Chapter 28

# Essential Oils for Health

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**ABSTRACT**

Essential oils, aromatic compounds extracted from various parts of plants, have been utilized for centuries across diverse cultures for their therapeutic properties. Essential oils possess a myriad of bioactive components, including terpenes, phenolics, and ketones, which contribute to their pharmacological effects. Research indicates that essential oils exhibit antimicrobial, anti-inflammatory, antioxidant, and analgesic properties, among others. These properties make them valuable in managing various health conditions, including respiratory ailments, skin disorders, anxiety, and stress. Different mechanisms of extraction of oils are present like steam distillation, Hydro distillation, superfluid extraction, microwave assisted and Ultrasound assisted extraction. Essential oils represent a promising avenue for promoting health and well-being, offering natural alternatives for managing a wide range of health concerns. Continued exploration and integration of these botanical extracts into healthcare practices hold the potential to enhance holistic approaches to health maintenance and disease management. This chapter provides an overview of the current understanding of essential oils and their potential health benefits.

**KEYWORDS**
Essential Oils, Composition; Extraction methods; Health; Benefits

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## INTRODUCTION

In reference to the notion of "Quinta essentia" developed by the renowned German-Swiss physician and alchemist Paracelsus (1493–1541), the term "essential oil" was coined in the 16th century. Paracelsus established the function of alchemy through the creation of herbal remedies and plant extracts. According to him, the distillation method was utilized to extract the most vital component of the plant, which he termed the "soul" or "essence for healing." This was achieved by distinguishing the "essential" and "non-essential" constituents (Dhifi et al., 2016).

According to the European Pharmacopoeia (Ph. Eur.) and the "Association Francaise de Normalisation" (Association Francaise de Normalisation, 2000), "essential oil" is a substance derived from a naturally occurring raw material derived from plants. It can be extracted through dry distillation, mechanical extraction, or distillation with water or steam from the epicarp of citrus sp. fruits. Subsequently, the aqueous phase is physically isolated from the essential oil (Buch, 2022; Do et al., 2015).

### Concept of Actual essential oil

Frequently, every plant is capable of producing essential oils, albeit in minute quantities and in unhealthy proportions. The assemblage of plants that yield essential oil, which holds significant commercial value, is referred to as the oil producing plants (Chlodwin and Novak, 2010). In general, essential oils are found in higher plants, of which there are approximately 17,500 known species. However, certain plant families, such as *Zingiberaceae, Poaceae, Apiaceae, Umbelliferae, Asteraceae, Lamiaceae, Rutaceae, Compositae, Lauraceae, Cupressaceae, Acoraceae, Rosaceae, Oleaceae, Myristricaceae, Myrtaceae,* and others, contain essential oils in healthy quantities (Butnariu and Sarac, 2018; Nieto, 2017; Rahman, 2016).

### Variety of Essential Oil

Two types of oils are synthesized by plants: regular and essential oils. Fixed oils are esters composed of a glycerol molecule that is triacylglycerols or triglycerides, to which three fatty acids are affixed. Essential oils (EOs), which are also referred to as fundamentals, flammable oils, ether oils, or aetheroleum, are intricate amalgamations of lipophilic, odoriferous, and volatile constituents that are frequently encountered in aromatic plants (Schmidt, 2010). Except for cinnamon, sassafras, and vetiver, a great deal of oils that are essential are colorless to light yellow, watery at the ambient temperature, and are lighter than water. Furthermore, certain chemical constituents of essential oils are optically active, soluble in the majority of organic solvents (e.g., ether, alcohol, acetone), and do not dissolve in water (Such, 2022).

**Part of plant from where we extract EO’s**

Typically, essential oils constitute a negligible portion of the dried matter of plants (less than 5%). They are found within specialized secretory structures, including glandular trichomes, oil cells, and secretory ducts or cavities. Seeds, foliage, the bark, fruit, vegetation, tree blossoms, roots, forests, and bulbs can all yield volatile or oily substances shown in table 1 (Souiy, 2023).

**Table 1:** Parts of plant material containing EO’s.

| Parts | Plants | References |
|---|---|---|
| Leaves | Cinnamon, eucalyptus, mint, oregano, pine, tea tree, lemon grass, basil etc. | (Souiy, 2023; Durczyńska et al., 2024). |
| Flowers | Clove, cumin, rose, lavender, jasmine, orange, tarragon etc. | |
| Fruit | Black pepper, nutmeg and xanthoxylum. | |
| Bark | Cinnamon and cassia. | |
| Wood | Atlas, camphor, sandal, rosewood etc. | |
| Seeds | Cumin, nutmeg, fennel, anise, almond etc. | |

**Composition of Essentials oils**

Essential oils (EOs) consist of a diverse array of lipophilic and nonpolar components (60–300) with low molecular weight and varying concentrations. Among these components, two or three appear to be the most significant: terpenoids, which are straight-chain compounds devoid of side chains; aromatic and phenolic components; sulfured derivatives; and straight-chain compounds (without side chains) (Baptiste, 2020). The variation in flavor and aroma of essential oils is profoundly influenced by factors such as the type of plant, harvest season, geographic location, dehydration methods, and extraction techniques (Baptiste, 2020; Dima and Dima, 2015). Terpenoids and polypropanoids comprise the primary volatile components of essential oils (Pandey et al., 2023).

**Terpenoids and terpenes**

Terpenes are secondary metabolites found in plants and are composed of isoprene (2-methylbuta-1,3-diene) units as their carbon backbone (Sadgrove, 2022). In plant cells, the mevalonic acid pathway leads to the synthesis of terpenes. Terpenoids are produced through a variety of biochemical processes, including oxidation and rearrangement of terpenes. Terpenoids are produced through biochemical modifications of oxidized derivatives of terpenes, including esters, ethers, acids, alcohols, ketones, and aldehydes.

Terpenoids constitute the most extensive category of phytochemicals, consisting of approximately 40,000 distinct compounds that have been identified through the process of metabolism (primary and secondary) (Lichtfouse, 2013). An annual addition is made to this category of natural products. Terpenoids can be broadly categorized into four distinct groups: authentic terpenes, saponins, cardiac glycosides, and steroids. These four classes of compounds are typically found in essential oils derived from plants and are found in virtually all biological systems (Sousa et al., 2023).

**Hemiterpenes**

Hemiterpenes constitute a negligible portion of the terpene composition found in essential oils. In general, these consist of the ester, aldehyde, and alcoholic groups attached to the 2-methylbutane skeleton (Sell, 2010). Hemiterpenes are exceedingly rare in essential oils, comprising fewer than one hundred (Ludwiczuk et al., 2017).

**Monoterpenes**

Certain essential oils contain monoterpenes, which are molecules with a low molecular weight and larger concentrations (>90%). Consequently, these molecules play a role in the development of a distinct odor exhibited by an herb (Bakkali et al., 2008). Monoterpenes are nearly ubiquitous in plant essential oils and contain a pair of bonds in their structural moiety. These monoterpenes are commonly implicated in plant-to-plant and plant-to-animal interactions, including allelopathic agents, seed dispersal, and fruit dissemination. Monoterpenes, which have over thirty fundamental skeletons, can be classified into three distinct subgroups: acyclic, monocyclic, and bicyclic (Sousa et al., 2023).

**Sesquiterpenes**

Another significant category of principal constituent terpenes found in essential oils are sesquiterpenes, which have a lower volatility than monoterpenes. These are generated through the fusion of three isoprene units, thereby enhancing their structural versatility. Different forms of sesquiterpenes result from combining all of these three isoprene units: linear, monocyclic, bicyclic, and tricyclic (Sousa et al., 2023).

**Diterpenes**

Diterpenes, which are chemically and structurally more complex, are rarely encountered as leftovers during the process of essential oil extraction and are typically found in association with plant resin. The high molecular weight of these compounds is a result of the C20 skeleton, rendering these individuals less volatile as well as less abundant in comparison to monoterpenes and sesquiterpenes (Avila, 2020).

**Extraction Methods**

Extraction procedures are applied to aromatic herbs or their constituent parts, including fruits, leaves, flowers, bark, and seeds, which are gathered at particular phases of maturation and then preserved under controlled conditions (including temperature, light, and humidity). Extraction techniques can be broadly categorized into two groups: traditional, conventional methods and novel approaches. Traditional approaches involve the thermal distillation of water to extract essential oils (EOs) from plant material. However, there have been advancements in extraction technologies that aim to address certain drawbacks associated with conventional methods. The procedure is conducted using energy sources that contribute to its environmental friendliness (Faugno, 2019).

**Classical Methods**

**Hydrodistillation**

EO extraction by hydrodistillation is the most ancient and straightforward process. By submerging the raw material in scalding water, which ensures an immediate interaction between the solvent being used and the plant stuff, this technique is distinguished (Presti, 2005). Here, the cellular walls are shattered, the oil and water evaporate, and the resulting vapor is a combination of water and volatile vegetable raw material chemicals. The immiscibility of volatile chemicals and water allows for additional separation by differential intensity (McLellan, 2016). Despite being the most ancient technique, hydrodistillation continues to be employed in the present day to extract hydrocarbons from various matrices. By employing this methodology, the essential oils of *Zingiberofficinale, Rosmarinusofficinalis L., Ziziphoraclinopodioides L., and Citrus latifolia Tanaka* are extracted.

**Steam Distillation**

Distillation by steam is one of the most popular techniques for extracting EOs. The extraction process operates on the identical principles that govern hydrodistillation. Primarily, the distinction is that the time required to extract the substrate from the water is shortened due to the lack of physical contact between the two. The specimen is positioned within a column, with the lower portion being linked to a beaker containing water that is being heated. The steam is directed through the sample, transferring essential oils to the condenser, which is attached to the top section. The water-oil mixture undergoes condensation as a result of this procedure; this mixture is amenable to liquid-liquid extraction (Irmak, 2008). Commercial and industrial-scale applications of this approach include essential oil (EO) extraction from hops and other plants, including lavender and patchouli.

**Organic Solvent Extraction**

Certain essential oils (including jasmine and rose) lack thermal stability and cannot tolerate high temperatures. When this is the case, inexpensive organic solvents with low boiling points and chemical inertness may be utilized. Organic solvent extraction involves subjecting the sample to immersion in an organic solvent for a designated duration, such as hexane, benzene, toluene, or petroleum ether, among others. This contact facilitates the transfer of the sample's soluble components. Evaporation of the solvent from the liquid phase concentrates the extracted matrix. The conventional method most frequently employed in the field of cosmetics is solvent extraction (Zhang et al., 2018).

**Cold Pressing**

By cold pressing, essential oils are extracted mechanically, through which the oil glands are ruptured and volatile substances are liberated. During this procedure, an aqueous dispersion is generated, from which the oil can be extracted using fractional distillation, centrifugation, or decantation. The cold pressing technique is primarily employed for the purpose of extracting oils from citrus produce (Faugno, 2019).

**Innovative Methods**

**Microwave-Assisted Extraction (MAE)**

In response to the demand for energy-efficient and environmentally sustainable extraction techniques, microwave-assisted extraction has emerged as a viable substitute for traditional methods. By subjecting the sample to a microwave reactor devoid of any solvent, the internal temperature of the sample cells is elevated as a result of the process of evaporation of the moisture induced by the electromagnetic energy conversion to heat. The rupture of the glands results in the discharge of the essential oil as the internal pressure rises (Kataoka, 2018). This methodology was employed to extract various essential oils from plant matrices, including basil, laurel, lemon, orange, rosemary, and mint (Sakkas and Papadopoulou, 2017).

**Table 2:** List of advantages and disadvantages of EO;'s extraction methods

| Method type | Method Name | Advantages | Disadvantages | References |
|---|---|---|---|---|
| Conventional | Hydrodistillation | - versatile<br>- Easy to apply<br>- selective | - no complete extraction<br>- high cost of energy<br>- long duration | (Sousa et al, 2022; Souiy, 2023; Murti et al., 2023). |
| | Steam distillation | - less cost<br>- less time | - longer extractions<br>- higher cost compound to long time | |
| | Organic solvent extraction | - simple cheap<br>- efficient<br>- suitable for small scale | - more time<br>- more use of solvent<br>- toxic effects | |
| | Cold pressing | -inexpensive<br>- simple<br>- suitable for production of citrus oils | - Not complete extraction<br>- Not feasible for low oil samples | |
| Innovative | Microwave-assisted | -High reproducibility<br>- low solvent use<br>- low energy<br>- simple<br>- more yield | - filtration required at the end | |
| | Ultrasound-assisted | - simple<br>- Inexpensive<br>-Less time<br>- Less solvent use | -difficult to scale up<br>- high energy use | |
| | Superficial fluid extraction | - less time<br>- less toxic<br>- solvent free extract | - high cost of equipment, installation and operation | |

**Ultrasound-Assisted Extraction (UAE)**

With the help of ultrasound, essential oil extraction can be amplified. So, to speed up mass transfer and the extraction process, it is typically used in conjunction with other extraction procedures. Under ultrasonic scanning, the sample is immersed in a solvent. Essential oils are released by mechanically vibrating the sample's walls and membranes, which is accomplished by rapidly moving the solvent through the sample. It is already being utilized on a big scale in various fields, like the food and medical industries, to improve the extracted substrate's quality, cut down on labor time, and boost yield (Picó, 2013).

**Supercritical Fluid Extraction (SCFE)**

Supercritical solvents include a variety of chemicals, including water, CO2, methane, ethylene, and ethane. The most used solvent, however, is carbon dioxide (CO2) because of its cheap cost, lack of flammability, low toxicity, and ease of reaching its critical point (low temperature, 31.2°C, and pressure, 72.9 atm, respectively. The oils are dissolved and extracted by passing the sample through supercritical fluid once the optimal extraction temperature and pressure have been chosen. When the pressure in the extraction solution drops below the critical point, the supercritical fluid becomes a gas and can no longer be used as a solvent; this process is then repeated (Yanga and Hu, 2014). This technique is finding more and more commercial usage in the extraction of essential oils from a variety of plant leaves, including those of the horseradish tree, laurel, rosemary, sage, and blooming plants (Baskar et al., 2019).

**Examples of different plants to get EO's**

**Rosemary essential oil**

There were two different ways that the essential oil may be retrieved from the various plant components.

**Hydrodistillation**

A solution will be prepared by combining water with rosemary powder or leaves. The essential oil would be extracted at a temperature of $80^0$C. It is possible to run the process in a Clevenger-type equipment until no more oil can be extracted. Steam has the ability to evaporate essential oils. Essential oil plus steam vapors condensed as they traveled through a condenser. Separation of the oil-and-water condensate is the next step. Because it is lighter than water, essential oil can be collected by settling it on top (McLellan, 2016).

**Steam Distillation**

When the steam is turned on, a batch of 100–200 g of ground and dried rosemary leaves will be put into the column by 2000 ml of water. The packed bed will be formed using the raw material. Once the cover is shut, steam is injected into the column to initiate the distillation process. Various steam flow rates will be applied to each plant bed. Every 5,15,30,60, and 100 minutes, we will collect the condensed steam and essential oil. The mixture will decant into its respective oil and water phases after condensation. After collection, the essential oil will be dried using anhydrous sodium sulfate as the drying agent and kept at 4oC until analysis (Aasima et al., 2024).

**Lavender essential Oil**

The fresh or partially dried leaves of the lavender plant are steam distilled to release their essential oil. As a result of less polar component loss, this method produces more oil than others. Lavender is usually harvested in the month of June. A still is filled with compressed lavender blossoms. With fewer pockets of air in the still, the oil production is increased. After that, the lavender flower is filled to the base and steam-rolled at low pressure using a boiler. Once the heating process is complete, a pipe carrying cold water is threaded through the still's core, releasing the oil-filled lavender flower pockets. After passing through a cold pipe with water, the steam from the heated lavender oil condenses into a reservoir where it can cool and settle. The oil and water will separate in the holding tank as a result of their different densities and polarities; then, the water will be piped out, leaving just the lavender essential oil (Jagdish, 2019).

**Castor Oil**

The solvent extraction method is the most typical approach. These involve mixing ground seeds with organic liquid chemicals like hexane (C6H14), filtering the mixture, and finally heating it to about 150 °C to evaporate the solvents. In order to refine the retrieved castor oil, hydrochloric acid is utilized to activate the clay. The extracted oil is neutralized by adding sodium hydroxide and sodium chloride. The oil obtained from the extraction procedure is modified using concentrated sulphuric acid (H2SO4), which is subsequently neutralized with sodium hydroxide (NaOH) (Qian et al., 2010). This method is often reserved for usage in laboratories because to its expensive cost and the fact that it utilizes solvents and operates at high temperatures.

**Tea tree Essential Oil**

Tea tree oil is obtained by steam distillation of the leaves and the ends of the branches. The condensed water distillate is next filtered to remove the oil, which ranges in color from clear to pale yellow. Oil typically extracts between 1% and 2% of the dry plant matter. Although solvent extraction, CO2 supercritical extraction, and distillation are alternative methods of essential oil extraction, steam distillation is still the method of choice for most commercially available oils. It is the best method for distilling vegetative materials because it is the most traditional, easy-to-use method of obtaining essential oils. In addition to producing steam that is readily available, inexpensive, safe, and recyclable, this process also causes no modifications to the essential oil's content during extraction. Consequently, stream distillation can be used to recover crude TTO, which accounts for 35-45% of the volume of Terpinen-4-ol (Hammer et al., 2006).

**Mode of action of EO's**

A distinct action mechanism for EOs is difficult to describe because of their highly varied compositions. It is true that a chemical may impact some tumor types while having no effect on others. To illustrate the point, research by Murata et al (2014) demonstrated that 1, 8-cineole/eucalyptol can cause human colon cancer cells to undergo apoptosis. On the other hand, according to Bayala et al (2014), this molecule does not impact the survival of prostate cancer and glioblastoma cells. The cell cycle, cell proliferation, and/or death are some of the mechanisms that could be observed, depending on how the active chemicals are enriched. The chemical makeup of an essential oil, specifically its principal functional groups (alcohols, phenols, terpene compounds, and ketone), is typically associated with its biological action.

**Bioactivity and different Applications of essential oils**

**Place in biological research related activities**

Due to their extraordinary potential of pharmacological actions and inclination to operate as natural preservatives, essential oils are currently a subject of significant relevance in research and various sectors (Rathore et al., 2023). Numerous studies have confirmed the beneficial effects of essential oils on the environment. Interactions between plants and animals, such as those that serve to ward off predators or restrict germination, or between plants and insects, such as those that aid in pollination, are among the most well-known (Gasmi et al., 2013).

Because microbial degradation can be harmful to customers' health, industries always seek out cosmetics with antimicrobial safety. Cosmetics formulated with essential oils can provide natural antibacterial protection due to their potent antimicrobial properties. Aromatherapy, agriculture (as an insecticide), food technology (as a flavoring agent for drinks, foods, spices, and preservatives), perfumery (as a perfume), and pharmacy (as a healer) all rely heavily on drugs containing essential oils. Essential oils are widely esteemed in the field of plant chemotaxonomy due to their life and significance (VWni et al., 2020).

**For cancer cure**

Inflammatory and oxidative disorders were the initial targets for the identification and use of most EOs. According to Sharma (2022), there is a connection between the formation of reactive oxygen species and the oxidation and inflammation that can cause cancer, suggesting that these essential oils may also possess anticancer properties. Essential oils (EOs) induce programmed cell death of cancer cells via apoptosis, necrosis, arrest of cell cycle, and dysfunctioning of main cell organelles as shown in figure 2). This is coordinated by an increase in membrane fluidity of the affected cell, reduced adenosine triphosphate (ATP) generation, alteration in pH gradient, and loss of mitochondrial potential, which are the major precursors of cell death (Sharma, 2022).

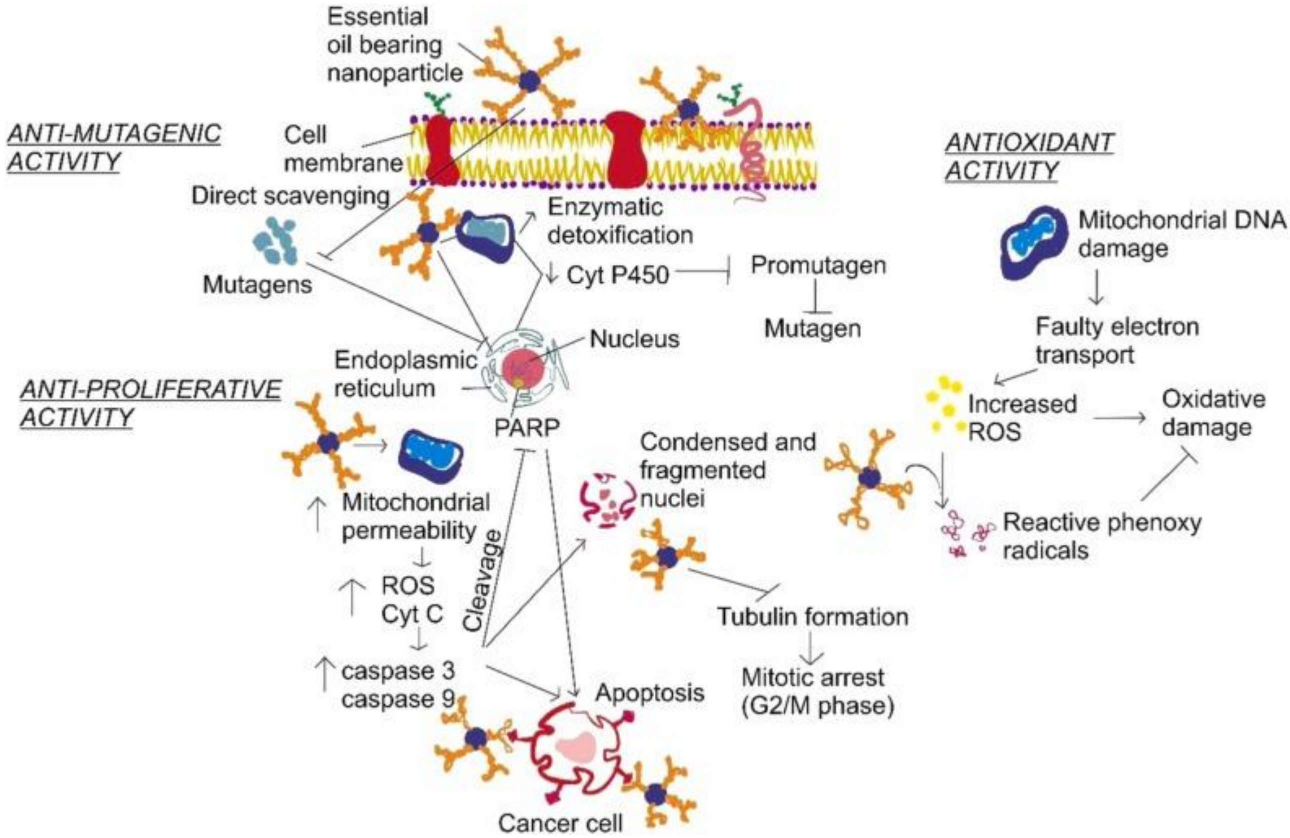


**Fig. 2:** Apoptosis in cancer cells due to Essential Oil (Sharma, 2022).

**Prostate cancer**

According to a study conducted by Quassinti et al (2013), the essential oil of *Hypericumhircinum L.* subsp. Majus exhibited antiproliferative effects in human prostatic adenocarcinoma (PC3). The apoptotic effect was observed in human prostate cancer cells that were hormone-dependent (LNCaP) or hormone-independent (PC-3), but not in epithelial cells (RWPE-1), when exposed to jacaric acid and four of its octadecatrienoic geo isomers (Gasmi, 2013). There was a notable reduction in prostate cancer cell proliferation when Pinus wallichiana EO was administered.

It was shown that the volatile oil of Solanum Eryanthum leaves had a strong inhibitory effect on PC-3 cells (Essien et al., 2012). According to Quassinti et al. (2013), Hypericum hircinum's glioblastoma essential oil showed antiproliferative effects on T98G human.

**Colon Cancer and Ovary Cancer**

Geraniol, a monoterpene present in essential oils of many plants, has the potential to represent a novel class of cancer chemo preventive medicines due to its antiproliferative effects on Caco-2 colon cancer cells (Garzoli et al., 2022). The ovary cells of Chinese hamsters were killed by the essential oil of Cymbopogon Citratus. The CHOK1 cells were inhibited by 68.3% when exposed to the essential oil of Malus Domestica leaves at a concentration of 1000 μg/ml. According to research conducted by Poviessi et al. (2014) the most potent inhibitor of human ovarian cancer cells HO-8910 was the volatile oil derived from the roots of Patrinia Scabra Bunge.

**Liver Cancer and Bone Cancer**

Essential oils extracted from N. variabillima leaves had a cytotoxic effect on human liver cancer. The essential oils of Zanthoxylum Schinifolium caused human hepatoma cells to undergo cell death (Su et al., 2013). HepG2 cell line relies on reactive oxygen species (ROS) generation rather than caspase activation (Junior, 2024). The anticancer activity of the volatile oil from Pyrolaeherba against SW1353 cells was found to be dose- and time-dependent. These EOs reduced the number of cells that entered the S phase and lowered the levels of cyclin D1, cyclin-dependent kinase (CDK)4, and CDK6, while raising the levels of p21 (Cai et al., 2013).

**For Nervous Disorders**

In persons younger than 60 years old and older than 60 years old, respectively, prior research has demonstrated that EOs effectively alleviate symptoms of sadness, anxiety, and stress. For example, people over the age of 60 who inhaled essential oils of chamomile and lavender reported less tension, anxiety, and despair. Suppression of sympathetic nervous system activity was proposed as a possible mechanism for the anxiolytic and antidepressant effects. Furthermore, studies have shown that inhaling lavender essential oil during a panic attack might have positive impacts on physiological health, including lowering blood pressure and respiratory rate (Ebrahimi et al., 2021).

**Against Corona Virus**

The lung and airways are the initial organs infected with SARS-CoV-2, hence it's beneficial that essential oils are mostly inhaled to target these places. In this way, essential oils have a good opportunity to deflect the binding of SARS-CoV-2 spike proteins to their corresponding ACE2 receptors on the parenchyma of the lung. It is possible to concentrate and distribute EOs with anti-COVID-19 activity into the lung, where they will be able to do their activities. The antimicrobial activity of essential oil vapor is superior than that of liquid EO. The formation of micelles by lipophilic molecules in the aqueous phase of essential oils inhibits their attachment to microbes. On the other hand, fungi are particularly targeted by the vapor phase of EOs because of their surface growth (Reyes- Jurado et al., 2020).

**Conclusion**

In conclusion, the exploration of essential oils for health within this book chapter underscores their remarkable potential as natural remedies for promoting physical, emotional, and mental well-being. Throughout history, these aromatic extracts have been revered for their therapeutic properties, and modern research continues to unveil their diverse pharmacological effects. From their antimicrobial and anti-inflammatory actions to their ability to alleviate stress and enhance relaxation, essential oils offer a holistic approach to health maintenance and disease management. Their integration into various healthcare practices, including aromatherapy, massage therapy, and herbal medicine, highlights their versatility and accessibility Moreover, ongoing research is necessary to deepen our understanding of their mechanisms of action and potential interactions with conventional medications. As we journey forward, the continued exploration and integration of essential oils into healthcare practices hold the promise of enhancing our ability to address a wide range of health concerns while promoting overall well-being. Through an embrace of nature's wisdom and the healing potential of essential oils, we can set out on a journey towards a more balanced, healthier way of living.

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