RESEARCH COMMUNICATIONS
(An International Open Access, Peer Reviewed, Multidisciplinary Online Journal)
https://research-communications.cmpcollege.ac.in
ISSN: 2584-1270
Volume: 2, Issue: 2, July-December 2024, pp. 117-123

A Review on the Stability of Essential Oils Under Different Storage Conditions

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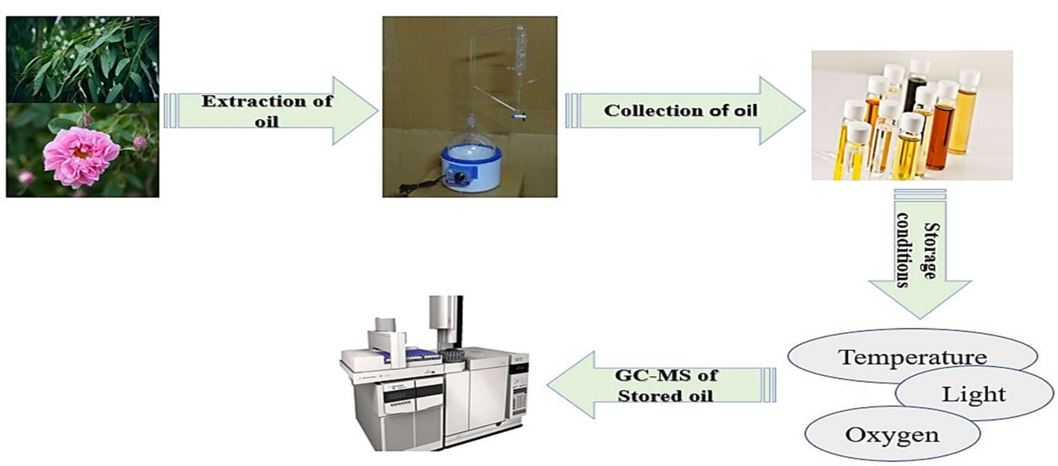
Abstract

The aromatic components of plants are essential oils, whose biological processes have known and used in flavouring, perfumery, medicine, and food preservation. These oils are known to include a number of lipid-soluble, hydrophobic, and volatile constituents originating from a wide array of chemical families, making them susceptible to conversion and degradation processes. After hydro-distillation, gas chromatography-mass spectrometry (GC/MS) is used to analyse essential oils. In the course of oxidation or polymerization, the oil's medicinal properties and purity might be lost. The quantity and quality of active chemicals contained in these oils are significantly affected by different factors such as temperature, light, oxygen availability, and storage conditions. This review article carefully examines and describes the factors influencing the stability and potential changes in the essential oils of spearmint, damask rose, lemongrass, and eucalyptus.



Keywords: *Essential Oil, Storage Conditions, Mentha spicata, Rosa damascena, lemongrass*

1. Introduction

Essential oils are being used for medicinal and therapeutic reasons for thousands of years. *Quinta essentia* was the phrase used by Paracelsus von Hohenheim to designate the term "essential oil" [1]. According to Sanchez [2], essential oils (EOs) constitute naturally occurring, hydrophobic, and volatile chemical compounds that can be derived from a variety of plant components, including seeds, wood, roots, flowers, leaves, peels, bark, fruits, and more. Chemically speaking, essential oils are secondary metabolic products found in fragrant plants that serve a variety of purposes, such as signalling across the plant as a reaction to environmental triggers, interacting with other members of the same species, and defending the plant against herbivores, microbes, and insects [3,4]. Because they have developed to protect themselves from predators, every plant species produces its own unique trademark blend of chemical components [5,6].

These oils are getting from aromatic plants found in moderate to warm climates like as the Mediterranean and tropical areas, and they play an important part in traditional medicine. The most common procedure for extracting essential oils are hydro-distillation, steam, and steam/water distillation. Other procedures include hot/cold pressing, aqueous infusion, supercritical fluid extraction, solvent extraction and effleurage method. A number of studies have been shown antibacterial properties of essential oil, and they have been proven to be effective against a wide spectrum of illnesses (7). Moreover, contagious illness including all that are resistant to drugs are acknowledged as main global causes of mortality, mainly in developing countries.

Therefore, it is imperative to look into and develop novel antimicrobials construct from natural constituents like essential oils in order to solve this problem (8). Strong antibacterial properties of essential oils (EOs) obtained from lavender, citrus fruits, rosemary, and other plants make them valuable as like a natural protective in food and cosmetics (9). Because of worries about skin problems, gastrointestinal issues, and an increased risk of cancer with long-term usage, natural antioxidants are seen as valuable substitutes for synthetic antioxidants (10). Various studies have also shown EOs to be effective natural antioxidants e.g. basil, oregano, lemon balm, thyme and sage (11).

EOs have been utilized significantly for a long time in herbs, spices, scents, medical treatments, aromatherapy, beauty products and in the pharmaceutical sector because of their anti-inflammation, carminative, antibacterial, appetizer, anti-spasmodic and tranquillizer traits [11].

The components of EOs may change during the process depending on the season of year when the plant is collected and the procedures employed in oil extraction [12]. The chemical nature of EOs varies according to the climate, origin, ecological factors, and the growing phase of the plants [13]. As a result, the scientific study seeks to gather exact information on essential oils, such as their chemical components, biological properties, and storage. Essential oil stability is critical for producers and consumers, but little is understood about it [14].

Terpenoids are vulnerable to oxidation during long storage time, which can lower the oil's quality and harm users' health by causing skin irritation [15]. Light, temperature, and the accessibility of oxygen are the main environmental aspects that impact the content of EOs [16,17,18].

Studies conducted in earlier years have revealed how the unique characteristics of EOs vary with respect to stability under different environments of storage [14]. To evaluate the existence and quantity of chemical substances, a number of elucidation techniques have been developed such as high-performance liquid chromatography (HPLC) and gas chromatography-mass spectrometry (GCMS) [19,20]. Compositional alterations and growth in oxidized chemicals might induce color change, rotten flavor or rise in viscosity [21].

2. Essential Oil Composition

EOs comprise a diverse set of unique, although often structurally linked, constituents. Every oil may be composed of a few individual chemicals or as a complex blend of well over 100 distinct constituents [22]. These compounds are made up of complicated molecules that include hydrogen, carbon, oxygen, and in certain cases, sulfur, nitrogen, bromine and chlorine [23]. These molecules have a molecular weight of no more than 500 Da and include just one to three atoms of oxygen [24]. Large components represent around 85% of the essential oil, with the remainder as traces [19]. The bioactive components are found in the two chemical families of terpenoids (monoterpenoids and sesquiterpenoids) and phenylpropanoids are important. Esters, alcohols, aldehydes, phenols, ketones, and oxides are examples of oxygenated substances [25]. One particular chemical group, known as terpene (Fig. 1), which is made up of various amounts of isoprene units (C_5H_8), makes up hydrocarbon molecules. While diterpenes ($C_{20}H_{32}$) may be found in isoprene chains, monoterpenes ($C_{10}H_{16}$) and sesquiterpenes ($C_{15}H_{24}$) are the major terpenes. [26]. There are numerous terpenes discovered in EOs, comprising alcohol derivatives (linalool, geraniol, and terpineol), ketones (p-vetivone, menthone, and carvone), esters (linalyl acetate, menthyl acetate, and cedryl acetate), aldehydes (geranial, citronellal, and cumin aldehyde), and phenols (thymol, carvacrol, eugenol) [27,28].

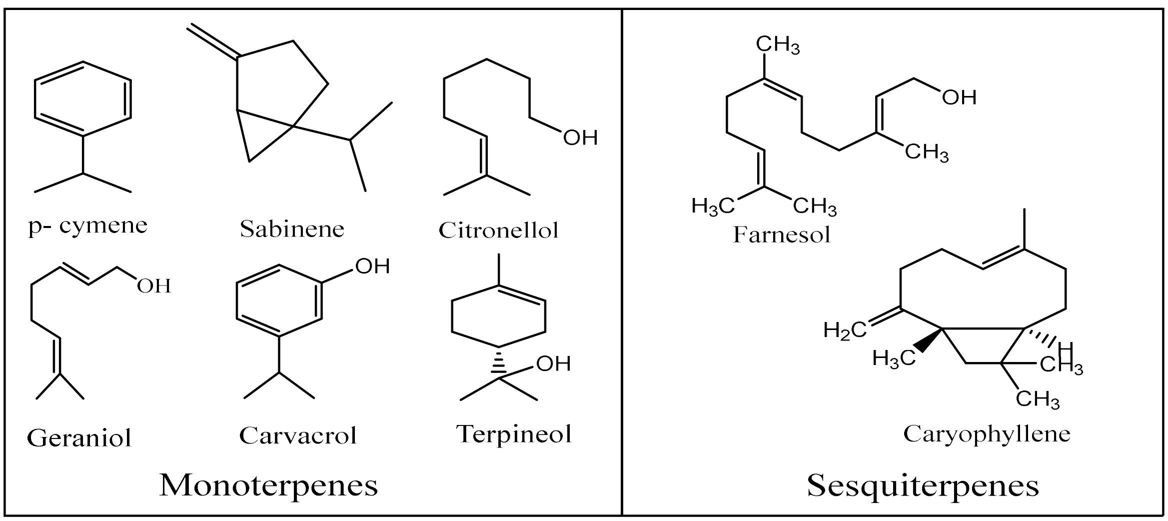


Fig 1: Structures of some terpenes

Several significant metabolic pathways are often used to produce EOs components. Terpenoids are molecules generated from isopentenyl diphosphate (IPP) and the isomeric form, dimethylallyl diphosphate (DMAPP) whereas phenylalanine is synthesized through the aromatic phenylpropanoids pathway such as shikimic acid [1,7]. All plant EOs have irregularities in their precise chemical makeup. The qualitative composition and contents of the isolated EOs are determined by intrinsic plant factors (such as genotype, the part of the plant used for extraction, plant maturity, time of harvest, etc.) and extrinsic factors associated with the growing agrotechnology, environment, extraction method, and storage condition [22,27].

3. Factors Affecting Stability of Essential Oils

3.1. Temperature: The stability of the EOs is greatly influenced by the environmental temperature in a various way. The rate of reaction changes with temperature which describes by The Arrhenius equation, indicates that the chemical reaction tends to speed up with temperature. Additionally, the Van't Hoff rule states that the rate of a chemical reaction generally doubles with a rise in temperature of about 10°C [6]. This rule is used to assess the stability at various temperatures. The breakdown of hydroperoxide and auto-oxidation both speed up with a rise in temperature since heat is clearly a component in the primary production of free radicals [29]. According to several research, essential oil frequently loses stability when the temperature rises from 4°C to 25°C [30] and 23°C to 28°C as the oxygen present in the oil is easily soluble at low temperature which may also affect the stability of essential oil [21].

3.2. Light: By stimulating the hydrogen abstraction and producing alkyl radicals, UV and visible light speed up the auto-oxidation process of EOs (Choe et al., 2006). In general, monoterpenes lose their quality more quickly when exposed to light than other components of EOs. Additionally, various plant species' EOs responded differently to exposure to light [16,21].

3.3. Availability of oxygen: Oxidation is one of the causes of EOs degradation, it is clear that oxygen availability is vital for EOs sustainability. According to Badgujar, V. C., et al. (2002), the rate of oil oxidation rises with the quantity of oxygen dissolved, which is strongly influenced by both temperature and the partial pressure of oxygen present in essential oil containers that are only halfway full.

3.4. Water: Essential oils' water content degrades their chemical makeup as well. As a result of hydro-distillation, compound spectra were altered at temperatures close to 100°C [31].

4. Impact of Storage Conditions on Some of the Essential Oils

Because of the increased production amount, inadequate storing of aromatic plants and their products can lead to chemical, physical, and microbiological changes that have a detrimental influence on both their suitability for use and their value in the market [32]. For the extraction of an ideal yield and superior EOs, proper agricultural practices throughout plant development, harvesting techniques, and after-harvest treatment are crucial. The components of EOs can convert to one another due to their structural connection through chemical or enzymatic oxidation, cyclization, dehydrogenation, or isomerization processes that are started either enzymatically or chemically [6]. The following section discusses changes in the chemical dressing of essential oils.

4.1. Mentha spicata oil: The oil is extracted from *Mentha spicata* usually known as spearmint and it's a lamiaceae family member. Among other things, it has antibacterial, diuretic, and antifungal properties. Spearmint oil chemical makeup considerably changed after being kept at a range of temperatures (-20°C, 4°C, and 25°C) for around 3 months. Carvone, piperitenone oxide, bourbonene, and (E)-caryophyllene concentrations increased over a period of three months when stored at 25°C. The amount of carvone increased from 49.91% to 56.92%. Peperitenone oxide has a similar rising trend. The amount of peperitenone oxide rose from 10.69% to 10.75%. On the other side, limonene, 1,8 cineole, germacene D, and (E)-farnesene amount dropped. In the starting of the distillation process, limonene was at 7.33% which eventually decreased to 6.61%. 1,8 cineole content decreased as well, from 3.78% to 3.34%. It was discovered that the freezer, as opposed to the surrounding temperature or the refrigerator, yielded high-quality *M. spicata* oil. Keeping spearmint oil at low temperatures preserves the oil's quality by causing less changes to its chemical components [13].

4.2. Rosa damascena oil: Among the highly aromatic roses, the Damask rose is a significant species. It yields very valuable EO, which is mostly utilized as a fragrance ingredient in cosmetics, drinks, ointments, lotions, and perfumes, among other goods. Additionally, it possesses antibacterial, anti-HIV, and antioxidant effects. Researchers gathered, distilled, and stored the EO of the damask rose at three distinct temperatures: 4°C, 18°C, and 25°C. Compared to flower oil held at 18°C and 25°C, the oil quantity preserved at 4°C was considerably greater. The content of oil progressively decreased as the storage period lengthened. When stored for longer duration of time at different temperatures, the percentage composition of methyl eugenol, citronellol, and nerol rose while that of geraniol and neryl acetate decreased [33].

4.3. Cymbopogon citronella oil: *A* Poaceae family member, *Cymbopogon citronella* is also said to as lemongrass. It incorporates an extensive range of therapeutic qualities, mostly antibacterial and antifungal, making it effective for treating inflammation, lowering blood pressure, reducing pain, and relieving stress. The percentages of geranial (53.11%), neral (33.21%), and caryophyllene oxide (1.30%) are higher in the newly distilled oil. 6-methyl hept-5-en-2-one (3.79%), limonene (1.26%), geraniol (3.49%), and γ-terpinene (1.19%) grew in quantity after a year, however, geranial and neral decreased in proportion by 26.66% and 22.82%, respectively. Because of this, lemongrass oil shouldn't be stored for a long time and should be used immediately as possible post extraction [34].

4.4. Eucalyptus citriodora oil: *E. citriodora*, sometimes known as lemon-scented gum, is a Myrtaceae family member. *Eucalyptus* oil is used to cure sore throats, coughs, colds, and other ailments because it has antibacterial and antiseptic characteristics. For four weeks, the derived essential oil was stored in both sunlight and shade. It was setup that the amount of oil exposed to the sun substantially decreased over the course of four weeks, going from 0.38% to 0.11%. However, the oil yield that was held in the shade reduced marginally, going from about 0.4% to 0.36% in just four weeks. The oils physiochemical study showed that neither the length of storage nor the storage environment had any effect on the oil's properties, with one notable exception of colour, that changed to light brown from pale yellow. According to these findings, storing leaves in the shade before manufacturing preserves their physiochemical makeup and oil content [35].

Conclusion

The effect of various storage environment on the chemical dressing of EOs has been discussed throughout the paper. EOs stability is a critical factor for both producers and consumers. Temperature, light, oxygen, and water are all-natural factors that can influence the quality and longevity of these oils. The impact of storage conditions on specific EOs, such as *Mentha spicata*, *Rosa damascena*, *Cymbopogon citronella*, and *Eucalyptus citriodora*, demonstrates that different oils respond differently to temperature and storage duration. As the temperature rose during storage, the percentage composition of limonene, 1,8 cineole, germacene D, and (E)-farnesene fell, while that of carvone, piperitenone oxide, bourbonene, and (E)-caryophyllene grew. This had an impact on the oil's quality. As storage time and temperature increased, the Damask rose oil's composition and content changed. Freshly distilled Cymbopogon citronella oil exhibited a greater concentration of chemical constituents; however, prolonged storage reduced its content. Eucalyptus oil should be stored in the shade to preserve its quality because sunlight greatly alters the oil's makeup. Lower temperatures can clearly assist protect the essential oils quality over time by producing less changes in their chemical components.

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