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Review

A status review on the medicinal properties of essential oils

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ABSTRACT

Essential oils (EOs) are complex mixtures of low molecular weight compounds extracted from plants by steam distillation and various solvents. Terpenoids and phenylpropanoids are the major constituents which provide characteristic aroma and biological properties to EOs. Essential oils are prescribed for a variety of health problems by traditional systems of medicine, all over the world. Various pharmaceutical and biological activities like, antibacterial, antifungal, anticancer, antimutagenic, antidiabetic, antiviral, antiinflammatory, and antiprotozoal properties are assigned to them. Extensive phytochemical analysis has lead to the characterization and identification of major components of EOs which are of wide interest, especially to cosmetic and pharmaceutical industries. Current status of the bio-active properties of EOs and their medicinal potential are covered in this review.

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1. Introduction

Essential oils of plant origin are one of the important products of agriculture based industry. They are commonly used as flavouring agents in food products, drinks, perfumaries, pharmaceuticals and cosmetics (Burt, 2004; Hussain et al., 2008; Teixeira et al., 2013). Around 3000 essential oils have been produced by using at least 2000 plant species, out of which 300 are important from the commercial point of view. 40,000–60,000 tonnes per annum production with estimated market value of 700 million US $, indicate that production and consumption of essential oils is increasing all over the World (Djilani and Dicko, 2012). Many factors including genetic variation, plant ecotype or variety, plant nutrition, application of fertilizers, geographic location of the plants, surrounding climate, seasonal variations, stress during growth or maturity and also the post harvest drying and storage, affect the chemistry of EOs. In addition, type of plant material used and the method of extraction determine the yield and composition (constituents) of an EO, and thereby decides its characteristic biological properties

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(Croteau, 1986; Alvarez-Castellanos and Pascual-Villalobos, 2003; Hussain et al., 2008). For example, EO from different plant parts like flowers, leaves, stems, roots, fruits and fruit-peels exhibit different biological and medicinal properties. Similarly, solvents of different polarities extract different group of compounds (Cowan, 1999). Many times it is difficult to differentiate and analyze effect of these factors because they influence one another (Terblanche and Kornelius, 2000).

Essential oils are complex mixtures of low molecular weight (usually less than 500 daltons) compounds extracted by steam distillation, hydrodistillation or solvent extraction (Nakatsu et al., 2000). They are usually stored in oil ducts, resin ducts, glands or trichomes (glandular hairs) of the plants (Baser and Demirci, 2007). On commercial scale, steam distillation is a preferred method for the extraction of essential oils (Masango, 2005). EOs may constitute 20–100 different plant secondary metabolites belonging to a variety of chemical classes (Carson and Hammer, 2011). Terpenoids and phenylpropanoids form the major constituents of the essential oils. In addition, few aromatic and aliphatic constituents are also present. Monoterpenes, sesquiterpenes and oxygenated derivatives of these two are the largest group of chemical entities in EOs (Carson et al., 2006). Most of the time the bioactivities of a particular EO is decided by eiether one or two of its main components (Bakkali et al., 2008). But, sometimes overall activity can not be attributed to any of the major constituents and presence of a combination of molecules modify the activity to exert significant effect. For example, it is reported that inhibitory activity of rosemary oil against insect larvae (lepidopteran larvae) is a consequence of synergistic effects of several chemical constituents, while no individual compound show the activity (Isman et al., 2008).

Natural products and their derivaties are important sources of novel therapeutic molecules (Clardy and Walsh, 2004). Plant essential oils possess various applications mainly in health, agriculture, cosmetic and food industries. Use of EOs in traditional systems of medicine is being practiced since ancient times in human history. Researchers from all over the world are trying to characterize a range of biological properties of EOs which includes antimicrobial, antiviral, antimutagenic, anticancer, antioxidant, antiinflammatory, immunomodulatory, and antiprotozoal activities (Bakkali et al., 2008). Efficiencies of various EOs are compared by analyzing the concentrations required to inhibit the growth of target organisms. Generally, minimum growth inhibitory concentrations (MICs), minimum lethal concentrations (MBCs or MFCs), MIC_{50} and LD_{50} values are used for comparison of bioactivities. These values are obtained with standardized methodologies. For example, protocols given by Clinical Laboratory Standards Institute (CLSI) and cell viability assessment by MTT or XTT assays are used for antimicrobial susceptibility testing (Bakkali et al., 2008; Hammer and Carson, 2011; Schnitzler et al., 2011).

Emergence of drug resistant strains of pathogens, increase in the immunocompromised population and limitations of the available antibiotics/drugs have motivated people to use the complementary and alternative therapies, including the use of EOs. Secondary metabolites which are naturally synthesized by plants in response to attack by insect pest and some times herbivores, constitute a complex mixture of EOs. These small molecule metabolites alone and in combination, (for example in the form of EOs) possess significant medicinal properties; hence, may be used for chemotherapy of infectious as well as non-infectious diseases (Samy and Gopalakrishnakone, 2010; Raut and Karuppayil, 2014).

2. Taxanomy of essential oil producing plants

Plants producing EOs belong to various genera distributed to around 60 families. Selected families such as Alliaceae, Apiaceae, Asteraceae, Lamiaceae, Myrtaceae, Poaceae and Rutaceae are well known for their ability to produce EOs of medicinal and industrial value (Table 1) (Vigan, 2010; Hammer and Carson, 2011). All of the EO producing plant families are rich in terpenoids. While, plant families like Apiaceae (Umbelliferae), Lamiaceae, Myrtaceae, Piperaceae and Rutaceae contain phenylpropanoids more frequently (Chami et al., 2004). Plants from these families are used for EO production at commercial level. For example, coriander, anise, dill and fennel oils are extracted from the plants – *Coriandrum sativum*, *Pimpinella anisum*, *Anethum graveolens* and *Foeniculum vulgare*, respectively. All of these belong to the family Apiaceae

Table 1
Essential oils of medicinal importance distributed to selected plant families.

Sr. no.	Plant family	Essential oil	Medicinal properties
1	Apiaceae (Umbelliferae)	*Carum nigrum* (Black caraway); *Anethum graveolens* (Dill); *Apium graveolens* (Celery); *Foeniculum vulgare* (Fennel); *Pimpinella anisum* (Anise); *Cuminum cyminum* (Cumin); *Corriandrum sativum* (Coriander)	Antibacterial; Antifungal; Anticancer; Antiviral; Anti-diabetic
2	Asteraceae (Compositae)	*Artemisia judaica*; *A.* annua; *A. absinthium* (Wormwood); *A. dracunculus* (Tarragon)	Antifungal; Anticancer; Antiviral
3	Geraniaceae	*Pelargonium graveolens* (Rose Geranium);	Antibacterial
4	Lamiaceae/Labiateae	*Origanum vulgare* (Origano); *Melissa officinalis* (Lemon balm); *Salvia officinalis* (Sage); *Mentha* sp.; *Mentha longifolia* (Wild Mint); *M. piperita* (Peppermint); *M. spicata* (Spearmint); *Ocimum basilicum* (Sweet Basil); *O. sanctum*; *Rosmarinus officinalis* (Rosemary); *Lavandula officinalis* (Lavender); *Lavandula* sp.; *Salvia sclarea* (Sage Clary)	Antibacterial; Antifungal; Anticancer; Antiviral; Antidiabetic; Antimutagenic, Antiprotozoal; Anti-inflammatory; Antioxidant
5	Lauraceae	*Cinnamomum* sp. (Cinnamon)	Antimicrobial; Anti-inflammatory; Antimutagenic
6	Liliaceae	*Allium sativum* (Garlic); *Allium cepa* (onion)	Antifungal; Antiviral; Antiprotozoal
7	Myrtaceae	*Syzigium aromaticum* (Clove); *Thymus vulgaris* (Thyme); *Thymus* sp.; *Melaleuca alternifolia* (Tea tree); *Eucalyptus globulus* (Blue gum); *Myristica fragrans* (Nutmeg)	Antibacterial; Antifungal; Anticancer; Antiviral; Antimutagenic Anti-inflammatory Antiprotozoal
8	Oleaceae	*Jasminum* sp.; *Olea europaea* (Olive)	Antibacterial, Anticancer
9	Piperaceae	*Piper nigrum* (Black pepper)	Antibacterial; Antifungal; Anticancer; Antiprotozoal
10	Pinaceae	*Cedrus libani* (Cedar wood oil)	Antifungal
11	Poaceae	*Cymbopogon martini* (Palmarosa); *Cymbopogon citrates* (Lemon grass); *Cymbopogon nardus* (Citronella grass);	Antifungal; Anticancer
12	Rutaceae	*Citrus* sp. (Lemon); *C. paradisi* (Grape fruit)	Antibacterial; Antifungal; Anticancer
13	Rosaceae	*Rosa* sp.;	Antifungal
14	Santalaceae	*Santalum* sp.; *Santalum album* (Sandalwood)	Antiviral
15	Zingiberaceae	*Zingiber officinale* (Ginger); *Zingiber montanum; Curcuma longa* (Turmeric); *Elettaria cardamomum* (Cardamom)	Antifungal; Anticancer; Antioxidant; Antimutagenic