



NATURAL SOURCES OF ESSENTIAL OILS AND THEIR PROPERTIES: A SYSTEMIC REVIEW

Ela Srivastava*, Priyanka Mathur

Applied Science and Life Science, Bhagwant University, Ajmer, Rajasthan, India

e-mail: researchpub.phd2021@gmail.com*, drpriyanka.mathurji@gmail.com

Abstract : This study aim to list most popular natural sources of essential oils and their properties i.e. applied method for oil extraction of oil, major components, odour uses and their applications. Since, essential oils have received a growing interest due to the high potential of their novel properties i.e. fragrant raw material for numerous products e.g. tooth paste, toilet soap, hand wash, shampoos, hair oils, bath soap, cosmetic products, floor cleaner, mosquito repellents, incense sticks, food products, therapeutic products, herbal medicines etc. Therefore, it is important to know the characteristics before the applying in particular products. It will be very helpful in the creation of new products with good quality. Simultaneously, it will be helpful for researchers, scientist, entrepreneurs, farmers and industries for creation of new perfumery products.

Keywords: Essential oils, Composition, Distillation, Odour

1. INTRODUCTION




Essential oils (EOs) are volatile odoriferous oils and secondary metabolites obtained from the volatile part of aromatic plants and are used by the plants as a defence mechanism against herbivore attacks [1]. They are complex concentrated mixtures of hydrophobic liquids constituted by terpenoid hydrocarbons, oxygenated terpenes, and sesquiterpenes and are responsible for their characteristic aroma. The components of plant essential oils are differentiated into two distinct chemical classes: terpenes and phenylpropanoids. Terpene compounds can be divided into mainly the mono-, sesqui-, and diterpenes, and their oxygenated derivatives, for instance, alcohols, oxides, aldehydes, ketones, phenols, acids, esters, and lactones [2]. The composition of essential oils shows high variability due to intrinsic factors related to plants (environment, maturity of plant, harvest time) and extrinsic factors related to the extraction method and environment [3].









Essential oils can be obtained from different parts of plants, including flowers (rose), leaves (peppermint), fruits (lemon), seeds (fennel), grasses (lemongrass), roots (vetiver), rhizomes (ginger), wood (cedar), bark (cinnamon), gum (frankincense), tree blossoms (ylang-ylang), bulbs (garlic), and dried flower










buds (clove), etc. [4]. They have been in existence for many years but their inspiration and natural abilities in day-to-day life have increased their study and experimental activities. Though, before essential oils can be used or analysed, they have to be extracted from the plants. Different methods that can be used to extract essential oils from aromatic plants, include steam distillation, hydro-distillation, organic solvent extraction, expression, enfleurage, microwave-assisted distillation, microwave hydro diffusion and gravity, high-pressure solvent extraction, supercritical carbon dioxide extraction, ultrasonic extraction, solvent-free microwave extraction, and the phytonic process [5-6]. Commercially, steam distillation is a preferred method for the extraction of essential oils [7].









Distillation is often performed by using the Clevenger, Dean-Stark, or Likens–Nikerson apparatus by continued heating and stirring in water or a solvent [8]. The time period of distillation depends on the plant material and is about 3-4 hours [9] Dhifi, W., et.al., 2016). To study the properties of essential oils and their composition, it is mainly conducted by gas chromatography-mass spectrometry (GC-MS), because chemical constituents are the major factors that influence the various properties of essential oils, obtaining accurate and detailed data of chemical constituents allow researchers to study the properties of essential oils more clearly [10]. Around 3000 essential oils have been produced from at least 2000 plant species, out of which 300 are important commercially [11]. These oils are used widely in cosmetics, and perfumes due to their sweet smell and in medicine, because they show antioxidant, antiproliferative, and antimicrobial activity [12]. They can also be used as substitutes for antibiotics [13], and have proven to be effective in a wide range of applications by decreasing the growth of pathogen microorganisms [14], or by displaying activity against antibiotic-resistant bacteria and chemotherapeutic-resistant tumors [15]. They are used to give flavour and fragrance in the food and cosmetics industries, where numerous herbal and spice ingredients are components in the manufacture of skin creams, lip balms, shampoos, soaps and perfumes [16]. This literature review aims to list most popular natural sources of essential oils and their properties (Table 1).








Table 1: List of natural sources of essential oils and their properties









S.No	Name	Photograph	Source	Extraction Method	Major Components	Odour	Uses	Reference
1.	Patchouli (Pogostemon Cablin)		Leaves	Hydro Steam Distillation	Germacrene, Sesquiterpene alcohol, Patchouli alcohol	Woody, Sweet, spicy	Relieving depression, Controlling appetite	[17]
2.	Roman Chamomile (Chamaemelum nobile)		Flowers	Steam Distillation	Terpenoids, Chamazulene, Bisabolol	Fresh, Sweet, Fruity, Slightly milky	Nausea Vomiting, Upset stomach	[18]
3.	Rosemary (Salvia Rosmarinus)		Leaves & Flowers	Hydro Distillation	p-cymene (44.02%), linalool (20.5%), gamma-terpinene (16.62%),	woody	Improve memory, Boost immunity	[19]

4.	Peppermint (Mentha Piperita)		Leaves	Hydro Steam Distillation	Menthol (40.7%), Menthone (23.4%)	Minty fresh, cool	Improve bowel syndrome, Common cold	[20]
5.	Ajwain (Trachyspermum ammi)		Seeds	Steam Distillation	Thymol (39.1%), oleic acid (10.4%), linoleic acid (9.6%), gamma-terpinene (2.6%)	Warm, Spicy, Pungent	Lowers blood pressure, Infection prevention	[21]
6.	Geranium (Pelargonium Graveolens)		Leaves	Hydro Steam Distillation	citronellol (37.5%), geraniol (6.0%), caryophyllene oxide (3.7%), menthone (3.1%), linalool (3.0%)	Sharp, herbaceous, green scent	Perfumery, blood disorder	[22]
	Clary Sage (Salvia Sclarea)		Leaves	Hydro Steam Distillation	linalyl acetate (34.62%), β -linalool (17.67%), α -muurolene (8.27%)	Sweet, herbaceous fresh tobacco	Anti-microbial, acne, wrinkle	[23]
8.	Vana Tulsi (Ocimum Tenuiflorum)		Leaves	Hydro Steam Distillation	Oleanolic acid, eugenol, linalool, carvacol	Clove scent, spicy	Cough, cold, fever, normalise BP	[24]
9.	Wild mint (Mentha Arvensis)		Leaves	Hydro Steam Distillation	Menthol (77.94%), isomenthone (5.24%), neomenthyl acetate (5.18%), menthone (5.00%)	Minty smell	Diarrhea, menstrual cramps	[25]
10.	Eucalyptus (Eucalyptus Globulus)		Leaves	Hydro Steam Distillation	Eucalyptol (51.62%), α -pinene (23.62%), p-cymene (10%), β -myrcene (8.74%), Terpinen-4-ol (2.74%) and γ -terpinene (2.59%)	Minty, camphorous scent	Nasal congestion, asthma, tick repellent	[26]
11.	Lemongrass (Cymbopogon flexuosus)		Leaves	Hydro Steam Distillation	Citral-a (33.1%), Citral-b (30.0%), Geranyl Acetate (12.0%) and Linalool (2.6%)	Citrusy scent (powerful)	Fighting bacteria, treating stomach ache	[27]



12.	Vetiver (Chrysopogon zizanioides)		Poppy flower	Hydro Distillatio	valerenol (18.48%), valerenal (10.21%), β - Cadinene (6.23%)	Dry, earth y, woddy, leathery, s moky	Skincell regenerat ion, blemi shes, acne removal	[28]
13.	Citronella (Cymbopogon Nardus)		Leaves & stems	Hydro Steam Distillation	Citronellal (5- 15%), Geraniol(18- 20%), Geranyl Acetate(2%), Citronellol(6- 8%)	Grassy, flowery smell	Insect repellent, anti- fungal agent, par asitic infection	[29]
14.	Tea tree (Melaleuca Alternifolia)		Leaves & stems	Hydro Steam Distillation	terpinen-4-ol, γ -terpinene, and α - terpinene	Fresh, camphor ous odour	Treating athletes foot, lice, nail fungus, in sect bites	[30]
15.	Lavender (Lavendula)		Leaves & stems	Hydro Steam Distillation	linalool, linalyl acetate, 1,8-cineole, β - ocimene, terpinen-4-ol, and camphor	Floral, fre sh, sweet, camphor, slightly fruity	Control nausea, v omiting, b oost immune system	[31]
16.	Jama Rosa (Cymbopogon Jwarancusa)		Leaves	Hydro Steam Distillation	Piperitone 33.05%, Geraniol 20.30%, 4- Carene 16.9%, γ -terpinen 6.5%, β - Piniene 3.5%	Rosy, gra ssy, terpe nic	Used for skin care	[32]
17.	Palma Rosa (Cymbopogon martini)		Leaves	Steam Distillation	Geraniol (79.19%), Geranyl Acetate (9.15%), And Linalool (3.64%)	Lemony, fresh, grassy	Aids disgestio n, boosts respirator y system	[33]
18.	Musk Dana (Abelmoschus Moschatus)		Seeds	Hydro Steam Distillation	Palmitic acid(20%), Oleic acid(20- 25%), Linoleic acid(50-57%), Stearic acid(2.5-4%)	Sweet, flo wery	Stomach & intestinal disorder, constipati on, nausea, stomach cancer	[34]
19.	Nagar Motha (Cyperus Scariosus)		Roots	Steam Distillation	Cyperene, Cyperenone, Cyperol, Cyperolone, Myristic-acid, Oleanolic-acid, Oleanolic-acid- 3- oneohesperidos ide, Oleic-acid	Warm, wo ody, spic y, narcoti c	Home remedy for managin g stomach disorder	[35]
20.	Kewra (Pandanus Odorifer)		Flowers	Hydro Distillation	terpinen-4-ol, α -terpineol and 2-phenyl ethyl alcohol	Sweet perfumed , similar to rose	Combat acne, dry skin, peeli ng in psoriasis	[36]

21.	Sandalwood (Genus Santalum)		Woods	Steam Distillation	α -Santalol and β -santalol and santenone	Floral, soft sweet balsamic	Headache, stomachache, urinary disorder	[37]
22.	Cinnamon (Cinnamomum Zeylanicum)		Leaves & bark	Hydro Steam Distillation & Steam Distillation	Leaves: Cinnamaldehyde (1-5%) Eugenol (70-95%) Barks: Cinnamaldehyde (65-80%) Eugenol (5-10%)	Warm, woody, spicy	Reduces feeling of depression, faintness, exhaustion	[38]
23.	Clove (Syzygium Aromaticum)		Leaves & buds	Hydro Steam Distillation	eugenol (76.8%), followed by β -caryophyllene (17.4%), α -humulene (2.1%), and eugenyl acetate (1.2%)	Sweet, spicy, nutmeg, woody	Anti-microbial, helps in digestion, sagging of skin	[39]
24.	Dill (Anethum Sowa)		Seeds & leaves & stems	Hydro Steam Distillation	carvone, limonene, α -phellandrene, β -phellandrene and p-cymene	Herbal, green, spicy	Menstrual cramps, aging skin, maintains cholesterol	[40]
25.	Java Citronella (Cymbopogon winterianus)		Leaves	Hydro Steam Distillation	Beta-Citronellal (21.59%), cis-geraniol (34.27%), Linalool, elemol	Crisp lemony aroma	Insect repellent, anti-fungal, lifts up mood	[41]
26.	Cumin Seed (Cuminum Cuminum)		Seeds	Steam Distillation	p-cymene and gamma-terpinene, cuminaldehyde, isomeric menthadien carboxaldehydes	Woody, pleasant spicy	High blood pressure, diarrhea, dysentery, digestive tract condition	[42]
27.	Neroli (Citrus Aurantium)		Flowers of bitter orange	Hydro Distillation	linalool (34.4%), linalyl acetate (11.3%) and limonene (10.9%)	Floral, citrus, green	Combats anxiety, treats acne, normalizes BP, lowers inflammation	[43]
28.	Basil (Ocimum Basilicum)		Leaves	Hydro Steam Distillation	methyl cinnamate (70.1%), linalool (17.5%), β -elemene (2.6%) and camphor (1.52%)	Herbal, green, leafy	Stomach Spasms, intestinal gas, colds, warts	[44]

29.	Rosewood (Dalbergia Sisoo)		Woods	Steam Distillation	linalool (87.93%), α - terpineol (2.9%), cis- linalool oxide (1.0-1.68%), translinalool oxide (0.90- 1.60%)	Rose like, sweet	Removes stretch marks, cough,an ti-fungal, anti- bacterial	[45]
30.	Sweet Orange (Citrus Sinesis)		Rind	Steam Distillation	limonene(77.4 9%), myrcene (6.27%), α - farnesene (3.64%), γ - terpinene (3.34%) [21,22], α - pinene (0.5- 2.4%), linalool(1.2- 0.9%)	Summery , warm	Reduces pain, relives stomach upset, natural househol d cleaner	[46]
31.	Ginger (Zingiber Officinale)		Roots	Steam Distillation	6-gingerol, 8- gingerol, and 10-gingerol, zingerone, β - bisabolene, α - curcumene, zingiberene	Strong warm,spi cy	Boosts digestion , enhance appetite	[47]
32.	Artemisia (Artemisia Absinthium)		Leaves	Hydro Steam Distillation	1,8-cineole, <u>camphor</u> , <u>linal ool</u> , thujone, myrcene, Beta- pinene	Herbal,gr een	Cures Cold, cough,di abeties,h earthburn, asthma	[48]
33.	Marigold (Tagetes)		Flowers	Hydro Distillation	limonene, α - pinene, β - pinene, terpinolene, (E)- β -ocimene, dihydrotagetone, tagetone, tagetone, β - caryophyllene, eugenol	Wet hay, straw,mu sky	Skin condition s,heal skin wounds, Helps in cancer,re duces body toxins	[49]
34.	Nutmeg (Myristica Fragrans)		Seeds	Steam Distillation	Sabinene(29.4 %), alpha- pinene(10.1%), beta- pinene(10.6%), limonene(3.6%)	Spicy, sweet,wo ody	Relives mental stress, eliminate d bad breath	[50]
35.	Turmeric (Curcuma Longa)		Roots	Steam Distillation	α -zingiberene (27.70–36.75 %), aromatic- turmerone (19.54–32.24 %), β - sesquiphelland rene (13.14– 18.23 %), α - turmerone (3.72–6.50 %), β -turmerone (2.86–5.60 %), β -bisabolene (2.50–3.46 %)	Haldi like, spicy	Skin rejuvenat or, facial masks, relives inflamma tion	[51]

36.	Tuberose (Polianthes Tuberosa)		Flowers	Hydro Distillation	methyl benzoate (30.17%), benzyl benzoate (23.64%), 7- decen-5-olide (13.33%), methyl salicylate (12.11%)	Floral, refreshin g, intense	Perfumes , relaxatio n, aromathe rapy	[52]
37.	Sugandh Mantri (Homalomena Aromatica)		Roots	Steam Distillation	linalool (62.5%), terpene-4-ol (7.08%), δ - cadinene (5.57%), α - cadinol (3.71%) and spatulenol (1.81%)	Pleasant spicy, refreshin g	Immune support, treating cold, injury	[53]
38.	Thyme (Thymus Vulgaris)		Flowers	Hydro Distillation	p-cymene (8.41%), γ - terpinene (30.90%) and thymol (47.59%)	Camphor like, rustic, fre sh, spicy	Germ killer in mouth- wash, boosts immunity , fights acne, anti- fungal	[54]
39.	Anise (Pimpinella Anisum)		Fruits	Steam Distillation	trans-anethole (82.1%), γ - himachalene (7.0%)	Sweet, clean, fresh	Upset stomach, runny nose	[55]
40.	Bergamot (Citrus Bergamia)		Rind	Steam Distillation	limonene (59.21%), linalool (9.51%), and linalyl acetate (16.83%)	Fruity, citrusy, floral hint	Lower choestro l, reduces inflamma tion, increase positive mood	[56]
41.	Bay (Laurus Nobilis)		Leaves	Hydro Steam Distillation	1,8-cineole (31.9%), sabinene (12.2%), and linalool (10.2%)	Medicina l, fruity, spi cy, herbaceo us	Anti- fungal, anti- viral, mouth sores, neuralgia s	[57]
42.	Jasmine (Jasmine Sambac)		Flowers	Hydro Distillation	benzyl acetate, linalool, benzyl alcohol, indole, benzyl benzoate, <i>cis</i> - jasmone, geraniol, methyl anthranilate	Floral scent	Improves mood, reduces stress, flavours in candy, ca ke	[58]
43.	German Chamomile (Matricaria Chamomilla)		Flowers	Hydro Distillation	α -Bisabolol oxide A (17.14%), Chamazulene (15.12%), En- in-dicycloether (6.22%), α -	Warm, herbaceo us, fruity(ap ple)	Wound healing, applied on skin, nervous & digesti ve	[59]

					Bisabolone oxide A (6.15%), n-Octanal (6.00%), α -Bisabolol oxide B (5.17%), 1,8-Cineole (3.86%)		systems	
44.	Davana (Artemisia Pallens)		Leaves & Flowers	Hydro Distillation	cis-Davanone (45.8%), bicyclogermacrene (9.6%), linalool (2.5%), caryophyllene oxide (2.2%), phytol (2.1%)	Sweet, exotic, floral, tad woody	High end perfumes, beautify skins	[60]
45.	Cedarwood (Cedrus Deodara)		Wood	Steam Distillation	thujopsene (47.1%), α -cedrol (10.7%), widdrol (8.5%) and cuparene (4.0%)	Woody, undertone of citrus	Acne treatment, pain relief, better sleep	[61]
46.	Iris (Iris Pallida)		Rhizome	Steam Distillation	myristic acid (56%), capric acid (14.50%), lauric acid (15.42%), α -irone (2.85%)	Skin like, smooth, buttery fresh baked	Anti-ageing, flavourous agent, body lotion	[62]
47.	Ylang Ylang (Cananga Odorata)		Flowers	Hydro Distillation	p-methylanisole, methyl benzoate, benzyl benzoate, benzyl acetate, geranyl acetate, cinnamyl acetate, (E,E)-farnesyl acetate, linalool, geraniol, benzyl salicylate	Slightly sweet, floral, jasmine like	Promotes relaxation, kills bacteria, kills head-lice, helps in memory & thinking	[63]
48.	Rose (Rosa Damascena)		Flowers	Hydro Distillation	citronellol (15.9-35.3%), geraniol (8.3-32.2%), nonadecane (4.5-16.0%), and heneicosane (2.6-7.9%)	Sweet, floral, honey-like	Rejuvenates skin, antioxidants, cures dry skin	[64]

49.	Monarda (Monarda Didyma)		Flowers	Hydro Distillation	thymol (59.3%), <i>p</i> - cymene (10.3%), terpinolene (9.2%), δ -3- carene (4.4%), myrcene (3.7%), and camphene (3.4%)	Sweet, citrus, floral	Anti- viral, Anti- fungal	[65]
50.	Firangipani (Plumeria)		Flowers	Hydro Distillation	α -cadinol (25.1%), germacrene-D- 4-ol (14.9%), γ -cadinene (11.8%) and α - muurolene (9.6%)	Sweetpea , sweet, bubblegu m	Headach e, backpain, relaxes nerves, muscles, anti- oxidants	[66]

CONCLUSION

This review reveals the parts of aromatic plants for extraction of essential oils, particular method for oil extraction, major percentage of components, odour profile and various applications i.e. cosmetics, food preservatives, etc. from the aromatic plants e.g. peppermint, rosemary, thyme, coriander, lemon, basil, fennel, grapefruit, tea tree, etc. The understanding of these aspects is necessary for providing optimal conditions to produce essential oils rich in compounds known for their biological activities as the results are of great interest also for the industries, scientists, researchers and new entrepreneurs of essential oils producers and products manufacturers.

REFERENCES:

1. Blowman, K., Magalhães, M., Lemos, M. F. L., Cabral, C., Pires, I. M., 2018. Anticancer Properties of Essential Oils and Other Natural Products. *Evid. Based. Complement. Alternat. Med.*, vol. 2018,
2. Moghaddam, M., Mehdizadeh, L., 2017. Chapter13-Chemistry of Essential Oils and Factors Influencing Their Constituents. In *Soft Chemistry and Food Fermentation; Elsevier*, 379–419.
3. Dhifi, W., Bellili, S., Jazi, S., Bahloul, N., Mnif, W., 2016. Essential Oils' Chemical Characterization and Investigation of Some Biological Activities: A Critical Review. *Medicines (Basel, Switzerland)*, 3(4), Article no. 25.
4. Tisserand, R., Young, R., 2013. Essential Oil Safety: A Guide for Health Care Professionals (2nd edition). *Elsevier Health Sciences*, United Kingdom. 5-22.
5. Farhat, A., Fabiano-Tixier, A.S., Visinoni, F., Romdhane, M., Chemat, F., 2010. A Surprising Method for Green Extraction of Essential Oil from Dry Spices: Microwave Dry-Diffusion and Gravity. *J. Chromatogr. A*, 1217 (47), 7345–7350.
6. Okoh, O. O., Sadimenko, A. P., Afolayan, A. J., 2010. Comparative Evaluation of the Antibacterial Activities of the Essential Oils of *Rosmarinus Officinalis* L. Obtained by Hydrodistillation and Solvent-Free Microwave Extraction Methods. *Food Chem.*, 120 (1), 308–312.
7. Masango, P., 2005. Cleaner Production of Essential Oils by Steam Distillation. *J. Clean. Prod.*, 13 (8), 833–839.
8. Zheljzkov, V. D., Cantrell, C. L., Tekwani, B., Khan, S. I., 2008. Content, Composition, and Bioactivity of the Essential Oils of Three Basil Genotypes as a Function of Harvesting. *J. Agric. Food Chem.*, 56 (2), 380–385.
9. Zheljzkov, V. D., Cantrell, C. L., Astatkie, T., Cannon, J. B., 2011. Lemongrass Productivity, Oil Content, and Composition as a Function of Nitrogen, Sulfur, and Harvest Time. *Agron. J.*, 103 (3), 805–812.
10. Chen, K., Zhang, M., Bhandari, B., Mujumdar, A.S., 2020. Edible flower essential oils: A review of chemical compositions, bioactivities, safety and applications in food preservation, *Food Research International* 139, Article Id 109809.
11. Djilani, A., Dicko, A., 2012. The therapeutic benefits of essential oils. *Nutr. Well-Being Health* 7, 155–179.

12. Pasiyas, I.N., Ntakoulas, D.D., Raptopoulou, K., Gardeli, C., Proestos, C., 2021. Chemical Composition of Essential Oils of Aromatic and Medicinal Herbs Cultivated in Greece—Benefits and Drawbacks. *Foods*, 10(10), Article No. 2354, 1-8.
13. Chaves, A.V.; He, M.L.; Yang, W.Z.; Hristov, A.N.; McAllister, T.A.; Benchaar, C., 2008. Effects of essential oils on proteolytic, deaminative and methanogenic activities of mixed ruminal bacteria. *Can. J. Anim. Sci.*, 88(1), 117–122.
14. Djilani, A., Dicko, A., 2012. The therapeutic benefits of essential oils. *Nutr. Well-Being Health* 7, 155–179.
15. Viktorová, J.; Stupák, M.; Rehorová, K.; Dobiasová, S.; Hoang, L.; Hajšlová, J.; Van Thanh, T.; Van Tri, L.; Van Tuan, N.; Ruml, T., 2020. Lemon Grass Essential Oil does not Modulate Cancer Cells Multidrug Resistance by Citral—Its Dominant and Strongly Antimicrobial Compound. *Foods*, 9(5), Article no. 585.
16. Safrudin, I., Maimulyanti, A., Prihadi, A. R. 2015. Effect of Crushing of Clove Bud (*Syzygium Aromaticum*) and Distillation Rate on Main Constituents of the Essential Oil. *American Journal of Essential Oils and Natural Products*, 2 (3), 12–15.
17. Mallappa Kumara Swamy, Uma Rani Sinniah, A Comprehensive Review on the Phytochemical Constituents and Pharmacological Activities of *Pogostemon cablin* Benth.: An Aromatic Medicinal Plant of Industrial Importance, *Molecules*. 20(5): 8521–8547, 2015.
18. Ompal Singh, Zakia Khanam, Neelam Misra, and Manoj Kumar Srivastava, Chamomile (*Matricaria chamomilla* L.): An overview, *Pharmacogn Rev.* 2011 Jan-Jun; 5(9): 82–95.
19. Mehmet Musa Ozcan 1, Jean-Claude Chalchat, Chemical composition and antifungal activity of rosemary (*Rosmarinus officinalis* L.) oil from Turkey, *Int J Food Sci Nutr.* 2008 Nov-Dec;59(7-8):691-8.
20. Erich Schmidt 1, Stefanie Bail, Gerhard Buchbauer, Ivanka Stoilova, Teodora Atanasova, Albena Stoyanova, Albert Krastanov, Leopold Jirovetz, Chemical composition, olfactory evaluation and antioxidant effects of essential oil from *Mentha x piperita*, *Nat Prod Commun.* 2009 Aug;4(8):1107-1
21. Gurdip Singh, Sumitra Maurya, C Catalan, M P De Lampasona, Chemical constituents, antifungal and antioxidative effects of ajwain essential oil and its acetone extract, *J Agric Food Chem.* 2004 Jun 2;52(11):3292-6.
22. Farukh S. Sharopov, Hanjing Zhang and William N. Setzer, Composition of geranium (*Pelargonium graveolens*) essential oil from Tajikistan, *American Journal of Essential Oils and Natural Products* 2014; 2 (2): 13-1.
23. Stanislava Tasheva, Vanya Gandova , Vanya Prodanova-Stefanova , Krasimira Marinova , Milen Dimov, Krasimira Dobрева and Albena Stoyanova, Investigation of the thermodynamic and thermal properties of clary sage (*Salvia sclarea* L.) essential oil and its main components, *E3S Web of Conferences* 286, 02003 (2021).
24. Hanaa A. Yamani, Edwin C. Pang, Nitin Mantri, and Margaret A. Deighton, Antimicrobial Activity of Tulsi (*Ocimum tenuiflorum*) Essential Oil and Their Major Constituents against Three Species of Bacteria, *Front Microbiol.* 2016; 7: 681.
25. Manpreet Kaur Makkar, Sunita Sharma, and Harleen Kaur, Evaluation of *Mentha arvensis* essential oil and its major constituents for fungitoxicity, *J Food Sci Technol.* 2018 Sep; 55(9): 3840–3844.
26. Ester Innocent, Francis Machumi, William Kisinza, Chemical composition of essential oils from *Eucalyptus globulus* and *Eucalyptus maculata* grown in Tanzania, *Scientific African* 12 (2021) e00758.
27. Somit Roy Chowdhury, P.K. Tandon & A.R. Chowdhury, Chemical Composition of the Essential Oil of *Cymbopogon flexuosus* (Steud) Wats. Growing in Kumaon Region, *Journal of Essential Oil Bearing Plants*, 588-593, 2013.
28. Andreea David, Fang Wang, Xiaoming Sun, Hongna Li, Jieru Lin, Peilei Li, and Gang Deng, Chemical Composition, Antioxidant, and Antimicrobial Activities of *Vetiveria zizanioides* (L.) Nash Essential Oil Extracted by Carbon Dioxide Expanded Ethanol, *Molecules*. 2019; 24(10): 1897.
29. N A Saputra, H S Wibisono, S Darmawan and G Pari, Chemical composition of *Cymbopogon nardus* essential oil and its broad spectrum benefit, *IOP Conf. Series: Earth and Environmental Science* 415 (2020) 012017.
30. Anton C de Groot 1, Erich Schmidt 2 Tea tree oil: contact allergy and chemical composition, *Contact Dermatitis*, . 2016 Sep;75(3):129-43
31. Marietta Białon Teresa Krzysko Lupicka, Ewa Nowakowska-Bogdan, Chemical Composition of Two Different Lavender Essential Oils and Their Effect on Facial Skin Microbiota *Molecules* 24(18):3270, 2019.
32. Chandan Prasad, Digvijay Singh, Omkar Shukla, U B Singh And Dr. Bhupendra Kumar Sarma, *Cymbopogon jwarancusa* - An important medicinal plant: A review, *The Pharma Innovation Journal* 2014; 3(6): 13-19.
33. Nafeesa Siddiqui & S. C. Garg, Chemical Composition of *Cymbopogon martinii* (Roxb.) Wats. var. *martini*, *Journal of Essential Oil Research*, Volume 2, 1990 - Issue 2.
34. Ashish Kumar and Jnanasha A C, Improved Cultivation practices for Muskdana, <https://www.biotecharticles.com/Agriculture-Article/Improved-Cultivation-practices-for-Muskdana-3932>.
35. Nafeesa Siddiqui, S. C. Garg, Chemical Composition of *Cymbopogon martinii* (Roxb.) Wats. var. *martini*, *Journal of Essential Oil Research*, Pages 93-94 , 2011.
36. V. K. Raina, Ajai Kumar, S. K. Srivastava, K. V. Syamsundar, A. P. Kahol, Essential oil composition of Kewda (*Pandanus odoratissimus*) from India, *Flavour and Fragrance Journal*, 2004, 434-436.
37. Rakesh Kumar, Nishat Anjum and Y.C. Tripathi, Phytochemistry And Pharmacology Of *Santalum Album* L.: A Review, *World Journal of Pharmaceutical Research*, 4, Issue 10, 1842-1876, 2015.

38. Pasupuleti Visweswara Rao and Siew Hua Gan, Cinnamon: A Multifaceted Medicinal Plant, Evidence-Based Complementary and Alternative Medicine, 2014, 12.
39. Diego Francisco Cortés-Rojas, Claudia Regina Fernandes de Souza, and Wanderley Pereira Oliveira, Clove (*Syzygium aromaticum*): a precious spice, Asian Pac J Trop Biomed. 2014 Feb; 4(2): 90–96.
40. Vishaldeep Kaur, Ramandeep Kaur, Urvashi Bhardwaj, A review on dill essential oil and its chief compounds as natural biocide, 36, 3, 2021, 412-431.
41. E Cahyono¹, C Kurniawan¹ and U Anggraito, Vapor-solid mixer design for cinnamal tea production, Journal of Physics: Conference Series 1918 (2021) 032020
42. Juergen Wanner¹, Stefanie Bail, Leopold Jirovetz, Gerhard Buchbauer, Erich Schmidt, Velizar Gochev, Tanya Girova, Teodora Atanasova, Albena Stoyanova, Chemical composition and antimicrobial activity of cumin oil (*Cuminum cyminum*, Apiaceae), Nat Prod Commun, . 2010 Sep ;5(9):1355-8.
43. O. Boussaada & R. Chemli, Chemical Composition of Essential Oils from Flowers, Leaves and Peel of *Citrus aurantium* L. var. *amara* from Tunisia, 9,133-139, 2006.
44. Poonkodi Kathirvel¹, Subban Ravi, Chemical composition of the essential oil from basil (*Ocimum basilicum* Linn.) and its in vitro cytotoxicity against HeLa and HEP-2 human cancer cell lines and NIH 3T3 mouse embryonic fibroblasts, Nat Prod Res. 2012;26(12):1112-8.
45. Ijaz Ali¹, Ghazala H Rizwani², Munawwer Rasheed³, Mohsin Ali⁴, Amir Hassan⁵, Sohail Hassan⁵, Ghazala Ishrat⁶, Erum Zaheer⁷, Kanwal Hussain⁵, Sana Rehman⁵, Chemical analysis of Dalbergia sissoo (Roxb.) pod oil by (GC-MS) / GC-FID and evaluation of antioxidant potential, Pak J Pharm Sci. 2019 Sep;32(5):2175-2181.
46. Simon Njoroge, Lan Phi Nguyen, Masayoshi Sawamura, Chemical Composition of Peel Essential Oils of Sweet Oranges (*Citrus sinensis*) from Uganda and Rwanda, 2009 Journal of essential oil-bearing plants JEOP 12(1):26-33.
47. Qian-Qian Mao, Xiao-Yu Xu, Shi-Yu Cao, Ren-You Gan, Harold Corke, Trust Beta, and Hua-Bin Li, Bioactive Compounds and Bioactivities of Ginger (*Zingiber officinale* Roscoe), Foods. 2019 Jun; 8(6): 185.
48. A. Basta, O. Tzakou, M. Couladis, M. Pavlovic, Chemical Composition of *Artemisia absinthium* L. from Greece, Journal of Essential Oil Research, 19, 316-318, 2007.
49. Bahare Salehi, Marco Valussi, Maria Flaviana Bezerra Morais-Braga, Joara Nalyda Pereira Carneiro, Antonio Lincoln Alves Borges Leal, Henrique Douglas Melo Coutinho, Sara Vitalini, Dorota Kręgiel, Hubert Antolak, Mehdi Sharifi-Rad, Nathália Cristina Cirone Silva, Zubaida Yousaf, Miquel Martorell, Marcello Iriti, Simone Carradori, and Javad Sharifi-Rad, *Tagetes* spp. Essential Oils and Other Extracts: Chemical Characterization and Biological Activity, Molecules. 2018 Nov; 23(11): 2847.
50. I.P.S. Kapoor, Bragy Singh, Gurdip Singh, C.S. De Heluani, Chemical composition and antioxidant activity of essential oil and oleoresins of nutmeg (*Myristica fragrans* Houtt.) fruits, January 2013 International Journal of Food Properties.
51. Kyu-Won Hwang, Daniel Son, Hyeong-Wook Jo, Chun Hwan Kim, Ki Cheol Seong & Joon-Kwan Moon, Levels of curcuminoid and essential oil compositions in turmeric (*Curcuma longa* L.) grown in Korea, Applied Biological Chemistry volume 59, pages 209–215 (2016).
52. Prapassorn Rakthaworn, Uraivan Dilokkunanant, Udomlak Sukkatta, Srunya Vajrodaya, Vichai Haruethaitanasan, Potechaman Pitpiangchan and Putthita Punjee, Extraction Methods for Tuberose Oil and Their Chemical Components, Kasetsart J. (Nat. Sci.) 43 : 204 - 211 (2009).
53. R.S. Policegoudra S. Goswami S.M. Aradhya S. Chatterjee S. Datta R. Sivaswamy P. Chattopadhyay L. Singh, Bioactive constituents of *Homalomena aromatica* essential oil and its antifungal activity against dermatophytes and yeasts *Activite antifongique de composants bioactifs d'huile essentielle de Homalomena aromatica contre des dermatophytes et des levures*, Journal de Mycologie Médicale, Volume 22, Issue 1, March 2012, Pages 83-87.
54. O Boruga, C Jianu, C Misca, I Goleț, AT Gruia, and FG Horhat, *Thymus vulgaris* essential oil: chemical composition and antimicrobial activity, J Med Life. 2014; 7(Spec Iss 3): 56–60.
55. Habib Ullah, Athar Mahmood and Bernd Honermeier, Essential Oil And Composition Of Anise (*Pimpinella Anisum* L.) With Varying Seed Rates And Row Spacing, Pak. J. Bot., 46(5): 1859-1864, 2014.
56. Bouzouita Nabihal, El Omri Abdelfatteh¹, Kachouri Faten¹, Casabianca Hervé² and Chaabouni Mohamed Moncef, Chemical Composition of Bergamot (*Citrus Bergamia* Risso) Essential Oil Obtained by Hydrodistillation, Apr. 2010, Volume 4, No.4 (Serial No.29), Journal of Chemistry and Chemical Engineering, ISSN 1934-7375, USA.
57. Lucia Caputo¹, Filomena Nazzaro², Lucéia Fatima Souza^{1,3}, Luigi Aliberti¹, Laura De Martino¹, Florinda Fratianni², Raffaele Coppola⁴ and Vincenzo De Feo¹, *Laurus nobilis*: Composition of Essential Oil and Its Biological Activities, Molecules. 2017 Jun; 22(6): 930.
58. P. K. Rout, S. N. Naik, Y. R. Rao, Composition of Absolutes of *Jasminum sambac* L. Flowers Fractionated with Liquid CO₂ and Methanol and Comparison with Liquid CO₂ Extract, Journal of Essential Oil Research, 22, 398-406, 2010.
59. Shahram Amiri, Shahram Sharafzadeh, Essential Oil Components of German Chamomile Cultivated in Firoozabad, Iran, Essential Oil Components of German chamomile Cultivated in Firoozabad, Iran, Oriental Journal Of Chemistry, 2014, Vol. 30, No. (1): Pg. 365-367.

60. Stefanie Bail, Gerhard Buchbauer, Erich Schmidt, Juergen Wanner, Alexander Slavchev, Albena Stoyanova, Zapriana Denkova, Margit Geissler, and Leopold Jirovetz, GC-MS-Analysis, Antimicrobial Activities and Olfactory Evaluation of Essential Davana (*Artemisia pallens* Wall. ex DC) Oil from India,
61. G.P.P.KamatouaA.M.ViljoenaT.ÖzekbK.H.C.Başer, Chemical composition of the wood and leaf oils from the “Clanwilliam Cedar” (*Widdringtonia cedarbergensis* J.A. Marsh): A critically endangered species, South African Journal of Botany, 76, Issue 4, 652-654, 2010.
62. Olga Mykhailenko, Composition of Volatile Oil of *Iris pallida* Lam. from Ukraine, Turk J Pharm Sci. 2018 Apr; 15(1): 85–90.
63. Loh Teng Hern Tan, 1 Learn Han Lee, 1 Wai Fong Yin, 2 Chim Kei Chan, 3 Habsah Abdul Kadir, 3 Kok Gan Chan, 2 and Bey Hing Goh, Traditional Uses, Phytochemistry, and Bioactivities of *Cananga odorata* (Ylang-Ylang), Evid Based Complement Alternat Med. 2015; 2015: 896314.
64. Zeinolabedi Seify, Mehrab Yadegari, Abdollah Ghasemi Pirbalouti, Essential Oil Composition of *Rosa damascena* Mill. Produced With Different Storage Temperatures and Durations, Horticultural Science and Technology. 31 August 2018. 552-559.
65. Donata Ricci,¹ Francesco Epifano,² and Daniele Fraternali, The Essential Oil of *Monarda didyma* L. (Lamiaceae) Exerts Phytotoxic Activity In Vitro against Various Weed Seeds, Molecules. 2017 Feb; 22(2): 222.
66. Oladipupo A. Lawal, Isiaka A. Ogunwande , Andy R. Opoku, Chemical, Composition of Essential Oils of *Plumeria rubra* L. Grown in NigeriaEuropean Journal of Medicinal Plants 6(1):55-61, 2015.

