

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

4,800

Open access books available

122,000

International authors and editors

135M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.

For more information visit www.intechopen.com



Aromatherapy as Complementary Medicine

Amira Ahmed Kamal El-din El-Anssary

Abstract

Aromatherapy is the practice of using the natural oils extracted from bark, flowers, stems, roots, leaves, or other parts of a plant to enhance psychological and physical well-being. It is a type of complementary medicine that uses volatile oils and other aromatic compounds with the aim of changing a person's mind and mood. Volatile oils are hydrophobic in nature. Essential oils are extracted by different methods as steam distillation. Some evidence exists that volatile oils may have therapeutic potential. Volatile oils are often absorbed through the skin, where they travel through the bloodstream and might promote whole-body healing. Essential oils are showing a spread of applications, including pain treatments, enhancement of mood, and increased cognitive function. Essential oils are available in a large number, each with its own healing properties.

Keywords: aromatherapy, complementary medicine, essential oils, therapeutic benefits, ketones, ancient civilization, biological activities, distribution

1. Introduction

For a long time, essential oils were well-known for their therapeutic importance. They were used as perfumes and flavors for foods and beverages or to heal both the body and mind for many years [1–4]. They were used in ancient civilizations as Chinese, Indian, and ancient Egyptian and show their uses in many treatments in different forms. The ancient Chinese were the first culture to use aromatherapy in folk medicine, and then the ancient Egyptians created undeveloped distillation machine that is used for the crude extraction. Greece learned a large deal from the ancient Egyptians, and they also learned the therapeutic and aromatic advantages of the aromatic plants [5–8].

Volatile oils consist of very small aromatic molecules that are easily absorbed through the skin and respiratory system. These medicinal compounds next enter the bloodstream and then spread all over the whole body where they can create their useful curing powers. As they are too concentrated, even a small amount of volatile oil is effective. Nowadays aromatherapy is one of the most popular complementary therapies, offering a highly effective treatment to both the acute and chronic diseases. In addition, the continuous use of aromatherapy and home-use products helps our immune system [9].

2. Definition and localization of essential oils

Volatile oils are aromatic compounds which occur only in 10% of the plant kingdom and are stored in plants in specific secretory cells such as glands, hairs, ducts, cavities, or resin ducts [10–13]. Essential oils are hydrophobic in nature; they can be dissolved by polar solvent like alcohols and nonpolar solvents, waxes, and oils. Most of them are pale yellow or with no color with the exception of the blue volatile oil of *Matricaria chamomilla* L., and most are liquid and of low density than water except the essential oil of *Cinnamomum verum* Blume. and *Syzygium aromaticum* L. [14, 15].

Volatile oils are easily oxidizable by light, heat, and air due to the presence of olefinic double bonds and functional groups such as hydroxyl, aldehyde, and ester [16, 17].

3. Extraction of volatile oils

The oils contained within the plant cells are liberated through heat and compression from different organs of the plant, for example, the leaves, flowers, fruit, bark, and gums. The extraction of the oils from different plant organs is achieved by different methods, such as hydro-distillation, which is the most common method of extraction [18, 19]. Essential oils are composed of a mixture of volatile components and consist of about 20–60 individual compounds, and some may contain more than 100 components as jasmine, lemon, and cinnamon volatile oils [20–23].

4. Factors affecting chemical composition of volatile oils

The fragrance and chemical composition of the oils can vary according to different factors as the geo-climatic location and growing conditions (soil type, climate, altitude, and amount of water available), season, and time of day when harvesting is done. Therefore, these factors influence the biochemical synthesis of the oils in a plant, so that the same species of the plant make the same volatile oil but maybe of different chemical compounds, which will affect their therapeutic activities. These different chemical compositions led to different chemotypes. Chemotype is in general a different population of the same species of plant which produces many chemical profiles for a particular class of secondary metabolites. Examples of some chemotypes are shown in **Table 1** [24–27].

5. Distribution of the volatile oils in the plant kingdom

Although only 100 species are widely known for their volatile oils, there are over 2000 plant species widespread over 60 families such as Lamiaceae, which is also

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

Table 1.
Examples of different chemotypes.

Class of compounds	Example	Bioactivities	References
Ketones	Carvone, menthone, pulegone, fenchone, camphor	Mucolytic, cell regenerating, sedative, antiviral, neurotoxic, analgesic, spasmolytic	[38–40]
Aldehydes	Citral, myrtenal, cuminaldehyde, citronellal, cinnamaldehyde, benzaldehyde	Antiviral, antimicrobial, tonic, vasodilators, hypotensive, calming, antipyretic, sedative	[26, 41]
Phenols	Thymol, eugenol, carvacrol, chavicol	Antimicrobial, spasmolytic, immune stimulating	[26, 40]
Alcohols	Linalool, menthol, borneol, santalol, nerol, citronellol, geraniol	Antimicrobial, antiseptic, tonifying, spasmolytic	[26, 40]
Lactones	Nepetalactone, bergaptene	Antimicrobial antiviral, antipyretic, sedative, hypotensive, analgesic	[26, 40]
Hydrocarbons	Limonene, myrcene, pinene, sabinene, cymene, myrcene, phellandrene	Stimulant, antiviral, antitumor, decongestant, antibacterial, hepatoprotective	[26, 40]
Esters	Linalyl acetate, geraniol acetate, eugenol acetate, bornyl acetate	Spasmolytic, sedative, antifungal, anti-inflammatory	[26, 40]
Oxides	Bisabolone oxide, linalool oxide, sclareol oxide	Anti-inflammatory, expectorant, stimulant	[26, 40]

Table 2.
Different classes of volatile oils and their biological activities.

called the mint family. It is one of most important plant families in the plant kingdom. This family is rich in essential oils, especially menthol thyme, Rosemary, and Oregano. Apiaceae or Umbelliferae is a family of mostly aromatic flowering plants, which contains economically important plants as caraway, coriander, cumin, and fennel [28–31]. Volatile oils contribute in a lot of industries as food products, drinks, perfumes, pharmaceuticals, and cosmetics [32–34]. The production and consumption of essential oils increase rapidly all over the world [35]. Regardless of the high costs because of the large amounts of plant material needed, volatile oil production has been increasing. The expected world production of the oils ranges from 40,000 to 60,000 tons/year and represents a market of approximately 700 million US\$ [36, 37]. Examples of some classes of essential oils their medical uses and structures are illustrated in (Table 2), (Figures 1 and 2) [26, 38–41].

6. Therapeutic benefits of essential oils

Many plant essential oils are used as medicine for hundreds of years and have demonstrated several health benefits, including effects on infectious, chronic, and acute diseases. The medical preparations made with plant essential oils as well as their single constituents applied in the therapy of human infectious diseases are well documented. However, the selection of suitable safe oil and the determination of the best efficient dose should be taken into consideration to avoid any side effects when they are applied [41]. The action of volatile oils begins by entering the human body through three possible ways including direct absorption through inhalation, ingestion, or diffusion through the skin tissue.

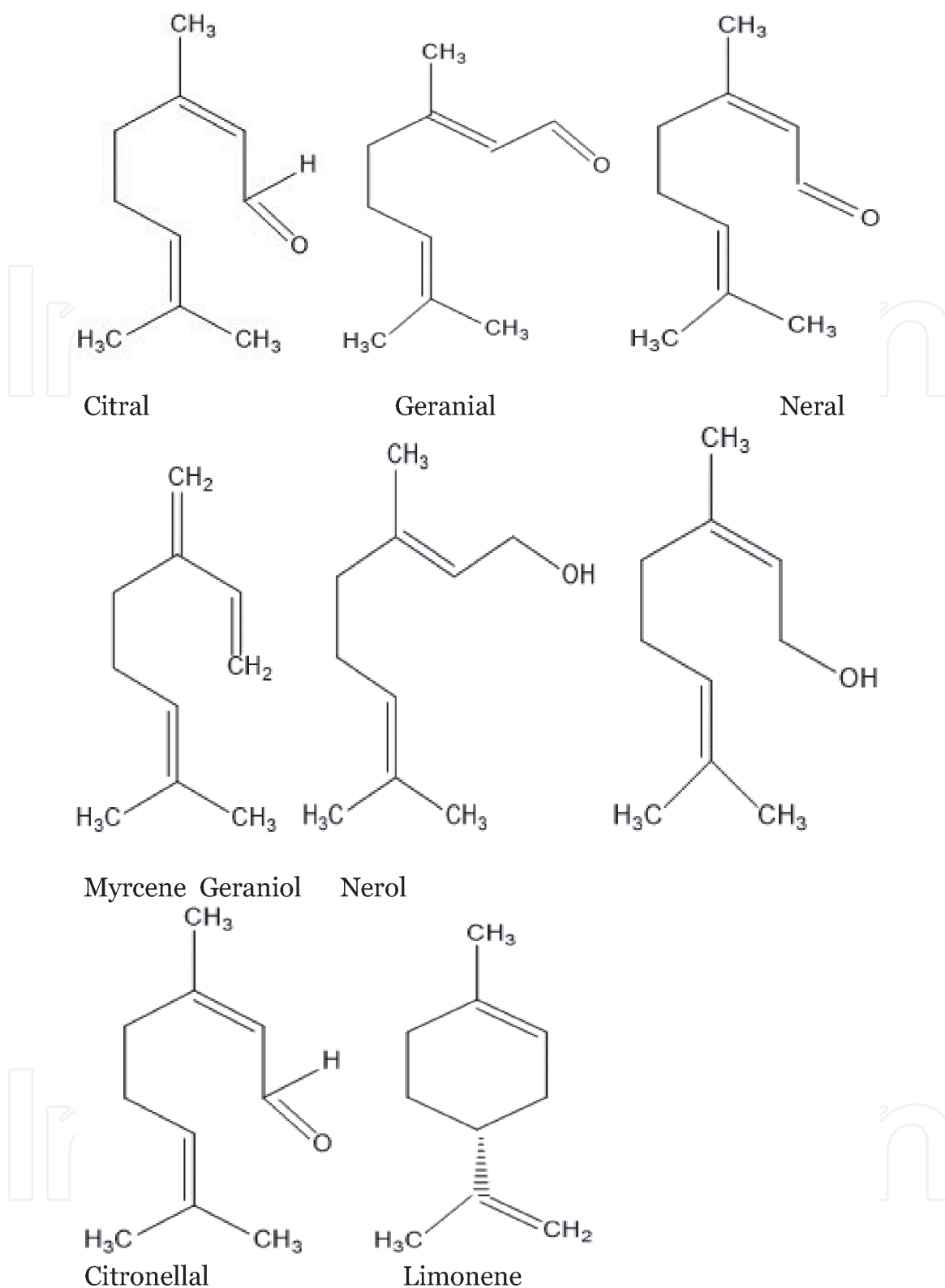


Figure 1.
Different classes of volatile oil.

6.1 Absorption through the skin

Volatile oil components are lipid soluble, so they have the ability to penetrate the membranes of the skin before being captured by the micro-circulation and drained into the systemic circulation, reaching all target organs [42, 43]. An example of this are the inflammatory disorders which are associated with pain, redness, and swelling, leading to loss of vital functions. Tea tree oil has been shown to increase monocytic differentiation *in vitro* and reduce inflammation, therefore assisting the healing of chronic wounds [44].

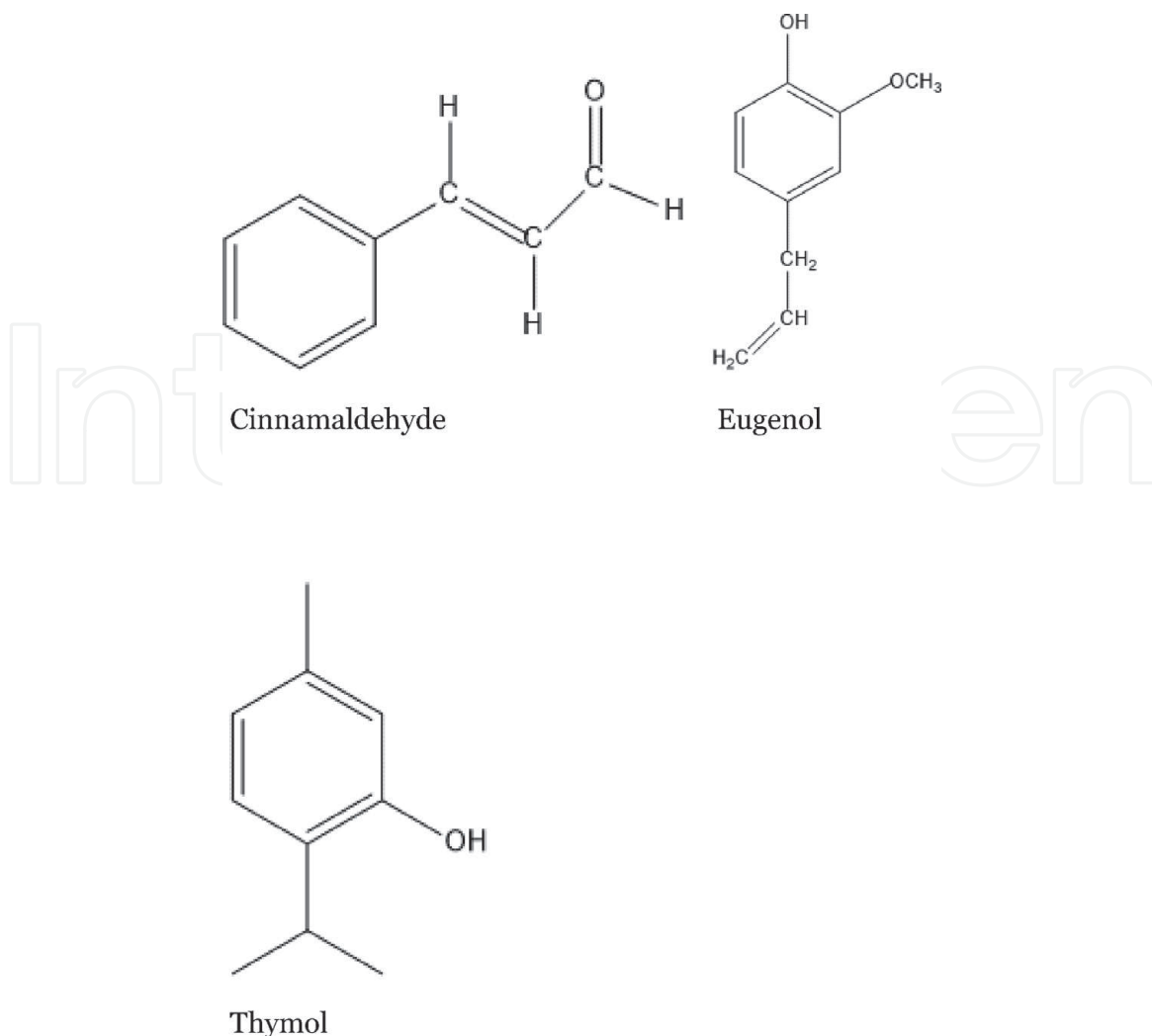


Figure 2.
Different classes of volatile oil.

6.2 Inhalation

Volatile oils enter the body through the respiratory system. Due to their volatile ability, they can be inhaled easily through the upper respiratory tract and enter the lungs, by which it can be spread to the blood stream. In general, the respiratory tract is considered to be the most easiest way of entry, followed by the dermal pathway [45]. 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 [46–48].

6.3 Ingestion

Oral ingestion of essential oils needs to be done carefully due to the possible toxicity of some oils. Ingested volatile oil compounds and/or their metabolites may then be absorbed and delivered to the rest of the body and then distributed to different organs. Once volatile oil are entered in to the body, they create their therapeutic effect through physiological functions (**Table 3**). For example, *Roman chamomile* is extensively used to relieve pain from physical conditions, menstrual cramps, and tension with its application on the lower abdomen [49–52].

No.	Name	Active compounds	Ref.	Biological activities	Ref.
1.	Chamomile essential oil (<i>Matricaria chamomilla</i> L.)	Bisabolol and chamazulene	[53, 54]	Anti-inflammatory Anti-allergic Anti-pruritic Decongestive Antispasmodic	[55–57]
2.	Anise essential oil (<i>Pimpinella anisum</i> L.)	Anethole	[58]	Antispasmodic 2-Emmenagogue Stomachic Carminative Diuretic	[59, 60]
3.	Nutmeg essential oil (<i>Myristica fragrans</i> Houtt.)	Sabinene, 4-terpineol, myristicin	[61]	Antimicrobial Pesticidal activity General tonic Antioxidant	[62, 63]
4.	Cedar essential oil (<i>Cedrus libani</i> (A. Rich.))	Limonene	[64]	Larvicidal Lymphotonic Powerful diuretic Regenerative blood Astringent Scalp tonic Antifungal	[65, 66]
5.	Garlic essential oil (<i>Allium sativum</i> L.)	Diallyl disulfide	[67, 68]	Protects and maintains the cardiovascular system Hypoglycemic Regulates blood pressure Antimicrobial	[67, 69, 70]
6.	Clove essential oil (<i>Syzygium aromaticum</i> L.)	Eugenol, eugenyl acetate	[71, 72]	Antiviral Antimicrobial Antifungal Aphrodisiac	[73, 74]
7.	Cinnamon essential oil (<i>Cinnamomum cassia</i> (Blume))	Cinnamaldehyde	[75, 76]	Powerful antibacterial Antiviral Antifungal	[77, 78]
8.	Eucalyptus essential oil (<i>Eucalyptus globulus</i> Labill.)	1,8-Cineole	[79, 80]	Anticatarrhal Expectorant and mucolytic Antimicrobial and antiviral	[81, 82]
9.	Peppermint essential oil (<i>Mentha piperita</i> L.)	Menthol and menthone	[83, 84]	Tonic and stimulant Decongestant Anesthetic and analgesic Antipruritic Expectorant	[85, 86]
10.	Lavender essential oil (<i>Lavandula officinalis</i> Chaix)	Linalool and linalyl acetate	[87, 88]	Antispasmodic Sedative Relaxing Analgesic and anti-inflammatory	[89, 90]
11.	Tea tree essential oil (<i>Melaleuca alternifolia</i> Cheel)	Terpinene-1-ol-4	[91]	Antimicrobial Antiviral Antiasthenic Neurotonic	[92–94]

No.	Name	Active compounds	Ref.	Biological activities	Ref.
				Decongestant Radioprotective	
12.	Lemon essential oil (<i>Citrus limonum</i>) (L.) Osbeck	Limonene	[95, 96]	Strengthen natural immunity Tonic nervous system Antimicrobial and antiviral	[97-99]

Table 3.
Therapeutic properties of some essential oils.

7. Conclusion


There is a significant and growing interest to find safe and effective methods of treatment. Aromatherapy is one of the most usable methods across the world. It has gained popularity due to its safety, easy accessibility, and effective effects. From previous data we can notice that essential oils have a lot of pharmacological effects and can help in the treatment of many diseases.

Author details

Amira Ahmed Kamal El-din El-Anssary
Pharmacognosy Department, Pharmaceutical Science Division, National Research Center, Giza, Egypt

*Address all correspondence to: amiraelanssary@yahoo.com

IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

References

- [1] Baris O, Güllüce M, Sahin F, Ozer H, Kılıc H, Ozkan H, et al. Biological activities of the volatile oil and methanol extract of *Achillea biebersteini* Afan. (Asteraceae). Turkish Journal of Biology. 2006;**30**:65-73
- [2] Margaris N, Koedam A, Vokou D. Aromatic Plants: Basic and Applied Aspects. The Hague, London, Boston: Martinus Nijhoff Publishers; 1982
- [3] Tisserand RB. In the Art of Aromatherapy. Rochester, VT: Healing Arts Press; 1997
- [4] Shibamoto K, Mochizuki M, Kusuhara M. Aroma therapy in anti-aging medicine. Anti-Aging Medicine. 2010;**7**:55-59
- [5] Burt S. Volatile oils: Their antibacterial properties and potential applications in foods. International Journal of Food Microbiology. 2004;**94**: 223-253
- [6] Suaib L, Dwivedi GR, Darokar MP, Kaira A, Khanuja SPS. Potential of rosemary oil to be used in drug-resistant infection. Alternative Therapies. 2007; **13**:54-59
- [7] Shirley Price's Aromatherapy Workbook. London, UK: Thorsons; 1993
- [8] Lawless J. The Illustrated Encyclopedia of Essential Oils. Rockport, MA: Element Books, Inc.; 1995
- [9] Saeidi K, Moosavi M, Lorigooini Z, Maggi F. Chemical characterization of the essential oil compositions and antioxidant activity from Iranian populations of *Achillea wilhelmsii* K. Koch. Industrial Crops and Products. 2018;**112**:274-280
- [10] Ahmadi L, Mirza M, Shahmir F. The volatile constituents of *Artemisia marschaliana* Sprengel and its secretory elements. Flavour and Fragrance Journal. 2002;**17**:141-143
- [11] Bezić N, Šamanić I, Dunkić V, Besendorfer V, Puizina J. Volatile oil composition and internal transcribed spacer (ITS) sequence variability of four south-Croatian *Satureja* species (Lamiaceae). Molecules. 2009;**14**:925-938
- [12] Ciccarelli D, Garbari F, Pagni AM. The flower of *Myrtus communis* (Myrtaceae): Secretory structures, unicellular papillae, and their ecological role. Flora. 2008;**203**:85-93
- [13] Gershenzon J. Metabolic costs of terpenoid accumulation in higher plants. Journal of Chemical Ecology. 1994;**20**:1281-1328
- [14] Gupta V, Mittal P, Bansal P, Khokra SL, Kaushik D. Pharmacological potential of *Matricaria recutita*. International Journal of Pharmaceutical Sciences and Drug Research. 2010;**2**: 12-16
- [15] Martín A, Varona S, Navarrete A, Cocero MJ. Encapsulation and co precipitation processes with supercritical fluids: Applications with volatile oils. The Open Chemical Engineering Journal. 2010;**4**:31-41
- [16] Skold M, Karlberg AT, Matura M, Borje A. The fragrance chemical caryophyllene air oxidation and skin sensitization. Food and Chemical Toxicology. 2006;**44**:538-545
- [17] Skold M, Hagvall L, Karlberg AT. Autoxidation of linalyl acetate, the main compound of lavender oil, creates potent contact allergens. Contact Dermatitis. 2008;**58**:9-14
- [18] Bowles EJ. The Chemistry of Aromatherapeutic Oils. 3rd ed. Griffin: Press; 2003

- [19] Surburg H, Panten J. In: Svoboda K, Hampson J, Hunter T, editors. Common Fragrance and Flavor Materials. Preparation, Properties and Uses. 5th ed. Weinheim: Wiley-VCH; 1999. p. 2006
- [20] Miguel MG. Antioxidant and anti-inflammatory activities of volatile oils. *Molecules*. 2010;**15**:9252-9287
- [21] Sell CS. The Chemistry of Fragrance. From Perfumer to Consumer. 2nd ed. Cambridge: The Royal Society of Chemistry; 2006. p. 329
- [22] Skaltsa HD, Demetzos C, Lazari D, Sokovic M. Volatile oil analysis and antimicrobial activity of eight *Stachys* species from Greece. *Phytochemistry*. 2003;**64**:743-752
- [23] Thormar H. Lipids and Volatile Oils as Antimicrobial Agents. Chichester: John Wiley and Sons; 2011
- [24] Andrade EHA, Alves CN, Guimarães EF, Carreira LMM, Maia JGS. Variability in volatile oil composition of *Piper dilatatum* L.C. *Rich. Biochemical Systematics and Ecology*. 2011;**39**:669-675
- [25] Zehra Küçükbay F, Kuyumcu E, Çelen S, Azaz AD, Arabac T. Chemical composition of the essential oils of three *Thymus* Taxa from Turkey with antimicrobial and antioxidant activities. *Records of Natural Products*. 2014;**8**: 110-120
- [26] Pengelly A. The Constituents of Medicinal Plants: An Introduction of the Chemistry and Therapeutics of Herbal Medicine. Australia, Sydney: Allen and Unwin; 2004
- [27] Sangwan NS, Farooqi AHA, Shabih F, Sangwan RS. Regulation of volatile oil production in plants. *Plant Growth Regulation*. 2001;**34**:3-21
- [28] Baylac S, Racine P. Inhibition of 5-lipoxygenase by volatile oils and other natural fragrant extracts. *International Journal of Aromatherapy*. 2003;**13**: 138-142
- [29] Delamare APL, Moschen-Pistorello IT, Artico L, Atti-Serafini L, Echeverrigaray S. Antibacterial activity of the volatile oils of *Salthrough officinalis* L. and *Salthrough triloba* L. cultivated in South Brazil. *Food Chemistry*. 2007;**100**:603-608
- [30] Sivropoulou A, Nikolau C, Papanikolaou E, Kokkini S, Lanaras T, Arsenakis M. Antimicrobial, cytotoxic, and antiviral activities of *Salthrough fruticosa* volatile oil. *Journal of Agricultural and Food Chemistry*. 1997; **45**:3197-3201
- [31] Sivropoulou A, Papanikolaou E, Nikolau C, Kokkini S, Lanaras T, Arsenakis M. Antimicrobial and cytotoxic activities of origanum volatile oils. *Journal of Agricultural and Food Chemistry*. 1996;**44**:1202-1205
- [32] Anwar F, Hussain AI, Sherazi STH, Bhangar MI. Changes in composition and antioxidant and antimicrobial activities of volatile oil of fennel (*Foeniculum vulgare* mill.) fruit at several, stages of maturity. *Journal of Herbs, Spices and Medicinal Plants*. 2009;**15**:1-16
- [33] Celiktas OY, Kocabas EEH, Bedir E, Sukan FV, Ozek T, Baser KHC. Antimicrobial activities of methanol extracts and volatile oils of *Rosmarinus officinalis*, depending on location and seasonal variations. *Food Chemistry*. 2007;**100**:553-559
- [34] Hammer KA, Carson CF, Dunstan JA, Hale J, Lehmann H, Robinson CJ, et al. Antimicrobial and anti-inflammatory activity of five *Taxandria fragrans* oils in vitro. *Microbiology and Immunology*. 2008; **52**:522-530

- [35] Lawless J. The Illustrated Encyclopedia of Volatile Oils: The Complete Illustrated Guide to the Use of Oils in Aromatherapy and Herbalism. Shaftesbury, Dorset, UK: Element; 1995
- [36] Verlet N. Huiles essentielles: Production mondiale, échanges internationaux et évolution des prix. Res. Mediterranea Magazine. 1994;1:4-9
- [37] Hunter M. Volatile Oils: Art, Agriculture, Science, Industry and Entrepreneurship. New York: Nova Science Publishers, Inc.; 2009
- [38] Gali-Muhtasib H, Hilan C, Khater C. Traditional uses of *Salthrough libanotica* (East Mediterranean sage) and the effects of its volatile oils. Journal of Ethnopharmacology. 2000;71:513-520
- [39] De Sousa DP, Júnior GA, Andrade LN, Calasans FR, Nunes XP, Barbosa-Filho JM, et al. Structure and spasmolytic activity relationships of analogues found in many aromatic plants. Zeitschrift für Naturforschung. Section C. 2008;63:808-812
- [40] De Sousa DP, Júnior GAS, Andrade LN, Batista JS. Spasmolytic activity of chiral monoterpene esters. Records of Natural Products. 2011;5: 117-122
- [41] Elshafie HS, Camele I. An overview of the biological effects of some mediterranean essential oils on human health. Biomed Research International. (Review article). 2017:14. Article ID: 9268468. DOI: 10.1155/2017/9268468
- [42] Adorjan B, Buchbauer G. Biological properties of volatile oils: An updated review. Flavour and Fragrance Journal. 2010;25:407-426
- [43] Baser KHC, Buchbauer G. Handbook of Volatile Oils: Science, Technology, and Applications. NW: CRC Press; 2010
- [44] Mart-nez-Pérez EF, Juárez ZN, Hernández LR, Bach H. Natural antispasmodics: Source, stereochemical configuration, and biological activity. (Review article). BioMed Research International. 2018:32. Article ID: 3819714. DOI: 10.1155/2018/3819714
- [45] Moss M, Cook J, Wesnes K, Duckett P. Aromas of rosemary and lavender volatile oils several, ially affect cognition and mood in healthy adults. International Journal of Neuroscience. 2003;113:15-38
- [46] Maxwell-Hudson C. Aromatherapy Massage Book Dorling. London: Kindersley; 1995
- [47] Price S. Aromatherapy for Common Ailments. London: Fireside; 1991
- [48] Price S. The Aromatherapy Workbook. London: Thorsons; 1993
- [49] Buchbauer G. Molecular interaction: Biological effects and modes of action of volatile oils. International Journal of Aromatherapy. 1993;5:11-14
- [50] Johnson AJ. Cognitive facilitation following intentional odor exposure. Sensors. 2011;11:5469-5488
- [51] Wei A, Shibamoto T. Antioxidant/lipoxygenase inhibitory activities and chemical compositions of selected volatile oil. Journal of Agricultural and Food Chemistry. 2010;58:7218-7225
- [52] Lawless J. The Illustrated Encyclopedia of Essential Oils: The Complete Guide to the Use of Oils in Aromatherapy & Herbalism. Rockport: Element Books Ltd.; 1995
- [53] Cemek M, Kaga S, Simsek N, Buyukokuroglu ME, Konuk M. Antihyperglycemic and antioxidative potential of *Matricaria chamomilla* L. in streptozotocin-induced diabetic rats. Journal of Natural Medicines. 2008;62: 284-293

- [54] Kamatou GPP, Viljoen AM. A review of the application and pharmacological properties of α -bisabolol and β -bisabolol-rich oils. *Journal of the American Oil Chemists' Society*. 2010; **87**:1-7
- [55] Jarić S, Kostić O, Mataruga Z, Pavlović D, Pavlović P. Traditional wound-healing plants used in the Balkan region (Southeast Europe). *Journal of Ethnopharmacology*. 2018; **211**:311-328
- [56] Tolouee M, Alinezhad S, Saberi R, Eslamifar A, Zad SJ, Jaimand K, et al. Effect of *Matricaria chamomilla* L. flower volatile oil on the growth and ultrastructure of *Aspergillus niger* Tieghem. *International Journal of Food Microbiology*. 2010; **139**:127-133
- [57] Shoara R, Hashempur MH, Ashraf A, Salehi A, Dehshahri S, Habibagahi Z. Efficacy and safety of topical *Matricaria chamomilla* L. (chamomile) oil for knee osteoarthritis: A randomized controlled clinical trial. *Complementary Therapies in Clinical Practice*. 2015; **21**:181-187
- [58] El-Salam MA, Ammar NM, Yassin N, Ezzeldin N, Ziki E, El-Anssary AK, et al. A clinico-pharmacological assessment of a herbal preparation for treatment of bronchial asthma. *World Journal of Medical Sciences*. 2015; **12**: 115-124
- [59] Mosaffa-Jahromi M, Lankarani KB, Pasalar M, Afsharypuor S. Efficacy and safety of enteric coated capsules of anise oil to treat irritable bowel syndrome. *Journal of Ethnopharmacology*. 2016; **194**:937-946
- [60] Iannarelli R, Marinelli O, Morelli MB, Santoni G, Maggi F. Aniseed (*Pimpinella anisum* L.) essential oils reduces pro-inflammatory cytokines and stimulates mucus secretion in primary airway bronchial and tracheal epithelial cell lines. *Industrial Crops and Products*. 2018; **114**:81-86
- [61] Muchtaridi, Subarnas A, Apriyantono A, Mustarichien R. Identification of compounds in the volatile oil of nutmeg seeds (*Myristica fragrans* Houtt.) that inhibit locomotor activity in mice. *International Journal of Molecular Sciences*. 2010; **11**: 4771-4781
- [62] Tomaino A, Cimino F, Zimbalatti V, Venuti V, Sulfaro V, De Pasquale A, et al. Influence of heating on antioxidant activity and the chemical composition of some spice volatile oils. *Food Chemistry*. 2005; **89**:549-554
- [63] Piaru SP, Mahmud R, Majid AMSA, Nassar ZDM. Antioxidant and antiangiogenic activities of the essential oils of *Myristica fragrans* and *Morinda citrifolia*. *Asian Pacific Journal of Tropical Medicine*. 2012; **5**:294-298
- [64] Cetin H, Kurt Y, Isik K, Yanikoglu A. Larvicidal effect of *Cedrus libani* seed oils on mosquito *Culex pipiens*. *Pharmaceutical Biology*. 2009; **47**:665-668
- [65] Dharmagadda VSS, Naik SN, Mittal PK, Vasudevan P. Larvicidal activity of *Tagetes patula* volatile oil against three mosquito species. *Bioresource Technology*. 2005; **96**: 1235-1240
- [66] Kizil M, Kizil G, Yavuz M, Aytakin C. Antimicrobial activity of resins obtained from the roots and stems of *Cedrus libani* and *Abies Cilicia*. *Applied Biochemistry and Microbiology*. 2002; **38**:144-146
- [67] Behbahani BAZ, Fooladi AAI. Evaluation of phytochemical analysis and antimicrobial activities *Allium* essential oil against the growth of some microbial pathogens. *Microbial Pathogenesis*. 2018; **114**:299-303
- [68] Thomson M, Ali M. Garlic (*Allium sativum*): A review of its potential use as

- an anti-cancer agent. *Current Cancer Drug Targets*. 2003;3:67-81
- [69] Klevenhusen F, Zeitz JO, Duval S, Kreuzer M, Soliva CR. Garlic oil and its principal component diallyl disulfide fail to mitigate methane, but improve digestibility in sheep. *Animal Feed Science and Technology*. 2011;166-167: 356-363
- [70] Bading Taika B, Bouckandou M, Souza A, Bouroubou HP, MacKenzie LS, Lione L. An overview of anti-diabetic plants used in Gabon: Pharmacology and toxicology. *Journal of Ethnopharmacology*. 2018;216:203-228
- [71] Silva NCC, Fernandes JA. Biological properties of medicinal plants: A review of their antimicrobial activity. *The Journal of Venomous Animals and Toxins Including Tropical Diseases*. 2010;16:402-413
- [72] Fichi G, Flamini G, Giovanelli F, Otranto D, Perrucci S. Efficacy of an volatile oil of *Eugenia caryophyllata* against *Psoroptes cuniculi*. *Experimental Parasitology*. 2007;115:168-172
- [73] Koba K, Nenonene AY, Raynaud C, Chaumont JP, Sanda K. Antibacterial activities of the buds volatile oil of *Syzygium aromaticum* (L.) Merr. and Perry from Togo. *Journal of Biologically Active Products from Nature*. 2011;1: 42-51
- [74] Machado M, Dinis AM, Salgueiro L, Custódio JBA, Cavaleiro C, Sousa MC. Anti-Giardia activity of *Syzygium aromaticum* volatile oil and eugenol: Effects on growth, throughbility, adherence and ultrastructure. *Experimental Parasitology*. 2011;127: 732-739
- [75] Hseini S, Kahouadji A. Étude ethnobotanique de la flore médicinale dans la région de Rabat (Maroc occidental). *Lazaroa*. 2007;28: 79-93
- [76] Vyawahare NS, Deshmukh VV, Gadkari MR, Kagathara VG. Plants with antiulcer activity. *Pharmacognosy Reviews*. 2009;3:118-125
- [77] Geng S, Cui Z, Huang X, Chen Y, Xu D, Xiong P. Variations in volatile oil yield and composition during *Cinnamomum cassia* bark growth. *Industrial Crops and Products*. 2011;33: 248-252
- [78] Cheng SS, Liu JY, Tsai KH, Chen WJ, Chang ST. Chemical composition and mosquito larvicidal activity of volatile oils from leaves of several, *Cinnamomum osmophloeum* provenances. *Journal of Agricultural and Food Chemistry*. 2004;52: 4395-4400
- [79] Nerio LS, Olivero-Verbel J, Stashenko EE. Repellent activity of volatile oils from seven aromatic plants grown in Colombia against *Sitophilus zeamais* Motschulsky (Coleoptera). *Journal of Stored Products Research*. 2009;45:212-214
- [80] Vilela GR, de Almeida GS, Moraes MHD, Brito JD, Da Silva MF, Silva SC, et al. Activity of volatile 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*. 2009;45: 108-111
- [81] Ben-Arye E, Dudai N, Eini A, Torem M, Schiff E, Rakover Y. Treatment of upper respiratory tract infections in primary care: A randomized study using aromatic herbs. *Evidence-Based Complementary and Alternative Medicine*. 2011;7. Article ID 690346
- [82] Caballero-Gallardo K, Olivero-Verbel J, Stashenko EE. Repellent activity of volatile oils and some of their individual constituents against *Tribolium castaneum* Herbst. *Journal of*

Agricultural and Food Chemistry. 2011;
59:1690-1696

[83] Alexopoulos A, Kimbaris AC, Plessas S, Mantzourani I, Theodoridou I, Stavropoulou E, et al. Antibacterial activities of volatile oils from eight Greek aromatic plants against clinical isolates of *Staphylococcus aureus*. Anaerobe. 2011;17(6):399-402

[84] Sala H. Aromatherapy: Current and emerging applications. Alternative and Complementary Therapies. 2011;17:26-31

[85] Sabzghabae AM, Nili F, Ghannadi A, Eizadi-Mood N, Maryam AM. Role of menthol in treatment of candidial napkin dermatitis. World Journal of Pediatrics. 2011;7:167-170

[86] Kumar P, Mishra S, Malik A, Satya S. Insecticidal properties of *Mentha* species. Industrial Crops and Products. 2011;34:802-817

[87] Lee YL, Wu Y, Tsang WH, Leung AY, Cheung WM. A systematic review on the anxiolytic effects of aromatherapy in people with anxiety symptoms. The Journal of Alternative and Complementary Medicine. 2011;17: 101-108

[88] Hajhashemi V, Ghannadi A, Sharif B. Anti-inflammatory and analgesic properties of the leaf extracts and volatile oil of *Lavandula angustifolia* Mill. Journal of Ethnopharmacology. 2003;89:67-71

[89] Woronuk G, Demissie Z, Rheault M, Mahmoud S. Biosynthesis and therapeutic properties of *Lavandula* volatile oil constituents. Planta Medica. 2011;77:7-15

[90] Zuzarte M, Gonçalves MJ, Cavaleiro C, Canhoto J, Vale-Silva L, Silva MJ, et al. Chemical composition and antifungal activity of the volatile oils of *Lavandula viridis* L'Hér. Journal of Medical Microbiology. 2011;60: 612-618

[91] Van Vuuren SF, Suliman S, Viljoen AM. The antimicrobial activity of four commercial volatile oils in combination with conventional antimicrobials. Letters in Applied Microbiology. 2009;48:440-446

[92] Garozzo A, Timpanaro R, Bisignano B, Furneri PM, Bisignano G, Castro A. In vitro antiviral activity of *Melaleuca alternifolia*. Letters in Applied Microbiology. 2009;49:806-808

[93] Lobo R, Prabhu K, Shirwaikar A, Shirwaikar A, Ballal M. Formulation and evaluation of antiseptic activity of the herbal cream containing *Curcuma longa* and tea tree oil. Journal of Biologically Active Products from Nature. 2011;1:27-32

[94] Mickienė R, Bakutis B, Baliu Konienė V. Antimicrobial activity of two volatile oils. Annals of Agricultural and Environmental Medicine. 2011;18: 139-144

[95] Bacanlı PM, Başaran AA, Başaran N. The antioxidant and antigenotoxic properties of citrus phenolics limonene and naringin. Food and Chemical Toxicology. 2015;81:160-170

[96] Fisher K, Phillips C. Potential antimicrobial uses of volatile oils in food: Is citrus the answer. Trends in Food Science and Technology. 2008;19: 156-164

[97] Koul O, Walia S, Dhaliwal GS. Volatile oils as green pesticides: Potential and constraints. Biopesticides International. 2008;4:63-84

[98] Pavela R. Insecticidal properties of several volatile oils on the house fly (*Musca domestica* L.). Phytotherapy Research. 2008;22:274-278

[99] Pavela R. Insecticidal activity of some volatile oils against larvae of *Spodoptera littoralis*. Fitoterapia. 2005; 76:691-696