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Research Article

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Essential Oil Essential Oil Analysis of Some Plants

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Abstract
Background: Essential oils are composed of terpenic or nonterpenic volatile compounds. They can be found in the forms of alcohol, acid, ester, epoxide, aldehyde, ketone, amine, and sulfide. The aim in the present study was to evaluate the chemical content of *Ocimum basilicum, Melissa officinalis, Lavandula officinalis, Mentha piperita L., Salvia officinalis L., and Thymus vulgaris L.* essential oils.
Methods: Essential oil samples of the plants were obtained by 4-hour water distillation in the Clevenger apparatus. After boiling started, distillation continued for 4 hours until the flow of liquid finished. The volatile oils were analyzed using a Shimadzu QP2010-Plus model GC/MS. The essential oil components were characterized using electronic libraries
Results: The main components of Ocimum basilicum were 53% 1,6-octadien-3-ol, The main components of Melissa officinalis were 26% d-limonene, The main components of Lavandula officinalis were 42.07% 1,6-octadien-3-ol, The main components of Mentha piperita L. were eucalyptol (cineole), The main components of Salvia officinalis L. were α-pinene, The main components of Thymus vulgaris L. were o-cymene.
Conclusions: Essential oils are also important in protecting foods due to their effects in treating bacterial infections, fungal diseases, wounds, burns, and acne.
Key words: Essential oils; Terpens; Chemical components

Introduction

Essential oils are composed of terpenic or nonterpenic volatile compounds. They are all hydrocarbons and their oxygenated derivatives. Some may contain nitrogen and sulfur. They can be found in the forms of alcohol, acid, ester, epoxide, aldehyde, ketone, amine, and sulfide. Nonterpenic hydrocarbons are derivatives of methane-derived paraffin (alkanes and alkenes). Terpenes are formed as a result of connecting isoprene units. Monoterpenes, sesquiterpenes, and even diterpenes are found in the structure of most essential oils (1). *Ocimum basilicum* has been used for medical purposes worldwide, especially in China and India, for many years. The aboveground parts of the plant are used to treat ear pain, joint rheumatism, itchy skin diseases, menstrual irregularities, malaria, kidney diseases, and mouth sores, and as a blood reliever before and after birth (2). The infusion (1-2%), which is prepared from the aboveground parts of the plant, is used as a sedative, stomach, urine booster, and gas diverter. The infusion (2-3%) prepared from the mature seeds of the plant is used as an internal cough reliever. Various forms of culture, fresh or dried, are used as spices to give flavor and aroma. *Ocimum basilicum* grows in many different chemotypes around the world. In the studies conducted, according to the volatile oil analysis of *Ocimum basilicum*, the major components were methyl eugenol (78%) and α-cubeben (6.2%) (3).

Melissa officinalis grows naturally in southern Europe, the Caucasus, northern Iran, and northern Iraq. It is used in treatment due to its sedative, stomach, degasser, diaphoretic, and antiseptic effects. The aboveground parts of the plant are used to treat migraine, asthma, heart disease, diabetes, and upper respiratory tract infections (4). The main components of these parts of the plant are hydroxycinnamic acid derivatives (4-7%). Rosmarinic acid and smaller amounts of p-coumaric acid, caffeic acid, syringic acid, chlorogenic acid, ferulic acid, gallic acid, and catechin are the main components of this group. In addition, the volatile oil content of the aboveground parts of the plant was recorded as 0.02-0.37% (5). This essential oil's main components are citral (40-70%), citronellal, geraniol, nerol, linalool, farnesyl acetate, humulene, β-caryophyllenes, and germacrene. It includes monoterpenic hydrocarbons such as β-pinene; oxygenated monoterpenes such as 2,3-dehydro-1,8-cineol, myrtenol, (Z)-carveol, and geranylacetate; and sesquiterpenic hydrocarbons such as caryophyllene and farnesol in the volatile oil. The content of the essential oil varies depending on the place of collection, climate, period of the plant, collection and storage conditions, and whether the droplet is dry or fresh (6).

Lavandula officinalis is a fragrant ornamental plant that can rise up to 1 m and has dark blue flowers in the summer. Lavender, which is a Mediterranean plant, is grown in coastal countries. It has a volatile oil containing pinene, cineol, borneol, and organic acids. It contains plenty of tannins. The most abundant substances in lavender essential oil are linalool, linalyl acetate, borneol, camphor, and 1,8-cineol. Among these, the linalool, linalyl acetate, and camphor determine essential oil quality. Linalool is a sedative, linalyl acetate drug, and natural camphor alone has an antiseptic effect on the lungs and respiratory tract (7). Considering the external factors such as the altitude, climate, and soil structure of the region where the plants are grown and the cultivation technique used, researchers give values in the range of 23-40% for the main compounds and 0.1-0.5% for camphor (7).

Among the terpenic compounds contained in *Salvia officinalis*, volatile oils have been studied quite extensively. It has been reported to contain tannins, phenolic acids, flavonoids, coumarins, vitamins, and glue. Moreover, 30-50% α- and β-thujone, 15% cineol, and 10% borneol are the most common and main compounds in the essential oil. In a study, α-thujone (25.8%), viridiflorol (20.4%), β-thujone (5.7%), and camphor (6.4%) were found in the essential oil of *S. officinalis*, which was produced by multiplying from the seed and the aboveground parts were collected after 6 months (8). In addition, the content of essential oils obtained from the plant leaves was determined by hydrodistillation using the Clevenger apparatus and solid phase micro-extraction. The main volatile components were α-thujone, camphor, β-thujone, 1,8-cineol, viridiflorol, and manool. However, it was observed that the amount of monoterpenes (1,8-cineol, camphor, and α- and β-thujone) increased with the hydrodistillation performed in the Clevenger apparatus. On the other hand, the amounts of viridiflorol, a sesquiterpene alcohol, and manool, a diterpene alcohol, decreased. Carnosic acid and carnosol are the best known phenolic diterpenes isolated from *Salvia officinalis* (9).

Thymus vulgaris essential oil contains phenols and terpenes, mainly thymol and carvacrol. In addition to flavonoids, including apigenin, luteolin, thymonin, and methylated flavones, phenolic glycosides, monoterpene-derived biphenyl compounds, monoterpene glycosides; phenolic acids such as caffeic acid and rosmarinic acid; saponins; long-chain saturated hydrocarbons, aliphatic aldehydes, aliphatic alcohols, and acetophenones. *T. vulgaris* contains 1.0-2.5% volatile oil with a total thymol and carvacrol ratio of up to 64% (10).

Mentha piperita leaves contain flavonoids, steroids, triterpenoids, and tannins. The plant also contains 1-menthyl-β-D glucoside, 1-menthyl-6'-O-acetyl β-D glucoside, and menthyl β-D glucoside, as well as vitamins C and E. Linarin was isolated from the flowers. The main components of its essential oil were menthol, p-menthone, iso-menthone, neomenthol, dl-limonene, menthyl acetate, piperitone, pulegone, isopulegol, isopulegol acetate, trans-caryophyllene, α-pinene, β-myrcene, Δ-3 carene, γ-muurolene, heptanoic acid, octanoic acid, nonanoic acid, and eugenol. It is used to treat respiratory distress, gas compression, functional gastrointestinal and gallbladder disorders, upper respiratory tract infections, and functional heart diseases (11).

The aim in the present study was to evaluate the chemical content of *Ocimum basilicum*, *Melissa officinalis*, *Lavandula officinalis*, *Mentha piperita* L., *Salvia officinalis* L., and *Thymus vulgaris* L. essential oils.

Materials and Methods

Ocimum basilicum, *Melissa officinalis*, *Lavandula officinalis*, *Mentha piperita* L., *Salvia officinalis* L., and *Thymus vulgaris* L. samples were obtained from the Mediterranean Region. The plants were separated from the stalk and leaf parts.

Essential oil samples of the plants were obtained by 4-hour water distillation in the Clevenger apparatus. First, 60 g of the ground plant samples to be distilled for essential oil were weighed, placed in a 1000-mL silicate flask, and 600 mL of distilled water was added. After boiling started, distillation continued for 4 hours until the flow of liquid finished. The boiling plant samples rise in the assembly together with the essential oil water vapor in the water mixture and accumulate in two phases in the collection balloon after condensing in the cooling part of the assembly. The upper part is volatile oil, and the water accumulated in the lower part is recirculated from the recovery tube to the balloon. When the distillation was completed, volatile oil was collected with the help of a tap. Anhydrous sodium sulfate was added, followed by shaking and filtration to remove moisture from the oils. The essential oils obtained were stored in amber bottles at -20 °C until they were analyzed. The volatile oils were analyzed using a Shimadzu QP2010-Plus model GC/MS. The essential oil components were characterized using electronic libraries (12) .

Results

Ocimum basilicum, *Melissa officinalis*, *Lavandula officinalis*, *Mentha piperita* L., *Salvia officinalis* L., and *Thymus vulgaris* L. samples were hydrodistilled in the Clevenger apparatus for 4 hours to obtain essential oils. The volatile oils were analyzed qualitatively with GC-MS.

The main components of *Ocimum basilicum* were 53% 1,6-octadien-3-ol and 3,7-dimethyl, 12.57% 3-allyl-6-methoxyphenol, 4.33% α-eucolyptol, 3.87% muurolol, 2.14% benzene and 1,2-dimethoxy-4,12 propenyl, and 1.72% bicyclo hept-2-ene and 2,6-dimethyl-6-(4-methyl-3-pentenyl-). These are followed by 0.85% bicyclogermacrene, 0.45% (+) -epi-bicyclosesquiphellandrene, 0.44% β-pinene, 0.33% α-pinene, 0.50% Myrcene, 0.50% d-limonene, 0.47% linalool oxide, 0.46% α□trans-linalool oxide, 0.09% cubebene, 0.26% β-bourbonene, 0.25% 9-octadecenoic acid, 0.08% caryophyllene oxide.

The main components of *Melissa officinalis* were 26% d-limonene, 13.60% neral, 14.93% citral, 11.45% caryophyllene oxide, 6.97% benzene, 1-(1,5-dimethyl-4-hexenyl)-4-methyl, 2.22% 6-methyl-5-hepten-2-one, and 1.94% 1H-cycloprop [e] azulen-7-ol, decahydro-1,1,7-trimethyl-4-methylene. These are by followed by 0.44% cis-vaccenic acid, 0.92% neoalloocimene, 0.82% 1H-3a,7-methanoazulene, 2,3,4,7,8,8a-hexahydro-3,6,8,8-tetramethyl, 0.67% β-bourbonene, 0.57% geranyl propanoate, 0.72% naphthalene, 1,2,3,4,4 a,5,6,8a-octahydro-7-methyl-4-methylene-1- (1-methyllethyl), 0.33% deltacadinene, and 0.27% 3-methyl-2-(2-methyl-2-butenyl)furan.

The main components *of Lavandula officinalis* were 42.07% 1,6-octadien-3-ol, 3,7-dimethyl, 18.26% linalyl acetate, 5.89% camphor, 4.83% alpha-terpineol, 3.73% eucalyptol(1,8-cineole), 2.56% geranyl acetate, and 2.21% hexyl-butyrate. This is followed by 1.30% myrcene, 0.97% cyclohexene, 1-methyl-5- (1-methylethenyl), 0.60% hexyl tiglate, 0.86% hexyl-ethanoate, and 0.47% caryophyllene oxide.

The main components of *Mentha piperita* L. were eucalyptol (cineole), cyclohexanone (5-methyl-2-(1-methylethyl)-cis-), cyclohexanol, 1-methyl-4-(1-methylethyl), pulegone (cyclohexanone, 5-methyl-2- (1-methylethylheylidene)-R), and trifluoroacetyl-α-terpineol. These are followed by isopulegol, 2-acetylcyclohexanone, L-menthone, 4-isopropyl-1,3-cyclohexanedione, menthol, 3,7-dimethyl-7-octen-2-ol, citronellyl butyrate, menthyl acetate, and citronellol.

The main components of *Salvia officinalis* L. were α-pinene, camphenene, 2(10)-pinene (bicycle (3.1.1) heptanes, 6,6-dimethyl-2-methylene α, eucalyptol, linalool, 3-thujanone, (+) α-2-winanone and -terpineol.

The main components of *Thymus vulgaris* L. were o-cymene, terpinene, thymol, and carvacrol. This is followed by caryophyllene, o-isopropylanisole, p-cymen-7-ol, 2,3,5-trimethylanissole, and 3,4-diethylphenol.

Discussion

In our study, the largest volatile oil component of *Ocimum basilicum* was 1,6-octadien-3-ol (53%). The essential oil components of *Ocimum basilicum* were linalool (37-60%), 1,8-cineol (0.2-14.5%), and eugenol (3.1-21.1%). In one study, the main components were methyl α□eugenol (78%) and α-cubebene (6.2%); in our study, α-cubebene made up 0.09%. In other studies conducted in different parts of the world, such as Sudan, Mississippi, Iran, and Egypt, very different chemotypes containing more than 50% estragole, linalool, geraniol, 1,8-cineol, eugenol, methyl eugenol, bergamotene, β-myrcene, limonene, epibicyclo-sesquiphellandrene, α-cadinol, menthone, estragole/linalool, linalool/methylnamate, linalool/geraniol, linalool/eugenol, methyl eugenol/linalool, and methyl eugenol/(E) α-menthol have been identified as the main components (13, 14). In our study, in *Melissa officinalis*, d-limonene, neral, citral, caryophyllene oxide, benzene, 1- (1,5-dimethyl-4-hexenyl)-4-methyl, 6-methyl-5-hepten-2-one, and decahydro-1,1,7-trimethyl-4-methylene were found. Studies have shown that the aboveground parts of the plant contain 0.02-0.37% volatile oil. It has been stated that the essential oil contains mono and sesquiterpene hydrocarbons such as β-pinene, caryophyllene, and farnesene. Drying the plant with hot or cold air also changes its content. In one study, sesquiterpenes such as β-cubebene, β-caryophylline, and β-cadinol were the main components in the plant's essential oil(15).

In the present study, the main components of *Lavandula officinalis* were 1,6-octadien-3-ol, 3,7-dimethyl, linalyl acetate, camphor, α-terpineol, eucalyptol(1,8-cineole), geranyl acetate, and hexyl-butyrate. In one study, the main components were linalool 31.9%-50.0% and linalyl acetate 15.4%- 42.0%. *L. officinalis* is used in the perfumery and cosmetics industries and for insect repellents and other non-perfumery uses (16). In our study, the main components of *Mentha piperita* L. include eucalyptol (cineole), cyclohexanone (5-methyl-2- (1-methylethyl) -cis-), cyclohexanol, and 1-methyl-4- (1-methylethyl). In a previous study conducted, the main components of the essential oil were menthol, p-menthone, isomenthone, neomenthol, dl-limonene, menthyl acetate, piperitone, pulegone, isopulegol, trans-caryophyllene, α-pinene and β-pinene (17). This study detected in *Salvia officinalis* L. α-pinene, camphene, pinene, α□eucalyptol, linalool, 3-thujanone, and α□terpineol. In one study, α□thujone, camphor, borneol, and muurolene were the main components. In a study conducted with the essential oils obtained from 25 natural populations collected from different regions of the Adriatic coast, the most common compounds were cis-thujone, camphor, trans-thujone, 1,8-cineol, β-pinene, camphene, borneol, and bornyl acetate. As a result of the analysis on volatile oil in a Brazilian sample, α-thujone, camphor, α-pinene, and β-thujone were the main components (18). In our study, the main components of *Thymus vulgaris* L. were o-cymene, terpinene, thymol, and carvacrol. Although it has been stated in many studies that thymol and carvacrol are the main essential oil components, each species has different chemotypes. In a study conducted on *T. vulgaris* in Lithuania, the main components of essential oil were 1,8-cineol, β-caryophyllene, and E-carvyl acetate; in another study, the characteristic components were stretching-1 (10), 5-dien-4-ol, stretching-1 (10), 4-dien-6-ol, linalool, and linalyl acetate (19). By investigating the effects of essential oils and aroma chemicals on the nervous system, scientific data were provided for the effects of aromatherapy and, more importantly, for the effects of essential oils and their compounds in contemporary treatment. Lavender essential oil and its main compounds, linalool and linalyl acetate, showed a dose-dependent sedative effect in both animals and humans. In studies conducted using electroencephalography with volatile compounds obtained by smell, while indicating a sedative effect with an abundance of α-waves, jasmine odor increased β-wave activity and led to stimulation (20). In an experiment conducted in healthy subjects, the effects of R- (-), S- (+), and racemic-linalool were examined. While racemic-linalool showed a sedative effect with R- (-) -linalool in lavender essence, S-(+) -linalool in another essential oil caused stimulation (21).Thyme essential oil is as effective as amphotericin B in protecting mice from systemic candidiasis. The effect of this essential oil was greater than that of carvacrol. This leads to the possibility that the effect of carvacrol is further strengthened in synergy with other compounds in the oil. It has been experimentally proven that the antimicrobial effect of carvacrol is further strengthened in the presence of p-cymene (22). Essential oils are also important in protecting foods due to their effects in treating bacterial infections, fungal diseases, wounds, burns, and acne. Aldehydes (e.g., cinnamaldehyde, citral, citronellal, perillaldehyde, and salicylaldehyde) and phenols (e.g., carvacrol, thymol, eugenol, and isoeugenol) are bactericidal.

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