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Chemical Composition and Antioxidant Activity of Essential Oils of some Iranian Herbs

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Medicinal herbs are an important element of medical system. The products of plant secondary metabolism, such as essential oils, aromatics, and volatile constituents, have a wide range of applications in folk medicine, food flavoring, and food preservation as well as in food and drug industries ([Ghasemi Pirbalouti, 2010](#)).

Essential oil and extracts from medicinal and aromatic plants by steam or hydro- distillation and solvent extraction are good sources of biologically active compounds known as phytochemicals ([Wink, 1999](#)).



Plant extracts with **antioxidant and antimicrobial** activities could be promising agents in the food and flavoring industry ([Imelouane et al., 2009](#)).

Iran is a vast country of rich plant resources including considerable number of medicinal and aromatic plants. About 1000-1200 species of medicinal and aromatic plants have been reported in the flora of Iran ([Mozaffarian, 2012](#)).

Zagros mountain chain situated from northwestern to southwestern and south Iran is the alpine region which is rich medicinal and aromatic herbs ([Mozaffarian, 2012](#)). In addition, an important part of ethnobotanical knowledge in Iran can be traced in the **nomadic** life that several nomadic tribes live in this region. Almost all of the families in a certain nomadic population have some considerable knowledge about local medicinal plants for treating common health problems ([Ghasemi Pirbalouti, 2009](#); [Mosaddegh et al., 2012](#))



Some Iranian medicinal and aromatic plants collected from the alpine of southwestern Iran, including

Satureja bachtiarica, *Satureja kellalensis*, *Thymus daenensis*,
Ziziphora tenuir, and *Z. clinopodioides* (**Lamiaceae**);

Echinophora cinerea, *Echinophora platyloba*, *Heracleum lasiopetalum*, *Zaravschanica membranacea*, and *Ferulago angulata* (**Apiaceae**);

Achillea kellalensis (**Asteraceae**);

Hypericum helianthemoides, *H. scabrum*, and *H. perforatum*
(**Hypericaceae**);

Valeriana sisymbriifolia Vahl. (**Valerianaceae**)

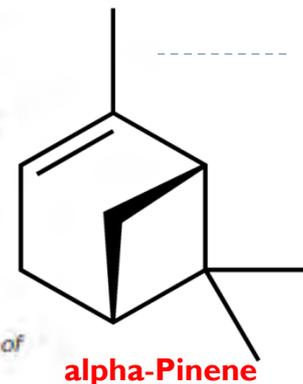
to study phytochemical characteristics and antioxidant activity were investigated.

ORIGINAL ARTICLE

Chemical composition and bioactivity of essential oils of *Hypericum helianthemoides*, *Hypericum perforatum* and *Hypericum scabrum*

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Abstract

Context: A number *Hypericum* species are well known for their therapeutic efficacy and use in traditional medicine. The various species of *Hypericum* have been traditionally used for the treatment of wounds, eczema, burns, trauma, rheumatism, neuralgia, gastroenteritis, ulcers, hysteria, bedwetting and depression.

Objective: This study evaluated the *in vitro* antioxidant, antibacterial and phytochemical properties of essential oils of *Hypericum helianthemoides* (Spach) Boiss., *Hypericum perforatum* L. and *Hypericum scabrum* L. (Hypericaceae) collected from alpine region of Southwest Iran.

Materials and methods: The essential oils obtained from dried flowering aerial parts of three *Hypericum* species were analyzed by gas chromatography and gas chromatography/mass spectrometry to determine chemical compositions. The antibacterial activity of essential oils within concentration ranges from 16 to 500 µg/mL was individually evaluated against *Bacillus cereus*, *Listeria monocytogenes*, *Proteus vulgaris* and *Salmonella typhimurium*. The 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity of essential oils was determined using DPPH assay.

Results: Essential oil yield of *H. helianthemoides*, *H. scabrum* and *H. perforatum* were 0.12, 0.20 and 0.21 mL/100g dried material, respectively. The major constituents of the essential oils were α -pinene (12.52–49.96%), β -pinene (6.34–9.70%), (*E*)- β -ocimene (4.44–12.54%), β -caryophyllene (1.19–5.67%), and germacrene-D (2.34–6.92%). The essential oils of three *Hypericum* species indicated moderate-to-good inhibitory activities against four bacteria, especially against *L. monocytogenes*.

Discussion and conclusion: The essential oils of the three studied *Hypericum* species sourced in alpine region of West Iran were rich in monoterpene and sesquiterpenes hydrocarbons. Among the three tested species, the essential oil of *H. scabrum* showed the highest antibacterial and antioxidant activities.

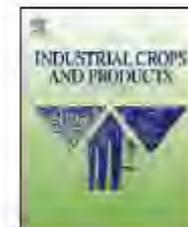




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Essential oil variation, antioxidant and antibacterial activity of mountain fennel (*Zaravschanica membranacea* (Boiss.) M. Pimen.)

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ABSTRACT

Mountain fennel [*Zaravschanica membranacea* (Boiss.) M. Pimen. syn. *Peucedanum membranacea* Boiss.] is a plant from the family Apiaceae which grows wild in Zagros mountains range, Iran. The plant has been used as a flavoring agent, especially dairy foods (yoghurt and cheese) and meat by the indigenous people of Chaharmahal va Bakhtiari, southwestern Iran. Essential oil was extracted from *Z. membranacea* aerial parts collected from the plants within seven natural habitats in three provinces, Iran. The hydrodistilled essential oil analyzed by GC and GC/MS. The highest oil yield was obtained from the Shirmard population with 1.63 ml/100 g dry matter. Results indicated significant differences among the various populations for the main constituents in the essential oils of *Z. membranacea*. The major constituents of the essential oils from various populations of *Z. membranacea* were *cis*- β -ocimene (8.28 \pm 1.09 to 54.84 \pm 3.16), sabinene (1.47 \pm 1.82 to 18.75 \pm 1.54), *trans*- β -ocimene (1.32 \pm 0.09 to 18.52 \pm 2.54), α -pinene (6.66 \pm 1.00 to 15.51 \pm 0.65), γ -terpinene (0.34 \pm 0.15 to 13.58 \pm 3.08), α -terpinolene (1.03 \pm 0.36 to 10.28 \pm 3.13), and β -pinene (0.63 \pm 0.16 to 8.38 \pm 0.04). *Z. membranacea* contained three chemotypes, including *cis*- β -ocimene/sabinene/ α -pinene (chemotype-I), sabinene/ γ -terpinene (chemotype-II), and *cis*- β -ocimene/*trans*- β -ocimene (chemotype-III). The essential oils of *Z. membranacea* indicated moderate-to-good inhibitory activities (MICs = 32–250 μ g/ml) against four bacteria, especially against *Proteus vulgaris*. In addition, the essential oils of *Z. membranacea* had weak-to-good antioxidant (DPPH) radical scavenging activity. Finally, the essential oil of *Z. membranacea* could be a potential source of natural products for use in food industry.



Essential oil and chemical compositions of wild and cultivated *Thymus daenensis* Celak and *Thymus vulgaris* L.



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A B S T R A C T

Thymus vulgaris L. and *Thymus daenensis* Celak from mint family (Lamiaceae) traditionally being used as source of the essential oil and phenolic components derived from their different parts. Growth, oil yield and chemical components of *T. vulgaris* and *T. daenensis* grown in different regions in south-central of Iran were investigated. The hydro-distillated oils obtained from wild and cultivated thyme species were analyzed by GC–MS. Twenty four components in total were identified representing more than 85–98% of the oil composition, with thymol (33.9–70.3%), carvacrol (4.0–24.8%), γ -terpinene (3.9–10.4%) and *p*-cymene (4.8–8.6%) in *T. daenensis*, and thymol (35.5–44.4%), carvacrol (4.4–16.1%), γ -terpinene (10.5–11.9%) and *p*-cymene (8.5–16.1%) in *T. vulgaris* as major constituents. Location had no significant effect on growth characteristics of the two thyme species, but the quantity and quality of their essential oils were different in different regions. *T. daenensis* cultivated in Saman region produced highest thymol (70.3%), whereas those cultivated in Shahrekord region produced highest oil yield (1.16%, v/w). *T. daenensis* wild growing produced highest carvacrol (24.8%). The results indicated that essential oils and their chemical compositions of *Thymus* species are strongly affected by environmental conditions and agronomic management practices. Cultivation of thyme, especially *T. daenensis* proved to be superior in both oil content and quality, in terms of substantial contents of phenolic monoterpenoids (thymol). Results of this study suggest that wild growing of *T. daenensis* in semiarid condition is not rich in essential oil and thymol, therefore farmers in semiarid regions should grow cultivated species for producing highest economic amount of extracted essential oil and thymol for pharmaceutical, therapeutic and food purposes.

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Chemical composition of the essential oil of *Satureja kallarica* Jamzad

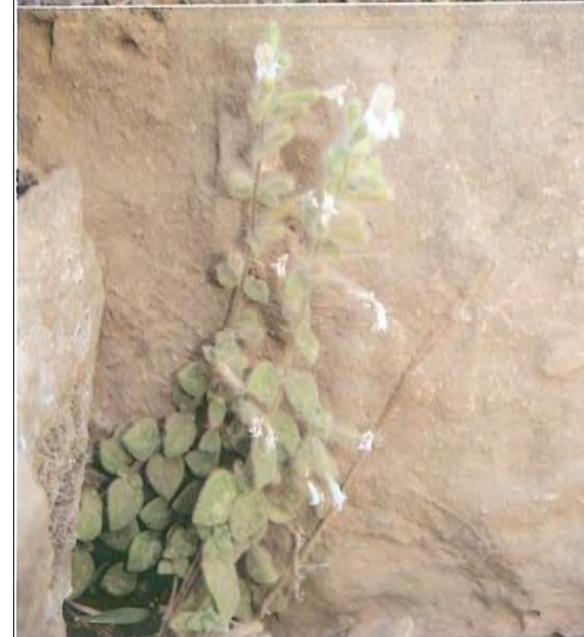
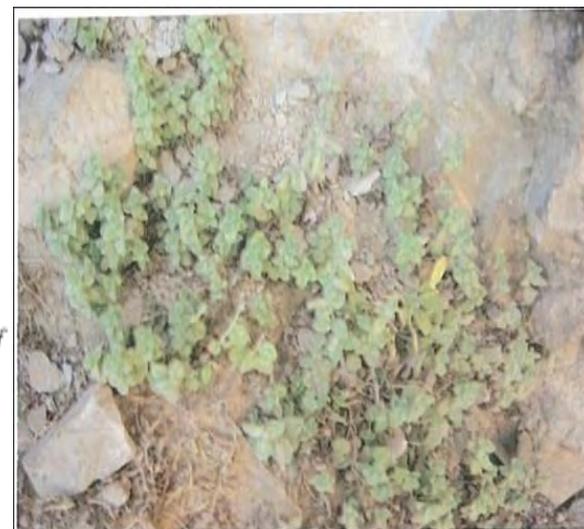
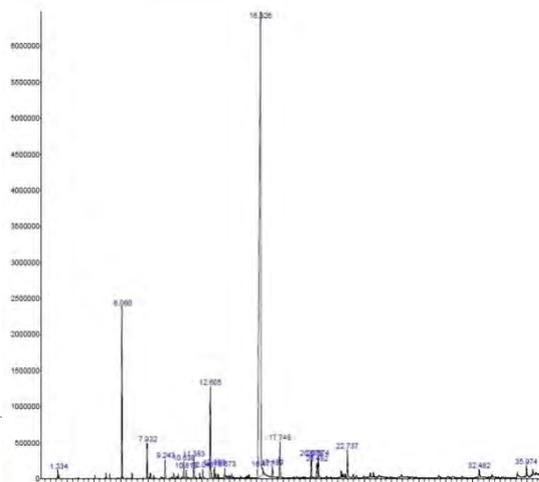
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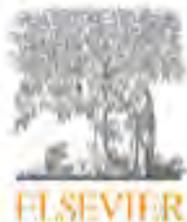
(Received 10 February 2013; final form 7 July 2013)

Satureja kallarica Jamzad belongs to the family Lamiaceae and is an endemic medicinal and aromatic plant in Iran. This is a herb growing wild in the alpine region (Kallar mountain) in southwest Iran. A GC and GC/MS analysis of essential oil isolated from the aerial parts of *S. kallarica* identified 12 constituents accounting for 91.9% of the total oil. The essential oil yield was 0.15 ml/100 g based on the dry weight of plant material. The major oil constituents were piperitenone oxide (71.2%), piperitenone (6.7%), and pulegone (5.4%). The essential oil was rich in monoterpenoids, especially oxygenated monoterpenes (80.1%).

Keywords: *Satureja kallarica* Jamzad; piperitenone; piperitenone oxide

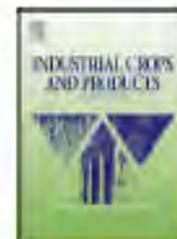


S. kallarica



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Short communication

Effects of drying methods on qualitative and quantitative of the essential oil of Bakhtiari savory (*Satureja bachtiarica* Bunge.)

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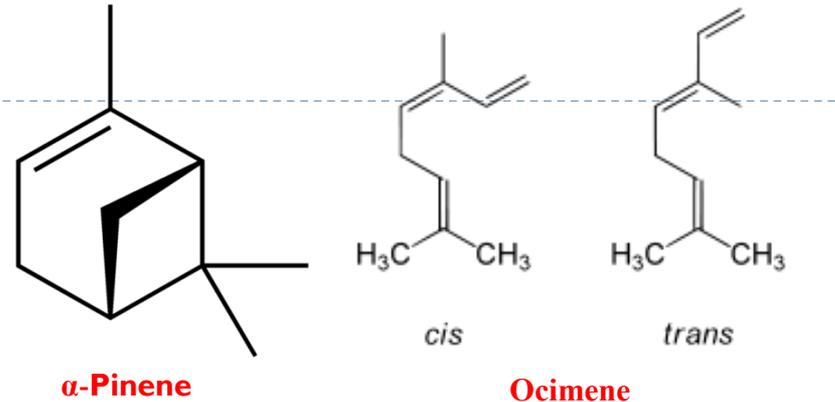
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A B S T R A C T

Bakhtiari savory (*Satureja bachtiarica* Bunge.) from mint family (Lamiaceae) is an endemic species plant widely distributed in southwest of Iran. The aerial parts of Bakhtiari savory were dried using different drying methods, i.e., sun-drying, shade-drying, oven-drying at 45 °C and 65 °C and freeze-drying. The essential oils of fresh and dried samples were obtained by hydro-distillation, and analyzed using gas chromatography–mass spectrometry (GC–MS). The highest essential oil yields (v/w on dry weight basis) were obtained by oven-drying at 45 °C (2.3%) followed by freeze-drying (2.1%), oven-drying at 65 °C (2.0%), shade-drying (1.7%), sun-drying (1.6%) and fresh sample (1.2%). Twenty-seven components were determined in essential oils of *S. bachtiarica*, which were mostly oxygenated monoterpenes and hydrocarbons monoterpenes. The main components in essential oils of fresh and dried Bakhtiari savory aerial parts were carvacrol (31.2–42.2%), γ -terpinene (10.9–18.3%), thymol (11.7–19.4%) and *p*-cymene (8.2–14.1%). Drying of aerial parts of Bakhtiari savory in the oven at 45 °C was the most suitable drying method considering short drying time and high-oil yield.

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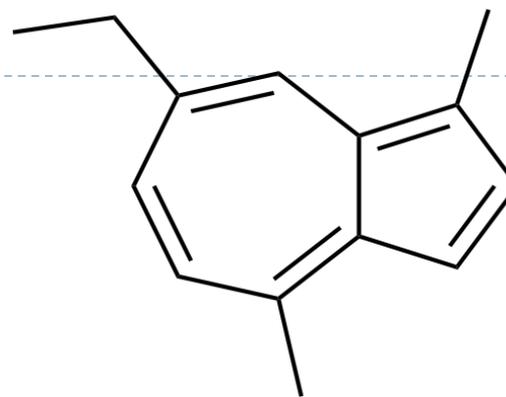
Ferulago angulata is a perennial aromatic herb. The aerial parts of *F. angulata* are used as a flavoring in foods, especially dairy foods by indigenous people in western and southwestern Iran. The major constituents of the essential oils of *F. angulata* were **α -pinene** ($9.9 \pm 3.2\%$ to $35.9 \pm 11.3\%$), ***trans*- β -ocimene** (16.2 ± 0.7 to 23.7 ± 5.4), sabinene ($1.4 \pm 0.7\%$ to 13.2 ± 0.6), *cis*- β -ocimene (2.5 ± 0.5 to 7.5 ± 0.8), α -phellandrene (0.4 ± 0.1 to $7.5 \pm 1.6\%$), β -phellandrene (0.0 to $7.4 \pm 1.5\%$), thymol ($0.3 \pm 0.2\%$ to 6.9 ± 4.9), and myrcene ($2.6 \pm 0.2\%$ to $6.2 \pm 1.3\%$). The essential oils from *F. angulata* indicated **weak to moderate** inhibitory activities (MICs = 250 to 500 $\mu\text{g/ml}$) against four bacteria, especially against *Listeria monocytogenes*. In addition, antioxidant (DPPH) radical scavenging activity was determined, and weak to **moderate inhibitory** activities were found for these oils.





Echinophora cinerea* and *E. platyloba (Apiaceae) grow wild in the Zagros mountains range, located in Iran. The plant has been used as a flavoring agent, and spice for foods. The major essential oil constituents of *E. cinerea* were **α - and β -phellandrene**, and α -pinene. The main component of *E. platyloba* was ***trans*- β -ocimene**. The essential oils of both species demonstrated **good** antioxidant activity. The essential oils of *Echinophora* sourced in alpine region of West Iran were rich in monoterpene hydrocarbons.





Chamazulene

A total of seven endemic *Achillea* species have been reported in Flora Iranica ³, which *Achillea kellalensis* (syn. *Achillea haussknechtii*) is distributed in Chaharmahal va Bakhtiari province, southwestern Iran. The main compositions of the essential oils from the flowers and leaves of *A. kellalensis* were **chamazulene** (49.0 to 52.6%), α -bisabolol (20.5 to 25.1%), β -myrcene (2.8 to 3.7%), and α -pinene (1.6 to 4.5%).

Diversity in the chemical composition of essential oils of *Ziziphora tenuior* as a potential source of pulegone

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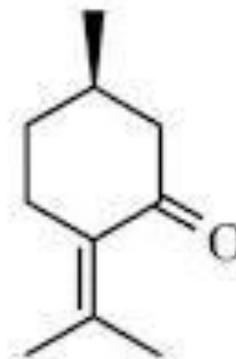
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Hydro-distilled essential oils of wild populations of *Ziziphora tenuior* L. aerial parts collected from various natural habitats in the alpine regions, Kerman province, Iran were investigated for their chemical components and oil yield diversity. The essential oil yields ranged from 0.7 to 1.5 ml/100 g dry plants. GC–MS analyses revealed 16 compounds, constituting 89–97% of the essential oils. Strong chemical variability, depending on the origin of the samples, was observed. The main constituents of the essential oils were pulegone (71.2 to 85.3%), limonene (0.51 to 7.8%), thymol (1.0 to 4.3%), and menthone (3.0 to 3.7%). Two different chemotypes were characterized: Chemotype I (pulegone) and Chemotype II (pulegone / limonene). The main source of variability in chemical composition and oil yield of the studied populations of *Z. tenuior* seemed to be a difference in environmental conditions and chemotypes as plant populations collected from close geographical areas were classified in a cluster. In conclusion, *Z. tenuior* is a good raw source of pulegone which has been widely used in food and drug industries.

Key words: Chemotype, essential oil, pulegone, variation, *Ziziphora tenuior* L.



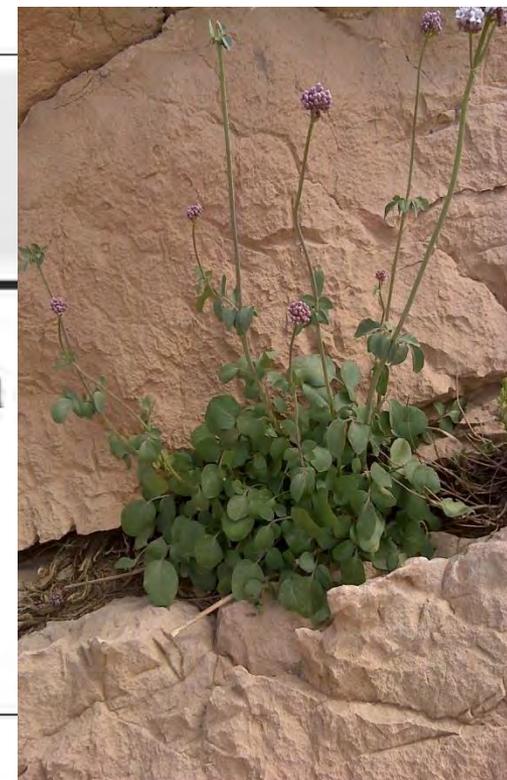


Chemical composition of essential oils from the aerial parts and underground parts of Iranian valerian collected from different natural habitats

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A B S T R A C T

Valeriana sisymbriifolia Vahl., as an Iranian endemic plant belongs to the family Valerianaceae, is widely distributed in the alpine regions of Iran. This study was done to study phytochemical characteristics of essential oils from the aerial parts (leaves, stem, and flowers) and underground parts (roots and rhizomes) of *V. sisymbriifolia* collected from four natural habitats in Southwestern Iran. The essential oils from both parts of the plant analyzed by GC and GC/MS. Results indicated that there was no significant difference among various populations for essential oil yield, while there was significant difference ($p \leq 0.01$) among different parts for oil yield. The essential oil yield of the roots and rhizomes of *V. sisymbriifolia* (0.25 ml/100 g dry matter) was higher than the aerial parts of the herb (0.08 ml/100 g dry matter). For interaction effects of population \times organ, the highest essential oil yield was obtained from the underground parts of the Choobin population with 0.32 ml/100 g dry matter. The major compounds in the essential oil from the aerial parts of *V. sisymbriifolia* were derivatives of phenol (*p*-cresol) and valeric acid (*n*-valeric acid and 3-methylvaleric acid). While, hydrocarbon monoterpenes (α -pinene and camphene), oxygenated monoterpenes (borneol and bornyl acetate), and hydrocarbon sesquiterpenes (*cis*- α -bisabolene) were the main components identified in the roots of rhizomes of *V. sisymbriifolia*. In conclusion, the main source of variability in chemical composition and oil yield of the studied populations of *V. sisymbriifolia* seemed to be due to differences in harvested parts of the plant. In total, the essential oil from the aerial parts and roots of *V. sisymbriifolia* could be serving a potential source of borneol, camphene, derivatives of valeric acid, and phenol, especially *p*-cresol and for use in food, cosmetic, and pharmaceutical industries.



Chemical composition of essential oils of *Ziziphora clinopodioides* Lam. (endemic Iranian herb) collected from different natural habitats

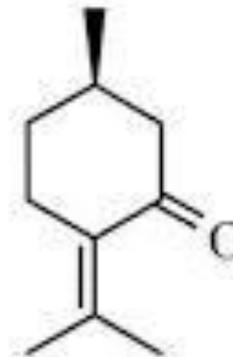
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Ziziphora clinopodioides Lam. is as an important medicinal and aromatic plant belonging to the Lamiaceae family. *Ziziphora* species are medicinal and aromatic plants that traditionally are used for the treatment of various diseases. In this study, essential oil of wild populations of *Z. clinopodioides* collected from various natural habitats in the alpine regions, Southwestern Iran was investigated. The hydro-distilled essential oils analyzed by GC and GC/MS. The essential oil yields ranged from 0.12 to 0.98 ml/100 gm dry plants. Results indicated that the main chemical compositions were pulegone (5.19 to 57.85%), limonene (0.26 to 12.79%), 1,8-cineole (0.00 to 27.4%), *p*-mentha-3-en-8-ol (2.03 to 15.15%), neomenthol (0.36 to 7.56%), bornyl acetate (0.47 to 9.37%), and piperitenone (0.70 to 9.05%). There were significant differences among the essential oils from *Z. clinopodioides* populations for yield oil and the major constituents such as pulegone, 1,8-cineole, *p*-mentha-3-en-8-ol, bornyl acetate, and piperitenone. In conclusion, the main source of variability in chemical composition and oil yield of the studied populations of *Z. clinopodioides* seemed to be a difference in environmental conditions and chemotypes as plant populations collected from close geographical areas were classified in a cluster.



Keywords: *Ziziphora clinopodioides* Lam., Chemical composition, Essential oils

RESEARCH ARTICLE

Effect of different drying treatments on essential oil yield, composition and color characteristics of *Kelussia odoratissima* Mozaff

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Kelussia odoratissima is known as an endemic and valuable spice plant. The effect of six different drying treatments (sun, shade, oven 45°C, oven 65°C, microwave and freeze drying) was studied on the color, essential oil content and chemical composition of *K. odoratissima* leaves. The essential oils were isolated from fresh and dried samples by a hydrodistillation method and analyzed using gas chromatography–mass spectrometry (GC–MS). The highest essential oil yield was obtained by shade drying (1.50%) followed by microwave (1.46%) and oven 65°C (1.43%) drying methods. The major compounds of *K. odoratissima* oils were (Z)-ligustilide, (E)-ligustilide and *cis*-3-butylidene phthalide. Drying treatments significantly increased (Z)-ligustilide compared with the fresh one. In this study, (Z)-ligustilide ranged from 48.67% in sun-dried samples to 68.3% in 45°C oven-dried ones. For color analysis, shade drying possessed the highest *a**/*b** value, followed by microwave and oven 45°C. Results showed that shade drying at ambient temperature significantly increased the essential oil yield and (Z)-ligustilide with acceptable color quality. Finally, shade and oven drying (<50°C) methods were introduced to produce appreciable essential oil yield, composition and color quality.

Keywords: *Kelussia*; drying; essential oil; (Z)-ligustilide; color

Kelussia odoratissima Mozaff is a new genus of Apiaceae family. It is an endemic and endangered medicinal and spice plant of Iran, which grows at high altitudes in the Zagros Mountains (1). *Kelussia odoratissima* (locally known as *Kelus* or *Karafs-e-Bakhtiari*) is a wild robust, erect, glabrous, perennial aromatic herb, which grows to a height of 120–200 cm, and is restricted to areas in Southwest Iran. *Kelussia odoratissima* is used as a food supplement and medicine; also, it is used fresh in salads, pickles, soups and yoghurt as a spice (2). The *Kelussia* leaves harvested at an early growing stage (about two to four leaves) are used as an edible wild vegetable for flavoring and for the treatment of indigestion and rheumatism disorders by the ethnic communities of Bakhtiari and Chaharmahal (3). It also has high nutritional value owing to high minerals and vitamins (4). The aerial part of the plant is commonly used as a popular garnish and as a folk medicine to treat hypertension and inflammation (2). Recent publications have revealed that it has sedative effect (5), high antioxidant activity and used as a prevention of jumping as the major signs of morphine withdrawal (5). In Iranian traditional medicine, it has

