Chromatography-mass spectrometric study of the chemical composition of Myrtus communis L. leaf essential oil

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of the article

Myrtus communis is a common species in tropical and subtropical regions. Myrtle is cultivated as an ornamental plant in areas with a temperate climate, such as Ukraine. It was introduced to the Nikitskyi Botanical Garden in 1967. The pharmacological properties of galenic preparations derived from *Myrtus communis* are primarily determined by the presence of essential oils. Galenic preparations from myrtle leaves have general tonic, antimicrobial (notably demonstrating high bactericidal activity against gram-positive bacteria and antibiotic and resistant strains, *Mycobacterium tuberculosis*), analgesic, astringent, expectorant, and anti-inflammatory effects. For a comprehensive study of this plant, it is essential to investigate the volatile fractions of its raw material.

The aim of the work is to conduct a chromatography-mass spectrometric analysis of the chemical composition of *Myrtus communis* L. leaf essential oil.

Materials and methods. The object of the study is the essential oil of *Myrtus communis*, cultivated at the Department of Pharmacognosy, Pharmacology and Botany of Zaporizhzhia State Medical and Pharmaceutical University, and obtained through hydrodistillation. Qualitative and quantitative determination of the essential oil components was carried out using the chromatography-mass spectrometric method on a high-performance gas chromatograph “Agilent 7890B GC System” (Agilent, SantaClara, CA, USA) with a mass spectrometric detector “Agilent 5977 BGC/MSD” (Agilent, SantaClara, CA, USA) and a DB-5ms chromatographic column (30 m × 250 μm × 0.25 μm). The component identification was performed using the NIST14 mass spectral library.

Results. Chromatography-mass spectrometric analysis revealed the presence of 42 key volatile compounds in *Myrtus communis* leaf essential oil, three of which were in isomeric forms. The five major components were myrtenyl acetate (24.12 %), linalool (16.73 %), cyclofenchene (10.37 %), *o*-xylene (7.85 %) and myrtenol (4.35 %). Terpenes were identified as the dominant group in *Myrtus communis* leaves, comprising 72.04 %.

Conclusions. The chemical composition of *Myrtus communis* leaf essential oil showed some differences compared to literature data that deal with geographical features (temperature, soil quality, day length), harvesting time and genotype variations. The research findings can serve as a basis for developing new pharmaceutical and cosmetic products containing myrtle essential oil. Besides, the analysis of the chemical composition of the essential oil can contribute to improving extraction technology and standardizing essential oils.

Keywords: Myrtus communis, volatile organic compounds, chromatography-mass spectrometry.

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Хромато-мас-спектроскопічне дослідження хімічного складу ефірної олії листя Myrtus communis L.

О. Є. Мацегорова, В. М. Одинцова

Myrtus communis – вид, поширений у тропічних і субтропічних регіонах. У регіонах із помірним кліматом, як-от в Україні, мирт культивують як декоративну рослину. Інтродукований у Нікітському ботанічному саду в 1967 році. Фармакологічні властивості галенових препаратів мирту звичайного визначаються передусім наявністю в них ефірних олій. Галенові препарати з листя мирту характеризуються загальною тонізувальною, протимікробною (мають високу бактерицидну активність щодо грам-позитивних і стійких до антибіотиків штамів бактерій, туберкульозної палички), знеболювальну, в’яжучу, відхаркувальну, протизапальну дії. Для комплексного вивчення цієї рослини доцільним є дослідження летких фракцій її сировини.

Мета роботи – хромато-мас-спектроскопічне дослідження хімічного складу ефірної олії листя *Myrtus communis* L.

Матеріали і методи. Об’єкт дослідження – ефірна олія мирту звичайного, що вирощений на кафедрі фармакогнозії, фармакології та ботаніки Запорізького державного медико-фармацевтичного університету. Ефірна олія одержана методом гідродистиляції. Якісне та кількісне визначення компонентів ефірної олії здійснили з використанням хромато-мас-спектрометричного методу на високо-

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Keywords: Myrtus communis, volatile organic compounds, chromatography-mass spectrometry.

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ефективному газовому хроматографі Agilent 7890B GC System (Agilent, SantaClara, CA, USA) з мас-спектрометричним детектором Agilent 5977 BGC/MSD (Agilent, SantaClara, CA, USA) та хроматографічною колонкою DB-5ms (30 м × 250 мкм × 0,25 мкм). Для ідентифікації компонентів використано бібліотеку мас-спектрів NIST14.

Результати. У результаті хромато-мас-спектрометричного дослідження виявлено 42 характерні компоненти летких сполук (3 із них – в ізомерному стані) в ефірній олії листя мирту звичайного з найбільшим вмістом таких п’яти компонентів: миртенілацетат (24,12 %), ліналоол (16,73 %), циклофенчен (10,37 %), *О*-ксилол (7,85 %) та миртенол (4,35 %). Встановили, що основна складова листя мирту звичайного – терпени з кількісним вмістом 72,04 %.

Висновки. Виявлено певні відмінності хімічного складу ефірної олії мирту звичайного порівняно з даними фахової літератури. Це пов’язано з географічним розташуванням (температура, якість ґрунту, тривалість дня), часом збирання та генотипом виду. Результати дослідження можуть стати основою для розроблення нових фармацевтичних і косметичних препаратів, що містять ефірну олію мирту. Аналіз хімічного складу ефірної олії може стати підґрунтям для вдосконалення технології видобутку та стандартизації ефірних олій.

Ключові слова: мирт звичайний, леткі органічні сполуки, хромато-мас-спектрометрія.

Актуальні питання фармацевтичної і медичної науки та практики. 2025. Т. 18, № 2(48). С. 131-137

Essential oils are natural secondary metabolites that contain a complex mixture of volatile compounds with a wide range of biological activities [1]. They are found in various parts of plants, including leaves, seeds, flowers, roots, and bark. Essential oils play a crucial role in plant life, as they contain compounds that help combat parasites and infections, possessing antibacterial, antifungal, and antiparasitic properties. Essential oils are used in perfumery, cosmetics, household product scenting, beverages, and medicine [2].

Myrtus communis L. belongs to the family *Myrtaceae* and is classified as an essential oil-bearing plant. It is a widespread species in typical Mediterranean flora and grows naturally in Iran, Spain, France, Greece, Turkey, Algeria, Morocco, Croatia, Italy, and Montenegro [3]. Although myrtle grows spontaneously, it is widely cultivated worldwide as an ornamental, small, evergreen perennial plant that can reach up to 2 meters in height [4].

In Ukraine, this plant can be successfully grown, but it requires special care. *Myrtus communis* L. can be cultivated only in the southern regions of Ukraine in open ground. In central and northern regions, it is traditionally grown as an indoor or container plant, which is placed outdoors during the summer months.

A literature review highlights the high biological activity of myrtle leaf essential oil. It is primarily used for the treatment of bronchitis, tuberculosis, diarrhoea, haemorrhoids, and prostatitis [4]. Notably, myrtle essential oil has nematicidal [5], biopesticidal [6], insecticidal [7], antimicrobial [8,9], and fungicidal [10] properties. Besides, it possesses antioxidant, anti-inflammatory, gastroprotective and hepatoprotective effects [11,12,13,14,15].

Essential oils of *Myrtus* species primarily consist of monoterpene hydrocarbons, oxygenated monoterpenes, simple ethers, esters, sesquiterpene hydrocarbons, oxygenated sesquiterpenes, aliphatic hydrocarbons, alcohols, and phenols, distributed in varying proportions [16]. Notably, the principal compounds remain consistent, despite variations in their relative percentages: myrtenyl acetate, 1,8-cineole, linalool, and α-pinene [8,9,17].

Although metabolic processes in living organisms are maintained by deep evolutionary history and exhibit high stability, they can be influenced by various factors. These include endogenous factors, such as genetic variations and development stage, and exogenous ones, such as soil properties, temperature, day length, humidity, nutrient availability, light, and geographical location [18]. When environmental conditions change, plants must adapt through biochemical pathways and processes. Consequently, populations of medicinal plants growing in different ecological conditions may produce a diverse range of active compounds, leading to variations in both the quantity and quality of these substances. This variability, in turn, may affect the plant’s therapeutic and biological activity [19,20].

Since existing references primarily provide information on *Myrtus communis* leaf essential oil from plants that grow spontaneously or are cultivated in other countries, studying the volatile fractions of *Myrtus communis* grown in Ukraine as an ornamental plant, is particularly relevant. Moreover, *Myrtus communis* is not in the Ukrainian pharmacopoeia. Therefore, understanding the composition of its essential oil is crucial for the further development of standardization methods. This will ensure the high quality and stability of products containing *Myrtus communis*, such as pharmaceutical preparations, cosmetic products, and aromatic additives.

Aim

The purpose of the work is to determine the qualitative and quantitative content of volatile compounds in *Myrtus communis* leaf essential oil using gas chromatography-mass spectrometry.

Materials and methods

The object of the study was *Myrtus communis* essential oil. The plant was cultivated under controlled microclimatic conditions at the Department of Pharmacognosy, Pharmacology, and Botany of Zaporizhzhia State Medical and Pharmaceutical University (Ukraine). *Myrtus communis* was grown on east-facing windowsills under a temperature regime of +18 °C to +26 °C and a relative humidity of 60–75 %, maintained through regular misting. Watering was performed using soft water: moderately abundant in summer and limited in winter. The plant material was dried in the shade at room temperature for 5 days, then crushed into pieces of 0.5–1.0 cm. The essential oil was extracted using the hydrodistillation method [21].

Qualitative and quantitative determination of the components of essential oil was performed using the chromatography-mass spectrometric method in the Gas Chromatography-Mass Spectrometry Laboratory of the Educational and Research Medical Laboratory Center with a vivarium of Zaporizhzhia State Medical and Pharmaceutical University.

Standard methods for determining chemical compounds were applied on a high-performance gas chromatograph "Agilent 7890B GC System" (Agilent, SantaClara, CA, USA) with a mass spectrometry detector "Agilent 5977 BGC/MSD" (Agilent, SantaClara, CA, USA) [22]. The DB-5ms chromatographic column was 30 m × 250 µm × 0.25 µm. The carrier gas (helium) flow rate was 1.3 ml/min. The injection volume was 0.5 µl, with a flow split ratio of 1 : 5. The sample introduction block temperature was 200 °C → 12 °C/s → 265 °C. The thermostat temperature was programmed, starting at 70 °C (with a minute hold) → 10 °C/min → 270 °C (with a four-minute hold). The GC/MS interface temperature was 275 °C; the ion source was 230 °C; the quadrupole mass analyzer temperature was 150 °C. The ionization method was EI at 70 eV, with a mass range of 30–700 m/z.

The identification of the components was conducted using the NIST14 mass spectral library. Within the framework of this study, the experiment was conducted once, following the preliminary calibration and metrological verification of the high-performance gas chromatograph.

Results

The essential oil was obtained from dried myrtle leaves using the hydrodistillation method, with a yield of 0.72 % relative to the total mass. The essential oil is a mobile, pale yellow liquid with a fresh, strong, camphor-like, sweet, and herbaceous aroma and a bitter, pungent taste.

The essential oil is a mobile, pale-yellow liquid with a fresh, strong, camphor-like, sweet-herbaceous aroma and a bitter, pungent taste.

The results of chromatography-mass spectrometric analysis of the qualitative and quantitative composition of volatile compounds in *Myrtus communis* L. leaves are in *Table 1*.

Table 1. Qualitative and quantitative composition of *Myrtus communis* L. leaf essential oil

No.	Component name	Chemical formula	Compound class	RT, min.	Area sum, %
1.	Myrtenyl acetate*	$C_{12}H_{18}O_2$	OM	17.963	24.12
2.	Linalool	$C_{10}H_{18}O$	OM	11.674	16.73
3.	Tricyclo[2.2.1.0(2,6)]heptane, 1,3,3-trimethyl-	$C_{10}H_{16}$	MH	6.81	10.37
4.	*o*-Xylene*	C_8H_{10}	AH	5.233	7.85
5.	Bicyclo[3.1.1]hept-2-ene-2-methanol, 6,6-dimethyl-	$C_{10}H_{16}O$	OM	14.315	4.35
6.	*o*-Xylene*	C_8H_{10}	AH	5.715	4.12
7.	*o*-Xylene*	C_8H_{10}	AH	4.98	3.51
8.	Eucalyptol	$C_{10}H_{18}O$	OM	9.51	2.86
9.	D-Limonene	$C_{10}H_{16}$	MH	9.409	2.66
10.	Safrole	$C_{10}H_{10}O_2$	OC	16.865	2.48
11.	1,4,7,-Cycloundecatriene, 1,5,9,9-tetramethyl-,Z,Z,Z-	$C_{15}H_{24}$	OC	21.207	2.32
12.	Methyl eugenol	$C_{11}H_{14}O_2$	OC	19.797	1.7
13.	*p*-Cymene	$C_{10}H_{14}$	AH	9.26	1.52
14.	Caryophyllene	$C_{15}H_{24}$	SH	20.29	1.23
15.	2-Naphthalenemethanol, 1,2,3,4,4a,5,6,8a-octahydro-α,α,4a,8-tetramethyl-,[2R-(2α,4α,α,8α,β)]-	$C_{15}H_{26}O$	OS	26.05	1.2
16.	Propanoic acid, 2-methyl-, butyl ester	$C_8H_{16}O_2$	OC	6.239	1.13
17.	Butanoic acid, 2-methyl-, 2-methylpropyl ester	$C_9H_{18}O_2$	OC	8.631	1.01
18.	(1*R*,3*E*,7*E*,11*R*)-1,5,5,8-Tetramethyl-12-oxabicyclo[9.1.0]dodeca-3,7-diene	$C_{15}H_{24}O$	OS	24.961	0.98
19.	Linalyl acetate	$C_{12}H_{20}O_2$	OM	15.742	0.96
20.	Propanoic acid, 2-methyl-, 2-methylbutyl ester	$C_9H_{18}O_2$	OC	9.008	0.71
21.	Geranyl acetate	$C_{12}H_{20}O_2$	OM	19.209	0.63
22.	Myrtenyl acetate*	$C_{12}H_{18}O_2$	OM	17.018	0.54
23.	Caryophyllene oxide	$C_{15}H_{24}O$	OS	24.299	0.54

Cont. of table 1.

No.	Component name	Chemical formula	Compound class	RT, min.	Area sum, %
24.	γ-Terpinene	$C_{10}H_{16}$	MH	10.218	0.53
25.	Isobutyric acid, 2-pinen-10-yl ester	$C_{14}H_{22}O_2$	OC	21.361	0.52
26.	(+)-4-Carene	$C_{10}H_{16}$	MH	11.005	0.48
27.	3-Carene*	$C_{10}H_{16}$	MH	8.784	0.46
28.	3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)-,(R)- ((-)-	$C_{10}H_{18}O$	OM	13.821	0.43
29.	Isospathulenol	$C_{15}H_{24}O$	OS	28.836	0.43
30.	2-Naphthalenemethanol, 1,2,3,4,4*a*,5,6,7-octahydro-α,α,4a,8-tetramethyl-,(2*R*-*cis*)-	$C_{15}H_{26}O$	OS	25.505	0.4
31.	(-)-*cis*-Myrtanyl acetate*	$C_{12}H_{20}O_2$	OM	19.377	0.33
32.	2-Cyclohexen-1-ol, 2-methyl-5-(1-methylethenyl)-, acetate, *cis*-	$C_{12}H_{18}O_2$	OM	18.039	0.32
33.	α-Phellandrene	$C_{10}H_{16}$	MH	6.54	0.31
34.	6-acetyl-2,2,4,4-tetramethylcyclohexane-1,3,5-trione	$C_{12}H_{16}O_4$	OC	18.674	0.29
35.	τ-Cadinol	$C_{15}H_{26}O$	OS	25.771	0.28
36.	2-Hexenal, (*E*)-	$C_6H_{10}O$	OC	4.832	0.24
37.	3-Carene*	$C_{10}H_{16}$	MH	9.878	0.24
38.	(3*R*,3*aR*,3*bR*,4*S*,7*R*,7*aR*)-4-Isopropyl-3,7-dimethyloctahydro-1*H*-cyclopenta[1,3]cyclo-propa[1,2]benzen-3-ol	$C_{15}H_{26}O$	MH	22.247	0.24
39.	Ethyl 2-(5-methyl-5-vinyltetrahydrofuran-2-yl)propan-2-yl carbonate	$C_{13}H_{22}O_4$	OS	10.63	0.23
40.	1-Bromo-3,7-dimethyl-2,6-octadiene	$C_{10}H_{17}Br$	OS	8.252	0.17
41.	Bicyclo[3.1.1]heptan-3-ol, 6,6-dimethyl-2-methylene-,[1S-(1α,3α,5α)]-	$C_{10}H_{16}O$	MH	12.692	0.15
42.	Bicyclo[3.1.0]hexane, 4-methylene-1-(1-methylethyl)-	$C_{10}H_{16}$	OM	7.911	0.11
43.	α-Campholenal	$C_{10}H_{16}O$	MH	12.262	0.09
44.	Benzenemethanol,α,α,4-trimethyl-	$C_{10}H_{14}O$	AH	14.118	0.07
45.	1-(3-Methyl-cyclopent-2-enyl)-cyclohexene	$C_{12}H_{18}$	MH	16.564	0.07
46.	3-Hexanone, 2-methyl-	$C_7H_{14}O$	OC	3.608	0.05
47.	1,1,5-Trimethyl-1,2-dihydronaphthalene	$C_{13}H_{16}$	AH	18.58	0.05
Total identified					100.01
Monoterpene hydrocarbons (MH)					15.6
Oxygenated monoterpenes (OM)					51.38
Sesquiterpene hydrocarbons (SH)					1.23
Oxygenated sesquiterpenes (OS)					3.83
Aromatic hydrocarbons (AH)					17.12
Other compounds (OC)					10.85

*****: the compounds are isomers.

Chromatography-mass spectrometric analysis revealed the presence of 42 key components of volatile compounds, three of which were in isomeric forms.

During the chemical analysis of the leaves, myrtenyl acetate was found to have the highest content (24.12 %), belonging to the class of oxygenated monoterpenes. It also has two isomers with concentrations of 0.54 % and 0.33 %. The next ones in quantitative content are linalool (oxygenated monoterpene) – 16.73 %, cyclofenchene (monoterpene hydrocarbon) – 10.37 %, o-xylene with isomers (aromatic hydrocarbons) – 7.85 %, 4.12 %, and 3.51 %, and Myrtenol (oxygenated monoterpene) – 4.35 %. It was determined that the primary constituents of *Myrtus communis* leaves are terpenes (72.04 %), with oxygenated monoterpenes accounting for 51.38 %. The next ones are monoterpene hydrocarbons with a content of 15.6 %, oxygenated sesquiterpenes – 3.83 % and sesquiterpene hydrocarbons – 1.23 %. The content of aromatic hydrocarbons was 17.12 %, while other compound classes accounted for 10.85 %.

The following compounds were identified on the chromatogram of *Myrtus communis* L. essential oil components: myrtenyl acetate with a retention time of 17.963 min, lina-

1

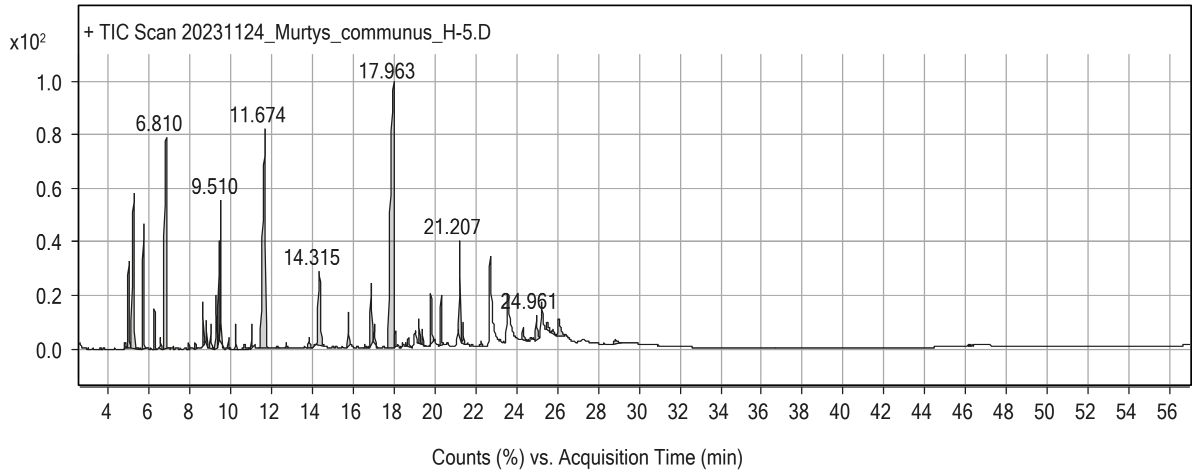

Fig. 1. Chromatogram of the components of *Myrtus communis* L. essential oil.

lool – 11.674 min, cyclofenchene – 6.81 min, and myrtenol – 14.315 min *(Fig. 1)*.

Discussion

Some differences in the chemical composition were observed compared to a literature review on essential oil extracted from *Myrtus communis* samples from different countries. The main compound in the essential oil of *Myrtus communis* from Tunisia was *α*-pinene, with a content of 45.3 % [9].

In contrast, an analysis of *Myrtus communis* leaf essential oil, derived from leaves collected during the flowering season from natural habitats in various locations in Morocco, demonstrated a significant presence of 1,8-cineole (42.22 %) [17]. Other studies by W. Ouedrhiri et al. concerning myrtle leaves from the Taonate region (Morocco) identified a different major compound – myrtenyl acetate (33.67 %) [23]. This variability in the chemical composition is related to the collection place and geographic origin. All these components play a crucial role in the plant's adaptation to its ecology and environment.

The components of the essential oil were evaluated within 14 samples of myrtle grown under greenhouse conditions. In the Fars province, the myrtle samples demonstrated significant variations in their chemical profile. There were 23 chemical compounds in the analyzed myrtle samples. Most of the compounds were *α*-pinene (2.35–53.09 %), linalyl acetate (0.00–45.3 %), caryophyllene oxide (0.97–21.8 %), germacrene D (0.00–19.19 %), *α*-humulene (0.00–18.97 %), 1,8-cineole (0.00–18.0 %), limonene (0.0–17.4 %) and *p*-cymene (0.0–13.2 %) [24].

Our research findings are consistent with the conclusions of R. B. Mansour et al., who reported that the main components of *Myrtus communis* leaf essential oil were myrtenyl acetate (30.6 %), linalool (14.9 %) and 1,8-cineole (eucalyptol) (9.9 %) [13].

Caputo L. et al. investigated the chemical composition of essential oil from fresh *Myrtus communis* collected in Bellosguardo (Salerno, Italy). A total of 59 compounds were identified, accounting for 98.4 % of the total oil content. Oxygenated monoterpenes were the predominant components (71.7 %), followed by monoterpene hydrocarbons (18.6 %) and sesquiterpene hydrocarbons (2,6 %). The major constituents were myrtenyl acetate (29.8 %), 1,8-cineole (21.9 %), *α*-pinene (14.7 %), and linalool (9.1 %). Other compounds present in the smaller amount included heptyl isobutyrate (3.2 %), geranyl acetate (2.6 %), *α*-terpineol (2.3 %), (*Z*)-caryophyllene (1.3 %), and *α*-humulene (1.1 %) [8].

In *Myrtus communis* L. leaf essential oil, which was collected in Vila Real, northern Portugal, the main compounds were ethylmyrtenyl (15.5 %), *β*-linalool (12.3 %), 1,8-cineole (9.9 %), ethylgeranyl (7.4 %), limonene (6.2 %), *α*-pinene (4.4 %), linalyl aminobenzoate (5.6 %), *α*-terpineol (2.7 %), *α*-terpinenyl acetate (2.2 %), methyl eugenol (1.8 %), and myrtenol (1.2 %). Other identified compounds included propanoic acid, 2-methyl-,2- (1.8 %), 7-isopropyl-7-methyl-nona-3,5-dien-2,8-dione (1.7 %), humulene-1,2-epoxide (1.2 %) and trans-pinocarvyl acetate (1.2 %). The remaining volatile compounds were present in amounts below 1 %, namely 2-hexanal, nonane, *β*-myrcene, terpinene-4-ol, nonane, 2,6-octadecenoic acid, 3,7-dimethyl-, *β*-caryophyllene, humulene, and caryophyllene oxide [25].

When comparing myrtle populations grown under greenhouse conditions with wild myrtle, the main components identified were *α*-pinene, linalyl acetate, caryophyllene oxide, germacrene D, *α*-humulene, 1,8-cineole, limonene and *p*-cymene. These compounds are likely to contribute to the potential applications of myrtle essential oil. The myrtle populations were primarily classified into four groups based on the dominant essential oil components:

– Group I: caryophyllene oxide / germacrene D / *α*-humulene / methyl eugenol chemotype;

– Group II: *α*-pinene / *p*-cymene / *α*-humulene / (*E*)-*β*-caryophyllene;

– Group III: *α*-pinene / 1,8-cineole and linalool;

– Group IV: linalyl acetate / *γ*-terpinene / 1,8-cineole / limonene.

The essential oil content in myrtle populations was influenced by various factors, including geographical origin, environmental conditions, and genetic traits. Selecting myrtle populations based on their distinct chemical profiles could help breeders develop targeted breeding strategies to create new genotypes, ultimately promoting their commercial cultivation [24].

Conclusions

1. Chromatography-mass spectrometric analysis revealed the presence of 42 key volatile compounds in *Myrtus communis* leaf essential oil, three of which were in isomeric forms. The five major components were myrtenyl acetate (24.12 %), linalool (16.73 %), cyclofenchene (10.37 %), *o*-xylene (7.85 %) and myrtenol (4.35 %). Terpenes were identified as the dominant group in *Myrtus communis* leaves, comprising 72.04 %. The chemical composition of *Myrtus communis* leaf essential oil showed some differences compared to literature data that deal with geographical features (temperature, soil quality, day length), harvesting time and genotype variations.

2. The research findings can serve as a basis for the development of new pharmaceutical and cosmetic products containing myrtle essential oil. Due to its high content of biologically active terpene compounds, particularly myrtenyl acetate, linalool, and myrtenol, myrtle essential oil exhibits significant potential for pharmaceutical applications, particularly in antiseptic, anti-inflammatory, spasmolytic, and antioxidant formulations. In cosmetology, myrtle essential oil can be incorporated into anti-aging and skincare products to enhance antioxidant activity, as well as into formulations for strengthening hair and controlling excessive scalp oiliness. Owing to its pronounced antimicrobial properties, myrtle essential oil may serve as an effective component in natural deodorants, antiseptic lotions, and skincare products designed for problematic skin.

3. Besides, the analysis of the chemical composition of essential oil can contribute to improving extraction technology and standardizing essential oils.

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