance allergens and preservatives in personal care products. *J Chromatogr A* 2014; **1344**: 1-14.
- [26] Dodd GH. The molecular dimension in perfumery. In: Toller SV, Dodd GH, editors. *Perfumery*. Netherlands: Springer; 1988, p. 19-46.
- [27] Baratta MT, Dorman HJD, Dean SG, Figueiredo C, Barrero JG, Ruberto G. Antimicrobial and antioxidant property of some commercial essential oils. *Flavour Fragr J* 1998; **13**: 235-44.
- [28] Baratta MT, Dorman HJD, Dean SG, Brondi DM, Ruberto G. Chemical composition, antimicrobial and antioxidant activity of laurel, sage, rosemary, oregano and coriander essential oils. *J Essent Oil Res* 1998; **10**: 618-27.
- [29] Liu SH, Lin TH, Chang KM. The physical effects of aromatherapy in alleviating work-related stress on elementary school teachers in Taiwan. *Evid Based Complement Altern Med* 2013; <http://dx.doi.org/10.1155/2013/853809>.
- [30] Colgate SM, Molyneux RJ. *Bioactive natural products detection, isolation and structural determination*. Florida: CRC Press; 1933.
- [31] Buchbauer G, Jirovetz L. Aromatherapy-use of fragrances and essential oils as medicaments. *Flavour Fragr J* 1994; **9**: 217-22.
- [32] Ziosi P, Manfredini S, Vertuani S, Ruscetta V, Radice M, Sacchetti G. Evaluating essential oils in cosmetics: antioxidant capacity and functionality. *Cosmet Toilet* 2010; **125**: 32-40.
- [33] Soden K, Vincent K, Craske S, Lucas C, Ashley S. A randomized controlled trial of aromatherapy massage in a hospice setting. *Palliat Med* 2004; **18**: 87-92.
- [34] Chang SY. [Effects of aroma hand massage on pain, state anxiety and depression in hospice patients with terminal cancer]. *Taehan Kanho Hakhoe Chi* 2008; **38**: 493-502. Korean.
- [35] Maeda K, Ito T, Shioda S. Medical aromatherapy practice in Japan. *Essence* 2012; **10**: 14-6.
- [36] Maxwell-Hudson C. *Aromatherapy massage book*. London: Dorling Kindersley; 1995.
- [37] Price S. *Aromatherapy for common ailments*. London: Fireside; 1991.
- [38] Price S. *The aromatherapy workbook*. London: Thorsons; 1993.

- [39] Lis-Balchin M. *Aromatherapy: a guide for healthcare professionals*. London: Pharmaceutical Press; 2006.
- [40] Svoboda KP, Deans SG. A study of the variability of rosemary and sage and their volatile oils in British market: their anti-oxidative properties. *Flavour Fragr J* 1992; **7**: 81-7.
- [41] Sienkiewicz M, Glowacka A, Poznańska-Kurowska K, Kaszuba A, Urbaniak A, Kowalczyk E. The effect of clary sage oil on staphylococci responsible for wound infections. *Postepy Dermatol Alergol* 2015; **32**(1): 21-6.
- [42] Lee KB, Cho E, Kang YS. Changes in 5-hydroxytryptamine and cortisol plasma levels in menopausal women after inhalation of clary sage oil. *Phytother Res* 2014; **28**(11): 1599-605.
- [43] Hillis WE. Polyphenols in the leaves of eucalyptus: a chemotaxonomic survey-II: the sections renantheroideae and renantherae. *Phytochemistry* 1967; **6**: 259-74.
- [44] Mulyaningsih S, Sporer F, Reichling J, Wink M. Antibacterial activity of essential oils from eucalyptus and of related components against multi-resistant bacterial pathogens. *Pharm Biol* 2011; **49**: 893-9.
- [45] Sadlon AE, Lamson DW. Immunomodifying and antimicrobial effects of eucalyptus oil and simple inhalation devices. *Altern Med Rev* 2010; **15**: 33-47.
- [46] Aazza S, Lyoussi B, Megías C, Cortés-Giraldo I, Vioque J, Figueiredo AC, et al. Anti-oxidant, anti-inflammatory and anti-proliferative activities of Moroccan commercial essential oils. *Nat Prod Commun* 2014; **9**(4): 587-94.
- [47] Lawless J. *The illustrated encyclopedia of essential oils: the complete guide to the use of oils in aromatherapy & herbalism*. Rockport: Element Books Ltd; 1995.
- [48] Tisserand R, Balacs T. *Essential oil safety: a guide for health professionals*. Edinburgh: Churchill Livingstone; 1995.
- [49] Ben Slima A, Ali MB, Barkallah M, Traore AI, Boudawara T, Allouche N, et al. Antioxidant properties of *Pelargonium graveolens* L'Her essential oil on the reproductive damage induced by deltamethrin in mice as compared to alpha-tocopherol. *Lipids Health Dis* 2013; **12**: 30.
- [50] Ben Hsouna A, Hamdi N. Phytochemical composition and antimicrobial activities of the essential oils and organic extracts from *Pelargonium graveolens* growing in Tunisia. *Lipids Health Dis* 2012; **11**: 167.
- [51] Ghannadi A, Bagherinejad M, Abedi D, Jalali M, Absalan B, Sadeghi N. Antibacterial activity and composition of essential oils from *Pelargonium graveolens* L'Her and *Vitex agnus-castus* L. *Iran J Microbiol* 2012; **4**(4): 171-6.
- [52] Boukhris M, Bouaziz M, Feki I, Jemai H, El Feki A, Sayadi S. Hypoglycemic and antioxidant effects of leaf essential oil of *Pelargonium graveolens* L'Hér. in alloxan induced diabetic rats. *Lipids Health Dis* 2012; **11**: 81.
- [53] Koulivand PH, Ghadiri MK, Gorji A. Lavender and the nervous system. *Evid Based Complement Altern Med* 2013; <http://dx.doi.org/10.1155/2013/681304>.
- [54] Kim S, Kim HJ, Yeo JS, Hong SJ, Lee JM, Jeon Y. The effect of lavender oil on stress, bispectral index values, and needle insertion pain in volunteers. *J Altern Complement Med* 2011; **17**: 823-6.
- [55] Ou MC, Hsu TF, Lai AC, Lin YT, Lin CC. Pain relief assessment by aromatic essential oil massage on outpatients with primary dysmenorrhea: a randomized, double-blind clinical trial. *J Obstet Gynaecol Res* 2012; **38**(5): 817-22.
- [56] Han SH, Hur MH, Buckle J, Choi J, Lee MS. Effect of aromatherapy on symptoms of dysmenorrhea in college students: a randomized placebo-controlled clinical trial. *J Altern Complement Med* 2006; **12**(6): 535-41.
- [57] Tisserand R, Young R. *Essential oil safety: a guide for health care professional*. 2nd ed. London: Churchill Livingstone; 2013.
- [58] Yavari Kia P, Safajou F, Shahnazi M, Nazemiyeh H. The effect of lemon inhalation aromatherapy on nausea and vomiting of pregnancy: a double-blinded, randomized, controlled clinical trial. *Iran Red Crescent Med J* 2014; **16**(3): e14360.
- [59] Namazi M, Amir Ali Akbari S, Mojab F, Talebi A, Alavi Majd H, Jannesari S. Aromatherapy with citrus aurantium oil and anxiety during the first stage of labor. *Iran Red Crescent Med J* 2014; **16**(6): e18371.
- [60] Watanabe E, Kuchta K, Kimura M, Rauwald HW, Kamei T, Imanishi J. Effects of bergamot (*Citrus bergamia* (Risso) Wright & Arn.) essential oil aromatherapy on mood states, parasympathetic nervous system activity, and salivary cortisol levels in 41 healthy females. *Forsch Komplementmed* 2015; **22**(1): 43-9.
- [61] Tassou CC, Drosinos EH, Nychas GJ. Effects of essential oil from mint (*Mentha piperita*) on *Salmonella enteritidis* and *Listeria monocytogenes* in model food system at 4 degrees and 10 degrees C. *J Appl Bacteriol* 1995; **78**: 593-600.
- [62] Ravid U, Putievsky E, Katzir I. Enantiomeric distribution of piperitone in essential oils of some mentha spp., *Calamintha incana* (sm.) heldr. and *Artemisia indica* L. *Flavour Fragr J* 1994; **9**: 85-7.
- [63] Srivastava JK, Shankar E, Gupta S. Chamomile: a herbal medicine of the past with bright future. *Mol Med Rep* 2010; **3**(6): 895-901.
- [64] Setzer WN. Essential oils and anxiolytic aromatherapy. *Nat Prod Commun* 2009; **4**(9): 1305-16.
- [65] Atsumi T, Tonosaki K. Smelling lavender and rosemary increases free radical scavenging activity and decreases cortisol level in saliva. *Psychiatry Res* 2007; **150**(1): 89-96.
- [66] al-Sereiti MR, Abu-Amer KM, Sen P. Pharmacology of rosemary (*Rosmarinus officinalis* Linn.) and its therapeutic potentials. *Indian J Exp Biol* 1999; **37**: 124-30.
- [67] Hammer KA, Carson CF, Riley TV. *In vitro* activity of *Melaleuca alternifolia* (tea tree) oil against dermatophytes and other filamentous fungi. *J Antimicrob Chemother* 2002; **50**: 195-9.
- [68] Hammer KA, Carson CF, Riley TV. Antifungal activity of the components of *Melaleuca alternifolia* (tea tree) oil. *J Appl Microbiol* 2003; **95**: 853-60.
- [69] Hammer KA, Dry L, Johnson M, Michalak EM, Carson CF, Riley TV. Susceptibility of oral bacteria to *Melaleuca alternifolia* (tea tree) oil in vitro. *Oral Microbiol Immunol* 2003; **18**(6): 389-92.
- [70] Koh KJ, Pearce AL, Marshman G, Finlay-Jones JJ, Hart PH. Tea tree oil reduces histamine-induced skin inflammation. *Br J Dermatol* 2002; **147**: 1212-7.
- [71] Pazyar N, Yaghoobi R, Bagherani N, Kazerouni A. A review of applications of tea tree oil in dermatology. *Int J Dermatol* 2013; **52**: 784-90.
- [72] Eisenhower C, Farrington EA. Advancements in the treatment of head lice in pediatrics. *J Pediatr Health Care* 2012; **26**: 451-61.
- [73] Carson CF, Smith DW, Lampacher GJ, Riley TV. Use of deception to achieve double-blinding in a clinical trial of *Melaleuca alternifolia* (tea tree) oil for the treatment of recurrent herpes labialis. *Contemp Clin Trials* 2008; **29**(1): 9-12.
- [74] Gnatta JR, Piason PP, Lopes Cde L, Rogenski NM, Silva MJ. [Aromatherapy with ylang ylang for anxiety and self-esteem: a pilot study]. *Rev Esc Enferm USP* 2014; **48**(3): 492-9. Portuguese.
- [75] Hongratanaworakit T, Buchbauer G. Relaxing effect of ylang ylang oil on humans after transdermal absorption. *Phytother Res* 2006; **20**: 758-63.
- [76] Bilsland D, Strong A. Allergic contact dermatitis from the essential oil of French marigold (*Tagetes patula*) in an aromatherapist. *Contact Dermat* 1990; **23**: 55-6.
- [77] Burfield T. Safety of essential oils. *Int J Aromather* 2000; **10**: 16-29.
- [78] Schaller M, Korting HC. Allergic airborne contact dermatitis from essential oils used in aromatherapy. *Clin Exp Dermatol* 1995; **20**: 143-5.
- [79] Henley DV, Lipson N, Korach KS, Bloch CA. Prepubertal gynecomastia linked to lavender and tea tree oils. *N Engl J Med* 2007; **356**: 479-85.
- [80] Oyedele AO, Afolayan AJ, Hutchings A. Compositional variation of the essential oils of *Artemisia afra* Jacq. from three provinces in South Africa—a case study of its safety. *Nat Prod Commun* 2009; **4**(6): 849-52.
- [81] Fujita KI, Chavasiri W, Kubo I. Anti-salmonella activity of volatile compounds of Vietnam coriander. *Phytother Res* 2015; <http://dx.doi.org/10.1002/ptr.5351>.
- [82] Karbach J, Ebenezzer S, Warnke PH, Behrens E, Al-Nawas B. Antimicrobial effect of Australian antibacterial essential oils as

- alternative to common antiseptic solutions against clinically relevant oral pathogens. *Clin Lab* 2015; **61**(1–2): 61–8.
- [83] Wan J, Wilcock A, Coventry MJ. The effect of essential oils of basil on the growth of *Aeromonas hydrophila* and *Pseudomonas fluorescens*. *J Appl Microbiol* 1998; **84**: 152–8.
- [84] Takarada K, Kimizuka R, Takahashi N, Honma K, Okuda K, Kato T. A comparison of the antibacterial efficacies of essential oils against oral pathogens. *Oral Microbiol Immunol* 2004; **19**: 61–4.
- [85] Medeiros JR, Campos LB, Mendonca SC, Davin LB, Lewis NG. Composition and antimicrobial activity of the essential oils from invasive species of the Azores, *Hedychium gardnerianum* and *Pittosporum undulatum*. *Phytochemistry* 2003; **64**: 561–5.
- [86] Samber N, Khan A, Varma A, Manzoor N. Synergistic anti-candidal activity and mode of action of *Mentha piperita* essential oil and its major components. *Pharm Biol* 2015; <http://dx.doi.org/10.3109/13880209.2014.989623>.
- [87] Mejía-Garibay B, Palou E, López-Malo A. Composition, diffusion, and antifungal activity of black mustard (*Brassica nigra*) essential oil when applied by direct addition or vapor phase contact. *J Food Prot* 2015; **78**(4): 843–8.
- [88] Prakash B, Singh P, Goni R, Raina AK, Dubey NK. Efficacy of *Angelica archangelica* essential oil, phenyl ethyl alcohol and  $\alpha$ -terpineol against isolated molds from walnut and their anti-aflatoxic and antioxidant activity. *J Food Sci Technol* 2015; **52**(4): 2220–8.
- [89] Trindade LA, de Araújo Oliveira J, de Castro RD, de Oliveira Lima E. Inhibition of adherence of *C. albicans* to dental implants and cover screws by *Cymbopogon nardus* essential oil and citronellal. *Clin Oral Investig* 2015; <http://dx.doi.org/10.1007/s00784-015-1450-3>.
- [90] Barkatullah Ibrar M, Muhammad N, De Feo V. Chemical composition and biological activities of the essential oil of *Skimmia laureola* leaves. *Molecules* 2015; **20**(3): 4735–45.
- [91] Mahboubi M, Kazempour N. The antifungal activity of *Artemisia sieberi* essential oil from different localities of Iran against dermatophyte fungi. *J Mycol Med* 2015; <http://dx.doi.org/10.1016/j.mycmed.2015.02.042>.
- [92] Deans SG, Ritchie G. Antibacterial properties of plant essential oils. *Int J Food Microbiol* 1987; **5**: 165–80.
- [93] Murbach Teles Andrade BF, Conti BJ, Santiago KB, Fernandes Júnior A, Sforcin JM. *Cymbopogon martinii* essential oil and geraniol at noncytotoxic concentrations exerted immunomodulatory/anti-inflammatory effects in human monocytes. *J Pharm Pharmacol* 2014; **66**(10): 1491–6.
- [94] Di Campli E, Di Bartolomeo S, Delli Pizzi P, Di Giulio M, Grande R, Nostro A, et al. Activity of tea tree oil and nerolidol alone or in combination against *Pediculus capitis* (head lice) and its eggs. *Parasitol Res* 2012; **111**(5): 1985–92.
- [95] Mills C, Cleary BJ, Gilmer JF, Walsh JJ. Inhibition of acetylcholinesterase by tea tree oil. *J Pharm Pharmacol* 2004; **56**: 375–9.
- [96] Satchell AC, Saurajen A, Bell C, Barnetson RS. Treatment of dandruff with 5% tea tree oil shampoo. *J Am Acad Dermatol* 2002; **47**: 852–5.
- [97] Anjum F, Bukhari SA, Shahid M, Bokhari TH, Talpur MM. Exploration of nutraceutical potential of herbal oil formulated from parasitic plant. *Afr J Tradit Complement Altern Med* 2013; **11**(1): 78–86.
- [98] Carnesecchi S, Langley K, Exinger F, Gosse F, Raul F. Geraniol, a component of plant essential oils, sensitizes human colon cancer cells to 5-fluorouracil treatment. *IARC Sci Publ* 2002; **156**: 407–9.
- [99] Calcabrini A, Stringaro A, Toccaceli L, Meschini S, Marra M, Colone M, et al. Terpinen-4-ol, the main component of *Melaleuca alternifolia* (tea tree) oil inhibits the *in vitro* growth of human melanoma cells. *J Invest Dermatol* 2004; **122**: 349–60.
- [100] Bhattacharjee B, Chatterjee J. Identification of proapoptotic, anti-inflammatory, anti-proliferative, anti-invasive and anti-angiogenic targets of essential oils in cardamom by dual reverse virtual screening and binding pose analysis. *Asian Pac J Cancer Prev* 2013; **14**(6): 3735–42.
- [101] Gkinis G, Tzakou O, Iliopoulou D, Roussis V. Chemical composition and biological activity of *Nepeta parnassica* oils and isolated nepetalactones. *Z Naturforsch C* 2003; **58**: 681–6.
- [102] Sadraei H, Asghari GR, Hajhashemi V, Kolagar A, Ebrahimi M. Spasmolytic activity of essential oil and various extracts of *Ferula gummosa* Boiss. on ileum contractions. *Phytomedicine* 2001; **8**: 370–6.
- [103] Grunfeld E, Gresty MA. Relationship between motion sickness, migraine and menstruation in crew members of a “round the world” yacht race. *Brain Res Bull* 1998; **47**: 433–6.
- [104] Howes MJ, Houghton PJ, Barlow DJ, Pocock VJ, Milligan SR. Assessment of estrogenic activity in some common essential oil constituents. *J Pharm Pharmacol* 2002; **54**: 1521–8.
- [105] Battaglia S. *The complete guide to aromatherapy*. Brisbane: Perfect Potion; 2004.
- [106] Buckle J. Literature review: should nursing take aromatherapy more seriously? *Br J Nurs* 2007; **16**: 116–20.
- [107] Price S, Price L. *Aromatherapy for health professionals*. 4th ed. New York: Elsevier Churchill Livingstone; 2011.
- [108] Varney E, Buckle J. Effect of inhaled essential oils on mental exhaustion and moderate burnout: a small pilot study. *J Altern Complement Med* 2013; **19**: 69–71.