

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

6,900

Open access books available

186,000

International authors and editors

200M

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



Essential Oils

Lubna Abdul Muttalib Al-Shalah,

Nada Khazal Kadhim Hindi and Israa Harjan Mohsen

Abstract

Modern science has tended to use several natural substances that have little or no side effects in daily use or to treat many diseases. Among these materials are essential oils that represent one of the secondary metabolic products of many plants such as Terpenes and Terpenoids, Alkaloids, and the Phenolic compounds, which are extracted by special methods from different parts of the plants. Several applications were using the essential oils such as in the nutrition, cosmetic manufacture, and alternatives to synthetic medication that uses to treatment several infections and diseases as disinfection, as an anti-inflammatory, mouthwashes, as well as in cleaning and calm mood and pesticides. This review describes essential oils, methods of their extraction, and ways of utilization and their application.

Keywords: essential oils, extraction, health benefit, antibacterial activity

1. Introduction

Plants produce thousands types of chemicals materials and included two types of metabolites (primary and secondary). Primary metabolites are macromolecules like carbohydrates, fats, proteins, nucleic acids, chlorophylls, hemes this molecular are required for their basic metabolic processes [1] plants, fungi and bacteria of definite genera and families create a number of organic compounds which are not included in primary metabolism that important in essential activity of organism (photosynthesis, respiration, and protein and lipid metabolism) and seem to have no function in growth and development of them [2]. Such compounds are called secondary metabolites (secondary plant products or natural products), there are other name which known as Phytogenic feed additives (PFA) or phytobiotics and botanicals, are commonly defined as various plant secondary compounds (PSC) and metabolites with beneficial effects on animal health and production, including feed and animal products. These compounds are accessory rather than central to the functioning of the plants in which they are found. These compounds are produced in small quantities and their extraction from the plant is difficult and expensive.

There important product of plant secondary metabolites as natural products: Terpenes and Terpenoids (25,000 types), Alkaloids (12,000 types) and the Phenolic compounds (8000 types) [3].

Essential oils (EOs) represent a major group of phytogenic feed additives (PFA). Plant oils and extracts have been used for a wide variety of purposes for many thousands of years [4], Due to their strong aromatic features and bioactivity, EOs have been widely used since ancient times in aromatherapy, as flavor and fragrances in cosmetics and foods, and more recently as pharmaceuticals, natural preservatives, additives, and biopesticides [5–7]. There are many defines of EO, like EO is a

mixture of low molecular weight constituents that are responsible for its characteristic aroma, or Essential oils are concentrated liquids of complex mixtures of volatile compounds and can be extracted from several plant organs [8]. The chemistry of EO constituents includes terpenoid and non-terpenoid hydrocarbons and their oxygenated derivatives [5, 9, 10]. Essential oils are concentrated plant extracts that retain the natural smell and flavor, or “essence,” of their source. Essential oils, also called volatile odoriferous oil, are aromatic oily liquids extracted from different parts of plants, for example, leaves, peels, barks, flowers, buds, seeds, and so on [11].

They may be found in different parts of the plant. Some EOs could be found in leaves (oregano), seed (almond), flower (jasmine), peel (bergamot), berries (juniper), rhizome (galangal ginger), root (angelica archangelica), bark (sassafras), wood (agar wood), resin (frankincense), and petals (rose) [12].

2. How do essential oils work

Essential oils include biological compounds like growth factors, hormones, and neurotransmitters that are concentrated from the plant. Several researches have been performed on PEOs in order to confirm their biological efficacy against bacteria and fungi [13]; PEOs have an antibacterial activity where they cause damage to cells via an interface with plasma membrane components which lead to leak the most important compounds and damage the transportation channels, especially of potassium ion [12, 13]. Volatiles from PEOs not only work on single target site in the cell but also they bind to protein structures of the cell. Some of the PEOs and their volatiles are found to be responsible in inhibiting the enzymatic proteins in some bacterial pathogens [14–16].

Essential oils used all over the world for disinfection, as anti-inflammatory, relaxing, and stimulating substances, and with potential and modern exploitation in clinical medicine are most commonly used in the practice of aromatherapy, in which they are inhaled, or be swallowed, or can interact with your body in several ways when applied to your skin, some plant chemicals are absorbed also commonly used in food and cosmetic industries [17] (**Figure 1**).

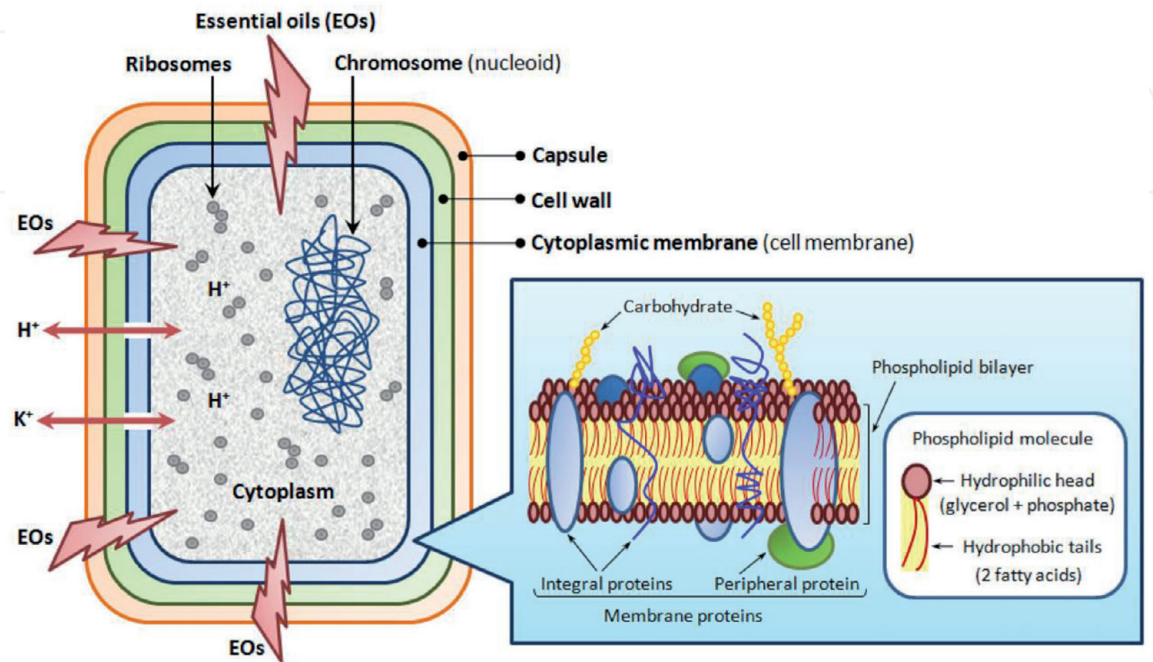


Figure 1. Schematic illustration for the effect of essential oils on bacteria cell. Source: Ref. [10].

3. Extraction of essential oils

Essential oils are produced from valuable plant products, generally of complex composition including the volatile principles contained in the plant and the more or less modified during the preparation process. The earliest recorded mention of the techniques and methods used to produce essential oils is believed to be that of Ibn al-Baitar (1188–1248). The oil droplets being stored in the oil glands or sacs can be removed by either accelerated diffusion through the cell wall or crush the cell wall [17–20]. The assumed techniques depend on the part of the plants where the oil is to be extracted, the stability of the oil to heat and susceptibility of the oil constituents to chemical reactions. An extract is derived when the plant material is soaked in a substance such as water, alcohol or other liquid for long periods of time so that its flavor, aroma or medicinal properties, infuses into the liquid [11].

Common techniques used for the extraction of essential oils are:

- Hydrodistillation
- Hydrodiffusion
- Effleurage
- Cold pressing
- Steam distillation
- Solvent extraction
- Microwave Assisted Process (MAP)
- Carbon dioxide extraction

3.1 Hydrodistillation

Hydrodistillation represents one of the most used traditional and a commonly methods of extraction used method of extracting essential oils from plant samples (wood and flower). This method may be further classified into the subcategories of steam distillation, water distillation, or a combination of water and steam distillation. Hydrodistillation include saturation of the powdered wood in the water in the first step, while the next step is to use the steam that result from the heating of the water reservoir then finally gather the oil that result after the reservoir cold. The advantage of this technique is that the required material can be distilled at a temperature below 100°C. there are many studies provided that the different extraction processes on yield and properties of essential oil from rosemary (*Rosmarinus officinalis* L.) by HD and solvent-free microwave extraction (SFME) [21]. While Golmakani and Rezaei (2008) [22] researched the microwave-assisted HD (MAHD), which is an advanced HD technique utilize a microwave oven in the extraction procedure.

MAHD was preferable in extraction time (75 min, compared to 4 h in HD). Ohmic-assisted HD (OAHD) is another advanced HD technique [23]. OAHD method had the extraction time of 24.75 min, while HD took 1 h for extraction of essential oil. No changes in the compounds of the essential oils obtained by OAHD were found in comparison with HD.

3.2 Hydro diffusion

Hydro Diffusion method for extraction of oils is a type of steam distillation and is only different in the way in which steam enters the container of the still. This method is preferred when the plant material has been dried and is not deteriorate at boiling temperature [24]. The steam in this method is drenched from the topmost onto the phytophagous matter and thus leads to impregnate the plants even more and less time. Hydrodiffusion method is superior to steam distillation because of shorter processing time and a higher oil yield with less steam used [11].

3.3 Steam distillation

One of the most widely used methods of extracting essential oils from their sources is steam distillation, and it is one of the preferred methods due to its low cost. In this method, the essential oil and aromatic components of the plant are gathered by utilize heating water or vapor and thus cause damage to plant cells and lead to release these materials [21, 25]. This method is applied in isolation of essential oils at temperatures approach to 100°C, and next with condensation to produce an immiscible fluid that can clarify it to isolate the oil, so it is used in the conservation of compounds that might rupture at elevated temperatures [23, 26, 27].

3.4 Solvent extraction

In this method, the extraction of the essential oil occur after utilization of a hydrocarbon solvent which is acts as dissolving material when added to the plant and leads to the formation of mixture contain the essential oil with other material. The next step includes purification by concentration and filtration of the mixture and then added of absolute alcohol that when evaporate left the oil behind it. This method represents the best in the formation of big amounts from the product oil because of the least display to high temperatures or air but on the other hand the residue that results by the way after the extraction had bad effects on the health and immunity [28].

3.5 Cold pressing

Uses large machinery to either grind the seeds/fruits to squeeze out the oil or pierce the rind and peel of the fruit while it is rotating to extract the oil. Cold pressing is used to extract the essential oils from citrus rinds such as orange, lemon, grapefruit and bergamot. In this method the heat is generated internally where it result from the revolving of the mixture and the friction lead to disconnect of the oil from the mixture and the next step include filtration of the oil to discard any residue and ensure the purification process [29].

3.6 Enfleurage

An intense and classical method of elicit essential oil from petals of flowers. The procedure includes coating fats above petals of the flower which act on the soak up the oils, and then utilize alcohol to isolate the essential oils from the fat, then let alcohol be evaporated and thus the essential oils are gathered [29].

3.7 Carbondioxide extraction

This method is traditional where it uses the liquid CO₂ via pressurized it and the essential oils of the plants dissolved in this liquid. The next step includes return

back of CO₂ to the state of gases thus gathered left the oil, so the positive feature of this method was kept the essential oil from damage by high temperatures [29].

4. List of essential oils

This list is organized alphabetically by the common essential oil name (Table 1).

NO.	Essential oils	NO.	Essential oils
1	Allspice (Pimento Berry, Jamaica Pepper)	23	Cassia
2	Amyris (Torchwood, West Indian Sandalwood)	24	Catnip
3	Angelica Root	25	Cedarwood Atlas
4	Anise (Aniseed)	26	Cedarwood Himalayan
5	Arborvitae (Western Red Cedar)	27	Cedarwood Virginian
6	Balsam Peru (Peru Balsam)	28	Celery Seed
7	Basil (Sweet Basil, Basil Linalool)	29	Cilantro (Coriander Leaf)
8	Bay Leaf	30	Cinnamon Bark
9	Bergamot	31	Cinnamon Leaf
10	Bergamot Mint	32	Cistus (Labdanum, Rock Rose)
11	Birch (Sweet Birch)	33	Citronella
12	Black Pepper	34	Clary Sage
13	Black Spruce	35	Clementine
14	Blue Cypress Blue Tansy	36	Clove Bud
15	Buddha Wood (Desert Rosewood)	37	Coffee
16	Blue Tansy (Moroccan Blue Chamomile)	38	Copaiba (Copaiba Balsam)
17	Cajeput (Cajuput, White Tea Tree)	39	Coriander Seed
18	Camphor (White Camphor, Camphor Laurel)	40	Cumin
19	Cannabis	41	Cypress
20	Caraway Seed	42	Davana
21	Carrot Seed	43	Dill Weed/Dill Seed
22	Cardamom	44	Douglas Fir
NO.	Essential oils	NO.	Essential oils
45	Elemi	73	Juniper Berry (Juniper)
46	<i>Eucalyptus dives</i>	74	Key Lime
47	<i>Eucalyptus globulus</i>	75	Kunzea
48	<i>Eucalyptus radiata</i>	76	Labdanum
49	<i>Eucalyptus smithii</i>	77	Laurel Leaf (Bay Leaf, Bay Laurel, Sweet Bay)
50	Everlasting (see Helichrysum)	78	Lavandin
51	Fennel (Sweet Fennel)	79	Lavender
52	Fir Balsam (Canadian Fir Needle)	80	Lavender (Spike Lavender)

NO.	Essential oils	NO.	Essential oils
53	Fir Needle (Siberian Fir)	81	Lemon Balm
54	Frankincense (Olibanum)	82	Lemon Eucalyptus
55	Galangal Root (Greater Galangal, Siamese Ginger)	83	Lemongrass
56	Galbanum	84	Lemon Myrtle
57	Geranium	85	Lemon Tea Tree
58	Geranium Bourbon	86	Lime Expressed
59	German Chamomile (Blue Chamomile)	87	Lime Distilled
60	Ginger	88	Mandarin
61	Gingergrass	89	Manuka (New Zealand Tea Tree)
62	Goldenrod	90	Marjoram (Sweet Marjoram)
63	Grapefruit	91	May Chang (Litsea)
64	Helichrysum (Everlasting, Immortelle)	92	Melaleuca
65	Hemlock (Spruce Hemlock, Tsuga)	93	Melissa (Lemon Balm)
66	Hemp (Cannabis)	94	Mountain Savory (Winter Savory)
67	Ho Leaf	95	Myrrh
68	Ho Wood	96	Myrtle
69	Hyssop	97	Neroli (Orange Blossom)
70	Immortelle	98	Niaouli
71	Jack Pine	99	Nutmeg
72	Jasmine Absolute	100	Opoponax (Sweet Myrrh, Opopanax)
NO.	Essential oils	NO.	Essential oils
101	Orange (Blood Orange)	127	Spearmint
102	Orange Blossom	128	Spikenard (Nard, Jatamansi)
103	Orange (Sweet Orange, Wild Orange)	129	Spruce Hemlock
104	Oregano	130	Star Anise
105	Palmarosa	131	Sweet Myrrh
106	Palo Santo	132	Tangerine
107	Patchouli	133	Tarragon
108	Peppermint	134	Tea Tree
109	Petitgrain	135	Thyme (Thyme Linalool,Thyme Thymol)
110	Pine (Scotch Pine, Scots Pine)	136	Tsuga
111	Pink Pepper	137	Turmeric
112	Plai	138	Valerian
113	Ravensara	139	Vanilla Absolute (Vanilla Oleoresin)
114	Ravintsara (Ho Leaf)	140	Verbena (Honey Verbena, Wild Verbena)
115	Rock Rose	141	Vetiver
116	Rosalina (Lavender Tea Tree)	142	White Fir
117	Rose Absolute (Rose Otte, Bulgarian Rose, Damask Rose)	143	Wintergreen

NO.	Essential oils	NO.	Essential oils
118	Rose Absolute (Provence Rose, Cabbage Rose)	144	Winter Savory
119	Rose Geranium	145	Yarrow
120	Rosemary	146	Ylang Ylang
121	Rosewood (Bios de Rose)	147	Yuzu
122	Sage (Dalmatian Sage, Common Sage)		
123	Sandalwood		
124	Saro (Mandravasarotra)		
125	Siberian Fir		
126	Silver Fir (Silver Fir Needle, Silver Spruce, White Fir)		

Table 1.
The most common name of the essential oil.

4.1 The application of oils essential

There were several applications using the essential oils such as in the nutrition, cosmetic manufacture and alternatives to synthetic medication that uses to treatment several infections and diseases [28]. Essential oils were used all over the world for disinfection, as anti-inflammatory, relaxing, and stimulating substances, and with potential and modern exploitation in clinical medicine and oil can act as antibacterial agent against a wide spectrum of pathogenic bacteria strains including: *Listeria monocytogenes*, *Listeria Linnocua*, *Salmonella typhimurium*, *Shigella dysenteriae*, *Bacillus cerus*, and *Staphylococcus aureus*. Mouth washes containing essential oils could also be used as part of plaque-control routine since they can penetrate the plaque biofilm and kill pathogenic-wall. It is also had antibacterial activity especially versus the pathogenic bacteria in dental and mouth and this feature help in adding the essential oil in washes of the mouth to keep the oral health and improve the odor of mouth, especially when mixed with chlorhexine gluconate which is an act in preventing the transmission of pathogenic bacteria.

Essential oil with high concentration of thymol and carvacrol e.g., oregano, savory and thyme, usually inhibit gram positive more than gram-negative pathogenic bacteria. However the antibacterial activity against gram- negative *Haemophilus influenza* and *Pseudomonas aeruginosa* respiratory pathogens, while gram-positive streptococcus pyrogens was the most resistant to the oil.

Recently, the sciences show several danger effects of the synthetic flavoring and preservatives materials in the food onto the human health so they directed to utilize alternatives such as essential oils as natural materials for its features in preservatives the food for long time, antibacterial effects, and decrease food deterioration [29]. Pathogenic microbes in storage food or food products are responsible to degrade or deteriorate the quality of food products, resulting in the emerging foodborne diseases in various regions of the world [30]. It is well known that some essential oils exert antimicrobial and antioxidant properties. Significant variations in the chemical composition of rosemary essential oils have been reported in relation to the geographic origin [27, 28]. Moreover, variations in the antioxidant and antimicrobial properties of rosemary oils from natural populations were also detected. Its applications are represented in the medicinal and therapeutics, such as aromatherapy, phytotherapy, antibacterial and antifungal uses, hypolipidemic, antitumor, etc.

5. Ways of utilization

The chemical structure of the essential oils is different from one the other and this feature influences their utilization ways and leads to variation in their absorption and the ways of their uses by the body. So, essential oils are generally used in four ways as follows.

5.1 Aromatically

In this way, the oils are inhaled via diluted and then using the diffuser which is act on lightening the oil and make it easy to broad into the air so, this help in treated the external respiratory passage, improve the emotional and mental state and decrease of anxiety, where some researches indicated that the inhalation of some essential oils such as lavender act as quite sedatives where it incorporated with cells of the brain via the receptors of smell or have effects on some hormones and enzymes and do its works as a relaxer, Uplifting Mood, Calm Mood and Meditation [31, 32].

5.2 Topically

This method includes applying the essential oil on the skin where it is absorbed easily. Some oils must be diluted before using while others need a carrier oils. The topical ways used in the support of stress when it used in massage and also it is used in the beauty products such as lotions and wax, but it may cause allergies to some peoples who suffering from skin sensitive so must be careful when using it and applied in small area of the skin after taking advice of the physician [32].

5.3 Internally

Some essential oils have medication features when ingested orally, that is, it act internally where it transported via the stream of blood to various parts of the body, they may acts as an anti-inflammatory, treats digestive disorders, improves digestion, and as a gas expeller. Efficient ways of internal implementation are by mixed the essential oils with some water or milk or by ingesting it as a capsule or in cooking [32].

5.4 Externally

The external way that uses essential oils (i.e., around the home) such as cleaning the home or dishes by add drops from the oil with the cleaning product for its activity as detergents, more effective in cleaning clothes, add nice smell and some act as expeller of insects [32].

6. Conclusions

Essential oils are natural substances extracted from several parts of plants by various methods. They are safe as food preservatives because they do not have side effects on human health. In addition, its bactericidal characteristics encourage utilizing them as medications and in beauty care products.

IntechOpen

Author details

Lubna Abdul Muttalib Al-Shalah¹, Nada Khazal Kadhimi Hindi^{2*}
and Israa Harjan Mohsen²

¹ University of Babylon, Babylon Province, Iraq

² Department of Basic and Medical Science, College of Nursing, University of Babylon, Babylon Province, Iraq

*Address all correspondence to: nadakhzal@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] Abdollahi M, Salehnia A, Mortazavi S. Antioxidant, antidiabetic, antihyperlipidemic, reproduction stimulatory properties and safety of essential oil of *Satureja khuzestanica* in rat in vivo. *Medical Science Monitor*. 2003;**9**:331-335
- [2] Pagare S, Bhatia M, Tripathi N, Pagare S, Bansal YK. Secondary metabolites of plants and their role: Overview. *Current Trends in Biotechnology and Pharmacy*. 2015;**9**(3):293-304
- [3] Hamid AA, Aiyelaagbe OO, Usman LA. Essential oils: Its medicinal and pharmacological uses. *International Journal of Current Research*. 2011;**33**(2):086-098
- [4] Hammer KA, Carson CF, Riley TV. Antimicrobial activity of essential oils and other plant extracts. *Journal of Applied Microbiology*. 1999;**86**:985-990
- [5] Bakkali F, Averbeck S, Averbeck D, Idaomar M. Biological effects of essential oils -a review. *Food and Chemical Toxicology*. 2008;**46**:446-475
- [6] Suryawanshi MA, Mane VB, Kumbhar GB. Methodology to extract essential oils from lemongrass. In: *Leaves: Solvent Extraction Approach*. IRJET. 2012;**3**:1775-1780
- [7] Aspen Leave a Comment. What is the difference between essential oil and extract (Active Ingredients from Aromatic and Medicinal Plants); 2016
- [8] Tripathi AK, Upadhyay S, Bhuiyan M, Bhattacharya PR. A review on prospects of essential oils as biopesticide in insect-pest management. *Journal of Pharmacognosy and Phytotherapy*. 2009;**1**(5):52-63.
- [9] Bajpai VK, Baek KH, SCH K. Review control of *Salmonella* in foods by using essential oils: A review. *Food Research International*. 2012;**45**(2012):722-734
- [10] Tongnuanchan P, Benjakul S. Essential oils: Extraction, bioactivities, and their uses for food preservation. *Journal of Food Science*. 2014;**79**(7):1231-1249
- [11] Burt SA. Essential oils: Their antibacterial properties and potential applications in foods—A review. *International Journal of Food Microbiology*. 2004;**94**:223-253
- [12] Cox SD, Mann CM, Markham JL, Bell HC, Gustafson JE, Warmington JR, et al. The mode of antimicrobial action of essential oil of *Melaleuca alternifolia* (tea tree oil). *Journal of Applied Microbiology*. 2000;**88**:170-175
- [13] Lambert RJW, Skandamis PN, Coote P, Nychas GJE. A study of the minimum inhibitory concentration and mode of action of oregano essential oil, thymol and carvacrol. *Journal of Applied Microbiology*. 2001;**91**:453-462
- [14] Juven BJ, Kanner J, Schved F, Weisslowicz H. Factors that interact with the antibacterial action of thyme essential oil and its active constituents. *The Journal of Applied Bacteriology*. 1994;**76**:626-631
- [15] Sikkema J, De Bont JAM, Poolman B. Mechanisms of membrane toxicity of hydrocarbons. *Microbiological Reviews*. 1995;**59**(2):201-222
- [16] Wendakoon CN, Sakaguchi M. Inhibition of amino acid decarboxylase activity of *Enterobacter aerogenes* by active components in spices. *Journal of Food Protection*. 1995;**58**(3):280-283

- [17] Firenzuoli F, Jaitak V, Bassolé IHN, Horvath G, Setzer WN, Gori L. Essential oils: New perspectives in human health and wellness evidence-based complementary and alternative medicine. 2014;**2014**:467363. DOI: 10.1155/2014/467363
- [18] Rao VPS, Pandey D. Extraction of essential oil and its applications. In partial fulfillment of the requirements of Bachelor of Technology. Chemical Engineering. 2006
- [19] Okoh OO, Sadimenko AP, Afolayan AJ. Comparative evaluation of the antibacterial activities of the essential oils of *Rosmarinus officinalis* L. obtained by hydrodistillation and solvent free microwave extraction methods. Food Chemistry. 2010;**120**:308-312
- [20] Golmakani M-T, Rezaei K. Comparison of microwave-assisted hydrodistillation with the traditional hydrodistillation method in the extraction of essential oils from *Thymus vulgaris* L. Food Chemistry. 2008;**109**:925-930
- [21] Perineau F, Ganou L, Vilarem G. Studying production of lovage essential oils in a hydrodistillation pilot unit equipped with a cohabitation system. Journal of Chemical Technology and Biotechnology. 1992;**53**:165-171
- [22] Gavahian M, Farahnaky A, Javidnia K, Majzoobi M. Comparison of Ohmic-assisted hydrodistillation with traditional hydrodistillation for the extraction of essential oils from *Thymus vulgaris* L. Innovative Food Science and Emerging Technologies. 2012;**14**:85-91
- [23] Donelian A, Carlson LHC, Lopes TJ, Machado RAF. Comparison of extraction of patchouli (*Pogostemon cablin*) essential oil with supercritical CO₂ and by steam distillation. Journal of Supercritical Fluids. 2009;**48**:15-20
- [24] Vian MA, Fernandez X, Visinoni F, Chemat F. Microwave hydrodiffusion and gravity, a new technique for extraction of essential oils. Journal of Chromatography. A. 2008;**1190**:14-17
- [25] Babu KGD, Kaul VK. Variation in essential oil composition of rose-scented geranium (*Pelargonium* sp.) distilled by different distillation techniques. Flavour and Fragrance Journal. 2005;**20**:222-231
- [26] Guan W, Li S, Yan R, Tang S, Quan C. Comparison of essential oils of clove buds extracted with supercritical carbon dioxide and other three traditional extraction methods. Food Chemistry. 2007;**101**:1558-1564
- [27] Farhat A, Fabiano-Tixier A-S, Maataoui ME, Maingonnat J-F, Romdhane M, Chemat F. Microwave steam diffusion for extraction of essential oil from orange peel: Kinetic data, extract's global yield and mechanism. Food Chemistry. 2011;**125**:255-261
- [28] Morsy NFS. Chemical structure, quality indices and bioactivity of essential oil constituents. 2017. DOI: 10.5772/66231
- [29] Fern J, Viuda-Martos LM. Application of essential oils in food systems. Foods. 2017;**6**:59
- [30] Jeffrey, Slater V. Guide to aromatherapy & essential oils. International Research Journal of Engineering and Technology (IRJET). 2016;**3**(08):2395-2472
- [31] Available from: <http://www.umm.edu/health/medical/altmed/treatment/aromatherapy>
- [32] Available from: www.sustainablebabysteps.com