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Chemical Composition of the Essential Oil from *Marrubium persicum* C. A. Mey. (Lamiaceae)

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ABSTRACT

Background: The essential oil of *Maruubium persicum* C. A. Mey (Lamiaceae) was obtained by hydrodistillation from aerial parts of the plant during flowering stage. ***Methods:*** The chemical analyses of the essential oil by GC/MS and GC/FID, allowed us to identify thirty three compounds, representing 94.4% of the total oil. ***Results:*** The essential oil of *M. persicum* was typically a complex mixture of mainly oxygenated non-terpenoids (51.5%), sesquiterpene hydrocarbons (27.9%), oxygenated sesquiterpenes (4.8%), monoterpene hydrocarbons (9%), and oxygenated monoterpenes (1.3%). The major components of the essential oil were m-tolualdehyde (19.2%) followed by acetophenone (14.6%), germacrene D (10.5%), β-caryophyllene (7.4%), β-farnesene (6.2%), and α-pinene (4.6%). ***Conclusion:*** In spite of the fact that *Marrubium* sp. contain quite lower amounts of aliphatic and non-terpenoid fractions, *M. persicum* revealed rather higher proportions of non-terpenoid compounds, namely acetophenone with different isomers of tolualdehyde which are considered to be reported for the first time in the genus *Marrubium*.

Introduction

Not surprisingly, the wide range of herbal medicines available today has been brought about by one of the most significant ancient heritages, the sophisticated experience of people who have tried over millennia to find useful plants for health improvement, with each generation adding its own experience to this tradition. Following on from scientific advancements, in a time of increased considerations to natural products as a safe herbal remedies, it is as important as ever to gather detailed documentations of the latter in every aspect.[1]

Lamiaceae family has been holding a place of value for hundreds of years due to the infusions and tinctures of numerous aromatic species used as components of herbal treatments for a variety of ailments.[2] Considering the endemism and diversity of the species used in traditional and folk medicine in Iran, *Marrubium* a genus of about 40 species of flowering plants in this family has a widespread usage by different cultures and also a high reputation in herbal medicine by several known healing attributes.[3]

Marrubium sp. are often perennial tomentose herbs, with wrinkled leaves, and small flowers in dense axillary clusters that are native to temperate regions of Europe and Asia.

Regarding the phytochemical analysis of the plants of this genus, they mainly produce diterpenes, polyphenols, steroids, phenylpropanoids and flavonoids, some of which have important biological properties.[4-8] Generally, species of this genus are characterized through having potential therapeutic activities, which have been supported by various studies demonstrating cytotoxicity, immunomodulating, vasorelaxant, antispasmodic, hypolipidemic, hypoglycemic, and analgesic properties of this genus.[9-15] Furthermore, studies dealing with the composition, antimicrobial and antioxidant activities of essential oils extracted from different species of the genus *Marrubium* have been previously reported.[16-25]

Based on Flora Iranica, *M. persicum*, is endemic to the countries; Armenia, Azerbaijan, Turkey and Iran which is considered to be an unknown source of chemical constituents, since there has been no study on *M. persicum*.[26] Regarding the number of reports on the chemical diversity and biological properties of the essential oils within a genus demonstrating both quantitative and qualitative diversity in the composition of the essential oils, assessing the volatile constituents naturally occurring in the essential oil of a plant seems to be of value. Hence, the present study was conducted to provide the very first and detailed GC-MS analysis of the volatile constituents from the aerial parts of *M. persicum* grown in Azarbaijan province in Iran. This

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report is a leading point in our study on the species of genus *Marrubium* of Iranian flora.

Materials and Methods

Plant Material

Aerial parts of *Marrubium persicum* C. A. Mey. were collected during the flowering stage from Varzeghan in East Azarbaijan province, Iran (38° 30′ 33.9′ ′N latitude, 46° 30′ 41″ E longitude, and 1940 m above sea level), in June 2011. A voucher specimen of the plant representing this collection has been deposited at the Herbarium of the Faculty of Pharmacy, Tabriz University of Medical science, Iran.

Essential oil extraction

Air-dried plant material of the aerial parts of *M. persicum* was subjected to hydrodistillation using a Clevenger-type apparatus (Clevenger, 1928). Since the oil content was low in quantity, the distillation time was prolonged (5h) and xylene was used as an absorbing medium. The obtained essential oil was stored in sealed glass vial at 4-5°C prior to analysis.

Gas Chromatography-Mass Spectrometry (GC-MS)

The essential oil was analyzed by GC-MS using a Shimadzu GC-MS-QP 5050A gas chromatograph fitted with a DB1 (methyl phenyl syloxane, 60 m x 0.25 mm i.d., 0.25 µm film thickness) capillary column. The GC was set at the following conditions with helium as the carrier gas; flow rate of 1.3 mL/min; linear velocity: 29.6 cm/s; Split ratio, 1:29; column temperature, 2 min in 60°C, 50-260 °C at 3 °C/min; injector temperature, 240 °C, and 1 µL of volume injection of the essential oil. The MS operating parameters were as follows: ionization potential, 70 eV; ion source temperature; 270 °C; quadrupole 100 °C, Solvent delay 2 min, scan speed 2000 amu/s and scan range 30-600 amu, EV voltage 3000 volts.

Identification of the compounds

The identification of compounds was based on direct comparison of the retention indices and mass spectral data with those for the standards and by computer matching with the Wiley 229, Nist 107, Nist 21 Library, as well as by comparing the fragmentation patterns of the mass spectra with those reported in the literature.[27] For quantification purpose, relative area percentages were obtained by FID without the use of correction factors, where the FID detector condition was set on a duplicate of the same column applying the same operational conditions.

Results

The hydrodistillation of the flowering aerial parts of M. persicum gave the essential oil in a very small quantity, justifying the categorization of the investigated species in the so-called “oil poor taxa” of the Lamiaceae family. The GC–MS analysis of the essential oil led to the identification of 33 different components, representing 94.4% of total oil constituents. All the compounds are arranged in order of their elution from the DB1-MS column and the retention time with their percentage composition are summarized in Table 1.

Table 1. Chemical constituent of the essential oil from aerial parts of *M. persicum*.

No.	RI[a]	Compounds	Area (%)
1	906	n-Nonane	1.6
2	932	Benzaldehyde	0.9
3	936	α-Pinene	4.6
4	966	1-Octen-3-ol	1.6
5	970	Sabinene	1.3
6	986	Myrcene	0.6
7	1003	Decane	0.2
8	1011	α-Tolualdehyde	2.4
9	1025	Limonene	2.5
10	1036	Acetophenone	14.6
11	1040	m-Tolualdehyde	19.1
12	1052	o-Tolualdehyde	3.5
13	1085	Nonanal	0.5
14	1087	Linalool	0.4
15	1230	Terpinen-4-ol	0.5
16	1250	α-Terpineol	0.3
17	1381	α-Cubebene	0.3
18	1389	β-Bourbonene	0.4
19	1424	β-Caryophyllene	7.4
20	1450	β-Farnesene	6.1
21	1457	α-Humulene	0.8
22	1482	Germacrene D	10.5
23	1497	Bicyclogermacrene	1.3
24	1505	β-Bisabolene	0.7
25	1520	δ-Cadinene	0.4
26	1570	Spathulenol	0.5
27	1577	Caryophyllene oxide	2.1
28	1689	α-Cadinol	0.5
29	1748	α-Bisabolol	1.7
30	1833	Hexahydrofarnesyl acetone	2.9
31	2592	Hexacosane[b]	0.8
32	2793	Octacosane[b]	1.1
33	2892	Nonacosane[b]	2.3
Total			**94.4**
Non-terpenoids			**51.5**
Monoterpene hydrocarbons			**9**
Oxygenated monoterpenes			**1.2**
Sesquiterpene hydrocarbones			**27.9**
Oxygenated sesquiterpenes			**4.8**

[a]RI is the Retention Index relative to C8–C24 n-alkanes on the DB-1 column.

[b]This compound was compared with an authentic sample.

The essential oil of *M. persicum* was typically a complex mixture of mainly oxygenated non-terpenoids (51.5%), sesquiterpene hydrocarbons (27.9%), oxygenated sesquiterpenes (4.8%), monoterpene hydrocarbons (9%), and oxygenated monoterpenes (1.2%). Among the non-terpenoid compounds, m-tolualdehyde, acetophenone, and α-tolualdehyde were the chief constituents with 19.1%, 14.6% and 2.4% parts present in the essential oil, correspondingly. The major sesquiterpenes of the oil were identified as germacrene D (10.5%), β-caryophyllene (7.4%), β-farnesene (6.1%), and bicyclogermacrene (1.3%). In the case of identified monoterpenes, α-pinene, limonene, and sabinene were considered as the most frequent constituents of the oil with the relative percentages of 4.6, 2.5, and 1.3%, respectively. Considering the oxygenated monoterpene and sesquiterpen compounds, terpinen-4-ol with 0.5% and caryophyllene oxide with 2.1% were the dominant components of the groupings. On the whole, the most abundant components of the *M. persicum* essential oil were m-tolualdehyde (19.1%) followed by acetophenone (14.5%), germacrene D (10.5%), β-caryophyllene (7.4%), β-farnesene (6.1%), and α-pinene (4.6%).

Discussion

Having reviewed the previously reports of the essential oils from genus *Marrubium*, underlying the fact that most species of *Marrubium* have rather low amounts of aliphatic and non-terpenoid fractions,[16-25] *M. Persicum* not only presented relatively higher amounts of non-terpenoids but also the most prominent constituent of the essential oil was a non-terpenoid compound, m-tolualdehyde. Meanwhile, it would be of note to mention new components, namely acetophenone together with different isomers of tolualdehyde present in the essential oil of *M. persicum*, were reported for the first time in the genus *Marrubium*. Regardless of the essential oil had been characterized with non-terpenoids as the most significant components, *M. persicum* essential oil contained relatively sizeable amounts of germacrene D supporting for the Lawrence concept that oil-poor species of the family Labiatae produce essential oils rich in sesquiterpene hydrocarbons, with germacrene D often being one of the predominant compounds.[28]

Furthermore, it is judicious to be reminiscent of the environmental factors like geography, altitude, temperature, day length, and edaphic conditions of the plant growing wild being notable agents playing key roles in the chemical composition of *M. persicum* oil. Seeing as, these factors could influence the biosynthetic pathways of plants, the relative proportion of the main characteristic compounds of the essential oils as the secondary metabolites would be variable. Based on the biosynthesis pathways of the essential oils, it is suggested that the production of terpenoid and non-isoprenoid compounds diverges early in the pathway of anabolic plant secondary compound synthesis.[29]

Conclusion

Regarding the similarities and differences in chemical composition of the oil compared to the other essential oil reports of different species from genus *Marrubium*, it was suggested that the variations in presence or absence and the identity of compounds within these species may arise from intrinsic (genetic, growth stage) and extrinsic conditions such as climatic, seasonal, environmental and distillation processes of these samples. Although, further studies are mandatory and would be of value in determining the origin of the differences detected among these essential oils, the authors hope this study could furnish the background for the basic experiments on the relative studies of this genus or family as it is the first report on the chemical constituents of *Marrubium persicum* essential oil.

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