Composition of the *Centaurea hyracanica* Bornm. essential oils in different parts of Iran

Fatemeh Askari*, Fatemeh Sefidkon and Mehdi Mirza

Research Institute of Forests and Rangelands, Agricultural Research Education and Extension Organization (AREEO), Tehran, Iran

Abstract

Centaurea hyrcanica is a kind of wheat flower distributed in North and North-East of Iran. This study aimed to determine chemical composition of essential oil of *C. hyrcanica* for food supply, cosmetics industry and medicinal uses. The plant parts *of C. hyrcanica* were collected at flowering stage from four localities in Mazandaran, Tehran, and Semnan provinces in May and June 2016. The plant parts including stem plus the leaf (SL), inflorescence (IF), and root (R) were dried and crushed in laboratory. The essential oils were obtained by hydro-distillation and were analyzed by gas chromatography (GC) and gas chromatography-mass spectrometry (GC/MS). Essential oil yields of stem plus the leaf, inflorescence, and root (w/w dried weight) from different localities varied in range of 0.03-0.14%, 0.03-0.28%, and 0.02 -0.77%, respectively. The major constituents of essential oils obtained from different parts of *C. hyrcanica* populations were caryophyllene oxide (13.6-44.8%) and spathulenol (3.6-16.,9%). The major constituent of root essential oils was *cis*-pinane (9.1%-24.2%). Ethyl tetradecanoate (≤18.8%) was a major constituent in different populations of *C. hyrcanica* except Pol Sefid samples. 1-Hexadecene, β-eudesmol, γ-eudesmol, and borneol were major compounds in essential oils of Pol Sefid samples. Results of this study suggest that *C. hyrcanica* in highland condition is rich in essential oil and aroma profile, therefore growing and cultivation of these plants in cold regions is appropriate for producing high economic essential oil extracts and aroma profile for therapeutic uses and food.

Keyword: stem plus the leaf, inflorescence, caryophyllene oxide, *cis*-pinane, spathulenol

Askari, F., F. Sefidkon, and M. Mirza. 2023. 'Composition of the *Centaurea Hyracanica* Bornm. essential oils in different parts of Iran'. *Iranian Journal of Plant Physiology 13* (1),4423- 4431.

Introduction

The genus *Centaurea* belongs to the Asteracea family. Genus Centaurea is divided into three subgenera, namely Centaurea, Cyanus, and Lopholoma (Hilpold et al., 2014). The genus Centaurea with 74 wild species is found in different regions of Iran with 37 endemic species. Subgenus Centaurea is distributed in the Mediterranean region, Western Asia and Central and Eastern Europe. In Iran *C. hyrcanica* is found in North and North-East of the country (Mozaffarian, 2018). This plant is a rough and dry perennial herb, with bright green color, lanuginous shape, numerous stems, and pink inflorescence (Ghahreman, 2012). There are several studies on essential oils compositions of different *Centaurea* species including, *C. zuvandica*, *C. intricate*,

* *Corresponding Author*
E-mail Address: fasgari@rifr-ac.ir
Received: November, 2020
Accepted:December, 2022

C.behen from Iran (Askari et al., 2013; Askari et al., 2014; Azadi and Nouri, 2014; Esmaeili and Khodadadi, 2012). Spathulenol (14.6%), n-hexadecanoic acid (13.4 %), 1-pentadecene (13.1%), and phytol (12.4%) were found to be the major components in *C. patula* essential oil. Essential oils yield of inflorescence, leaves, stems, and branches of *C. aeolica* harvested in Italy were 1.93, 0.02, 0.02, and 0.13% respectively. The main constituents were β-eudesmol, caryophyllene oxide, (*E*)-12-norcaryophyll-5-en-2-one, and hexahydrofarnesyl acetone in flowers; hexahydrofarnesyl acetone, 2-methyloctadecane, and tricosane in leaves, hexadecanoic acid, caryophyllene oxide, and β-eudesmol in the stems and branches. Analysis of the essential oils in the aerial parts of *C. diluta* gave mainly fatty acids and their ester derivatives, the main ones being hexadecanoic acid and (*Z,Z*)-9,12-octadecadienoic acid methyl ester (Jemia et al., 2015).

The yields of *C. pullata*, *C. grisebachii*, *C. affinis* essential oils were 0.03, 0.01, and 0.02% respectively, the main components of *C. pullata* essential oil were caryophyllene oxide, for *C. grisebachisubsp* essential oil were 6,10,14-trimethyl pentadecan-2-one and spathulenol, and the major constituents of *C. affinis* essential oil were grisebachii, thymol, and dodecanol (Djeddi et al., 2011). The essential oil yield of *C. intricata* flowering aerial parts from Iran was 0.07%, the major compounds were β-caryophyllene (18.1%), germacrene D (14.9%) and caryophyllene oxide (11.8%), and the volatile oil of the flowering aerial parts of *C. intricata* was characterized by the high content of sesquiterpene hydrocarbons (49.6%) (Azadi and Nouri, 2014)

The essential oils obtained from flowers, leaves, and stems of *C. polypodiifolia* were similar in yield (ca. 0.01% based on dried material), and 55 components were identified (Yaglioglu and Demirtas, 2015); the main components were caryophyllene oxide (17.6%), *cis*, *cis*-7,10,13-hexadecatrienal, tetracosane (14.9%), and heneicosane (12.9%). Also, α-Bisabolol (23.9%), *trans*-nerolidol (8.5%), caryophyllene oxide (8.1%) and n-hexadecanoic acid (10.8%) were the major components of stem oil, and the main component of *C. polypodiifoliain* leaf was germacrene D (28.8%) (Yaglioglu and Demirtas, 2015). Polatoglu et al. (2014a) reported that the essential oil yield in both *C. kilaea* and *C. cuneifolia* was less than 0.01% (v/w). They showed that the main essential oil components of flower in *C. kilaea* were hexadecanoic acid (26.2%), tetradecanoic acid (18.1%), *β*-eudesmol (3.3%), and decanoic acid (3.1%), and in its stem plus leaf oil, the major compounds were hexadecanoic acid (55.5%) and *β*-eudesmol (3.2%). In their achieved result in flower, the major compounds were hexadecanoic acid (32.9%), tetradecanoic acid (14.4%), heptacosane (6.1%), and nonacosane (4.3%) (Polatoglu et al., 2014a). Based on the report of Polatoglu et al. (2014b) the flowers and stems of *C. stenolepis* had a very low amount of essential oil yield, <0.01% (v/w). In the essential oil of the flower, the main components were caryophyllene oxide (12.6%), hexadecanoic acid (10.6%), and β-eudesmol (7.2%), and in the stem oil, forty compounds were identified that the main ones of them were hexadecanoic acid (38.4%) and phytol (12.9%) (Polatoglu et al., 2014b)

Novakovic et al. (2016) identified 121 compounds in the oils of *C. atropurpurea* and *C. orientalis* flowering heads. They reported that in all samples, sesquiterepenes were the most abundant group, representing 53.9-74.0% of the total oil, with germacrene D and *β*-caryophyllene as the major constituents.

Major constituents of the essential oils of *Centaurea* species from Turkey were spathulenol (8.1%) and hexahydrofarnesyl acetone (7.8%) in *C. aphrodisea*; caryophyllene oxide (17.1%) and heptacosane (8.1%) in *C. athoa*; hexadecanoic acid (27.9%) and cyclosativene (13%) in *C. iberica*; hexadecanoic acid (8.2%) and phytol (5.6%) in *C. hyalolepis*, and hexadecanoic acid (8.1%) and hexahydrofarnesyl acetone (7.1%) in *C. polyclada* (Erel et al., 2013).

β-caryophyllane (24.5%), β-selinene (13.9%) and valencene (11.7%) were the main components among the sixteen constituents characterized in the *C. behen* oil representing 93.7% of the total detected components (Esmaeili and Khodadadi, 2012). The yellowish essential oil yield of whole plant in that study was 0.16% (w/w).

In a recent study, Hexanal, Hexadecanoic acid, and α-pinene were identified in *C. rupestris* and in *C. finazzeri* (Novakovi´c et al., 2022). In addition, spathulenol, caryophyllene oxide and allooaromadendrene were reported in five Centaurea species including *C. scoparia*, *C. calcitrapa*, *C. glomerata*, *C. lipii* and *C. alexandrina* (Reda et al., 2021).

The literature reviewed as above presents the studies on composition of the essential in various centurea species around the world. However, there has been no report on essential oil composition of *C. hyracanica* in Iran. Therefore, the purpose of the present study was to evaluate the essential oil compositions of various parts of *C. hyrcanica* collected from different localities in a comparative study among different localities of *C. hyrcanica* in relation to essential oil yield and composition.

Materials and Methods

Plant materials

At the flowering stage, plant specimens of *C. hyrcanica* were collected from two sites in Mazandaran (Pol Sefid and Sangdeh) and also from two sites containing Firuzkuh and Khatirkuh located in the province of Tehran and Semnan, respectively. All the samples were collected from May to June 2016. The geographical properties of all sampling sites and the relevant map are presented in Table 1 and Fig. (I), respectively. Stem plus the leaf (SL), inflorescence (IF), and root (R) samples of *C. hyracanica* were collected from three shrubs in different locations. Then, they were dried at room temperature, and subsequently crushed to small particles.

Table 1
Geographical properties of studied localities

Locality	Province	Decimal Degree (Y)	Decimal Degree	Altitude (m)	latitude	long	Y UTM	X UTM	Minimum Temperature (°C)	Maximum Temperature (°C)	Average Temperature (°C)	Average Humidity (%)	Precipitation (mm)
Firuzkuh	Tehran	35.757001°	52.773894°	140	35°45'24.99"	52°46'26.01"	3958439	660375	1.8	16.8	9.3	51	286.5
Khatirkuh	Semnan	35.900064°	53.100007°	240	35°54'0.32"	53° 6'0.08"	3974902	689519	8	18	13	45	350
Pol Sefid	Mazandaran	36.118394°	53.056665°	200	36° 7'6.03"	53° 3'23.99"	3999032	685097	10.5	20.2	15.3	68	576.2
Sangdeh	Mazandar	36.068395°	53.216685°	150	36° 4'6.27"	53°13'0.15"	3993809	699628	7	19	13	60	550

Table 2
Essential oil yield of different plant parts of *Centaurea hyrcanica* populations

Locality	Province	Altitude (m)	Stem + Leaf	Inflorescence (%)	Root Yield (%)
Pol Sefid	Mazandaran	2000	0.03	0.28	0.77
Sangdeh	Mazandaran	1500	0.10	0.03	0.10
Firuzkuh	Tehran	1400	0.11	0.05	0.12
Khatirkuh	Semnan	2400	0.14	0.06	0.02

Essential oil extraction

In order to extract essential oil, 50 gram powdered plant material was mixed with 500 ml distillated water and was subjected to hydro-distillation for two hours in a Clevenger-type apparatus (British Pharmacopoeia, 2017). The oils were extracted in three replications and mixed before analysis. The essential oils were dried over anhydrous sodium sulfate and stored in sealed vials at 4 ℃ before analysis.

Gas chromatography and mass Spectroscopy

GC analysis was performed using a Shimadzu GC-9A Ga chromatograph equipped with a DB-5 fused silica column (60 m x 0.25 mm; film thickness 0.25 micron). Oven temperature was 50 ℃ for 5 min and was then programmed to 270 ℃ at a rate of 3 ℃ /min, injector and detector (FID) temperatures were 280 ℃, carrier gas was helium with a linear velocity of 32 cm/s. The relative amounts of individual components were based on electronic integration of peak area without the use of an internal standard or FID response factor correction.

GC/MS analysis was carried out on a Varian 3400 GC-MS system equipped with a DB-5 fused silica column (60 m x 0.25mm, film thickness 0.25 micron) and interfaced with a Varian ion trap detector. Oven temperature ws 50-270 ℃ at a rate of 3 ℃/min, injector and transfer line temperature were 280 ℃ and 290 ℃, respectively; carrier gas was helium with a linear velocity of 31.5 cm/s, split ratio 1/60, ionization energy 70 eV, scan time 1s, and mass range 40-400 amu.

Identification of compounds

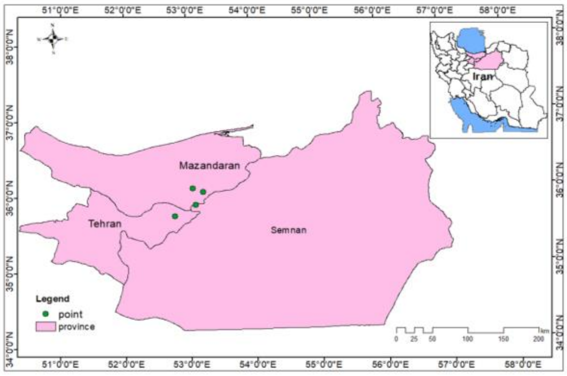

Fig. I. Map of the locations of the study regions

The essential oil components were identified by comparing their mass spectra with the Wiley library as well as with authentic compounds. This was confirmed by comparison of their retention indices with those of authentic compounds as well as with data published in the literature. Quantification data was obtained from GC-Fid area percentages without the use of correction factors (Adams, 2017; Davies, 1990; Shibamoto, 1987).

Result

Essential oil yield

The average yields of essential oils of the stem plus the leaf (SL), inflorescence (IF), and root (R) of *C. hyrcanica* are shown in Table 2. The highest essential oil yield of SL, IF, and R samples of *C. hyrcanica* were 0.03, 0.28, and 0.77%, respectively corresponding to Pol Sefid samples (Table 3). The color of SL, IF, and R essential oils was Pale yellow.

Chemical composition

Chemical composition of the essential oils obtained from *C. hyracanica* SL, IF, and R are summarized in Table 3, and the relevant chromatograms are presented in Fig. II (A-L In SL essential oils, 15 to 26 compounds were found that constituted 94.5% to 97.9% of all essential oils (Table 3).In IF essential oils 13 to 26 constituents were found, which represent about 90.5% to 99.3% of the total essential oils; also 17 to 24 constituents were identified in R essential oils

Table 3
Percentage of volatile compounds identified in the essential oils of stem plus the leaf, inflorescence and seed of *Centurea hyrcanica*

Compounds	RT	RI*	Firuzkuh			Khatirkuh			Pol Sefid			Sangdeh		
			Stem + Leaf	Inflorescence	Root	Stem + Leaf	Inflorescence	Root	Stem + Leaf	Inflorescence	Root	Stem + Leaf	Inflorescence	Root
cis-pinane[1]	7.28	982	-	-	15.3	-	-	9.1	-	-	16.4	-	-	24.2
ρ-cymene[1]	8.53	1020	0.1	-	-	-	-	-	-	-	-	-	-	-
1,8- cineol[2]	8.76	1026	-	-	1.8	-	-	-	-	-	-	-	-	-
n-nonanal[5]	11.51	1100	0.2	0.5	0.4	1.1	1.0	0.7	2.2	0.8	0.3	0.5	0.6	0.6
camphor[2]	13.28	1141	0.8	2.0	2.3	-	-	-	3.5	5[illegible]	4.9	-	-	1.0
borneol[2]	14.29	11.65	0.2	0.9	-	0.2	1.5	-	1.3	1[illegible]	-	1.9	1.8	-
decanal[2]	15.83	1201	-	-	0.4	-	1.9	0.4	-	-	-	2.3	5.5	0.5
bornyl acetate[2]	19.49	1284	1.0	1.9	1.1	-	-	-	-	-	-	6.9	10.8	0.7
thymol[2]	19.71	1289	-	-	-	-	0.4	-	1.8	-	0.2	2.3	5.7	-
carvacrol[2]	20.14	1298	-	-	-	-	-	-	-	-	0.2	2.0	3.3	
α-copaene[3]	23.49	1374	0.6	0.5	-	-	0.5	-	0.2	4.6	-	1.9	-	1.0
β-cubebene[3]	24.04	1387	1.1	1.5	1.6	0.2	0.7	1.2	0.9	1.0	3.9	-	-	1.4
β-elemene[3]	24.15	1389	0.7	0.5	3.4	-	-	1.0	-	4.5	-	2.3	-	5.7
α-cederene[3]	25.06	1410	3.2	-	3.2	0.2	1.8	1.0	-	-	4.4	-	0.4	4.6
E-caryophyllene[3]	25.36	1417	4.5	14.2	7.6	0.2	-	9.5	2.6	2.1	6.6	1.6	1.4	7.7
β-cedrene[3]	25.42	1419	2.1	1.5	-	-	-	-	-	-	-	-	0.4	-
α-humulene[3]	26.82	1452	2.7	2.0	0.5	0.8	2.0	-	0.3	-	-	0.4	0.6	1.1
E-β-farnesene[3]	26.92	1454	1.9	1.5	-	-	-	-	1.0	-	0.9	0.4	0.8	-
germacrene D[3]	28.15	1484	3.1	2.9	5.2	-	-	0.4	1.4	1.7	3.5	1.1	-	1.1
β-selinene[3]	28.37	1489	3.1	1.3	-	0.4	2.0	-	2.0	-	-	4.3	0.7	-
epi-cubenol[4]	28.55	1493	-	0.7	7.3	-	-	3.1	-	-	-	-	0.2	11.1
germacrene B[3]	31.24	1559	-	-	4.7	-	-	1.4	-	-	-	-	-	4.9
Spathulenol[4]	31.96	1577	16.9	9.0	14.7	10.8	10.1	6.9	8.5	8.2	5.6	11.8	10.9	3.6
caryophyllene oxide[4]	32.16	1582	22.5	34.6	13.6	40.2	44.8	18.2	18.4	31.7	17.6	27.6	28.6	15.5
1-hexadecene[4]	32.44	1588	3.5	2.4	3.3	2.9	3.5	9.1	17.1	3.2	19.0	2.2	-	1.2
humulene epoxide II[4]	33.20	1608	1.4	1.8	-	-	4.3	-	-	-	-	2.1	1.4	-
10-epi-γ-eudesmol[4]	33.77	1622	-	2.3	-	-	-	-	-	-	-	0.4	0.4	-
γ- eudesmol[4]	34.08	1630	-	-	-	16.3	2.5	4.4	9.6	1.4	0.7	-	1.0	-
Cubenol[4]	34.63	1645	-	0.6	-	-	-	0.4	2.0	-	-	-	-	-
β-eudesmol[4]	34.79	1649	3.6	2.8	0.8	-	-	-	18.5	14.5	4.4	0.5	0.4	1.8
geranyl valerate[2]	35.02	1655	1.5	2.4	-	0.9	1.6	0.7	-	-	-	0.5	1.1	1.1
isobornyl isobutanoate-8-hydroxy[2]	35.75	1674	2.0	3.8	1.5	0.3	1.5	0.7	-	-	-	-	-	-
elemol acetate[4]	35.97	1680	1.5	1.8	-	-	3.3	3.5	-	-	-	3.6	-	3.6
n-heptadecane[4]	36.74	1700	4.4	-	1.0	-	-	1.9	-	-	-	-	-	4.0
(2*E*,6*E*)-farnesol[4]	38.30	1742	2.0	0.7	0.9	9.0	5.3	7.2	3.2	-	2.9	5.9	2.4	2.2
ethyl tetradecanoate[5]	40.25	1795	11.6	5.2	4.4	12.4	-	16.3	-	-	-	15.4	18.8	0.9
n-nonadecane[5]	43.92	1900	-	-	2.1	-	8.5	-	-	-	-	-	-	-
n-tetracosane[5]	59.33	2400	-	-	-	-	-	-	-		-			
n-pentacosane[5]	62	2500	-	-	-	-	-	-	-	-	-	-	-	-
Hydrocarbon monoterpen[1]			0.1	0	15.3	0	0	9.1	0	0	16.4	0	0	24.2
Oxygenated monoterpene[2]			5.5	11.0	5.3	1.4	6.9	1.8	6.6	16.8	5.3	15.9	28.2	3.3
Hydrocarbon sesquiterpene[3]			23	25.9	26.2	1.8	7	14.5	8.4	13.9	19.3	12	4.3	27.5
Oxygenated sesquiterpene[4]			55.8	56.7	41.6	79.2	73.8	54.7	77.3	59	50.2	54.1	45.3	43
Others[5]			11.8	5.7	6.9	13.5	9.5	17	2.2	0.8	0.3	15.9	19.4	1.5
Total		-	96.2	99.3	95.3	95.9	97.2	97.1	94.5	90.5	91.5	97.9	97.2	99.5
Number			26	26	24	15	19	21	18	13	17	23	22	23

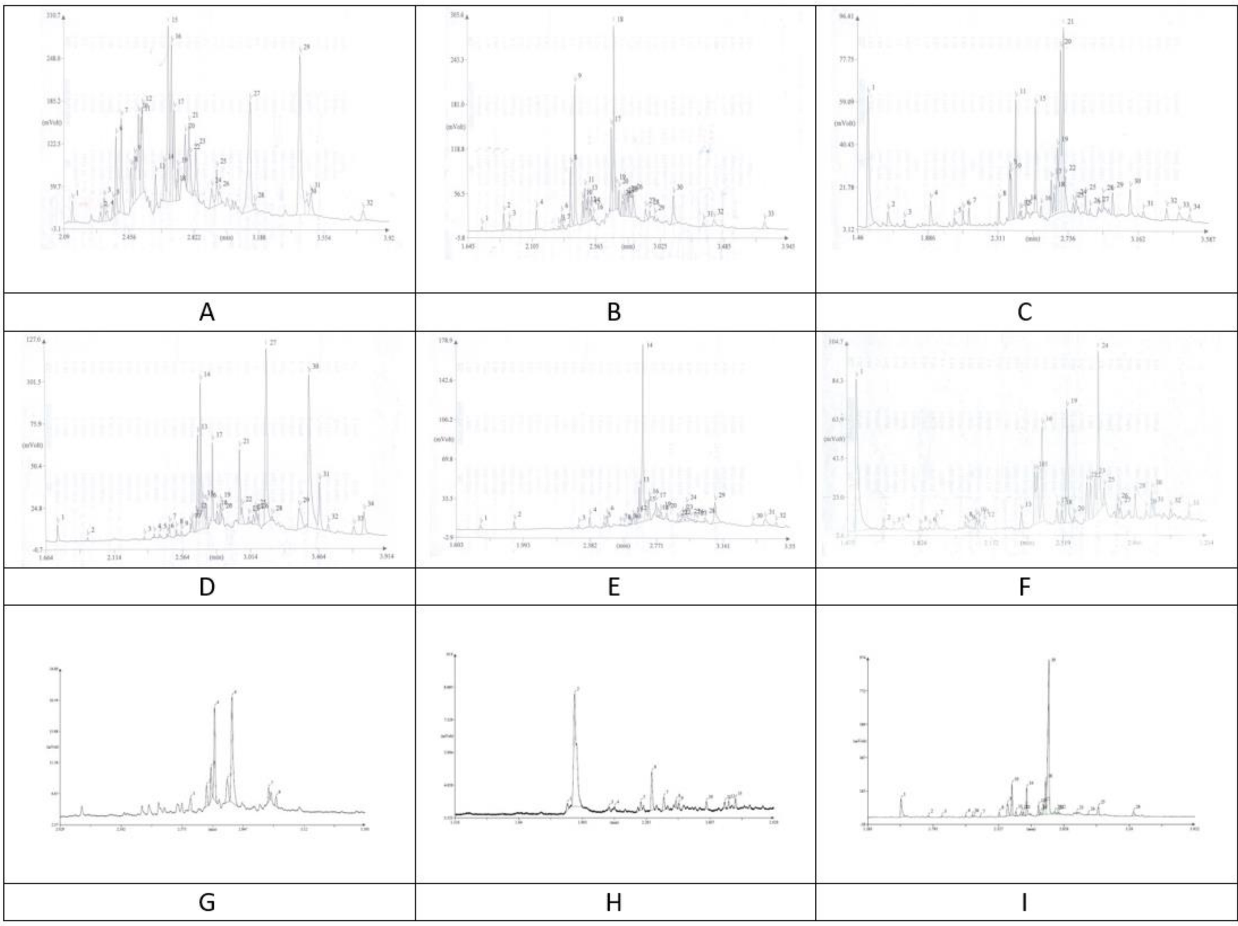

Fig. II. Chromatograms of GC, A: Firuzkuh (Stem + Leaf), B: Firuzkuh (Inflorescence), C: Firuzkuh (Root), D: Khatirkuh (Stem + Leaf), E: Khatirkuh (Inflorescence), F: Khatirkuh (Root), G: Pol Sefid (Stem + Leaf), H: Pol Sefid (Inflorescence), I: Pol Sefid (Root), J: Sangdeh (Stem + Leaf), K: Sangdeh (Inflorescence), and L: Sangdeh (Root)

accounting for 96.4% to 99.5% of the total essential oils. Caryophyllene oxide was a major component in the all samples. It was between 18.4 to 40.2% in SL essential oils, 28.6 to 44.8% in IF essential oils, and 13.6 to 18.2% in R essential oils. Spathulenol was another major component in all of the *C. hyrcanica* essential oils (3.6 to 16.9%). *Cis*-pinane as a major constituent (9.1 to 24.2%) was found only in root essential oils.

Ethyl trtradecanoate (≤18.8%) was found as a major constituent in essential oil of different populations of *C. hyrcanica* except Pol Sefid samples. Another main component in Firozkoh samples was (*E*)-caryophyllene, which wqas measured as 4.5%, 14.2%, and 7.6% in SL, IF, and R essential oils ,respectively. In Pol Sefid samples, 1-hexadecene and β-eudesmol were major compounds in SL, IF, and R essential oils (17.1% and 18.5%), (3.2% and 14.5%), and (19.0% and 4.4%) respectively, and also the highest amount of borneol (11.3%) was found in inflorescence essential oil. Results also indicated that bornyl acetate (6.9% and 10.8%) was a major constituent in SL and IF essential oils of Sangdeh samples, respectively. The major volatile constituents γ-eudesmol (16.33% and 9.6%) were obtained from SL essential oil of Khatirkuh and Pol Sefid samples, respectively.

Discussion

Results showed variation in essential oil yield can be related to climatic factors. Pol Sefid region with the highest maximum and mean temperature, the lowest minimum temperature as well as the highest precipitation compared to other localities had the highest essential oil percentage in roots followed by inflorescence, which could be attributed to its ecological characteristics. Also the lowest caryophyllene oxide percentage in stem plus leaf and highest amount of 1-hexadecane and β-eudesmol in different plant parts of Pol Sefid sample can be related to ecological difference between this region in comparison with the other regions under study. Such variations were seen among other samples, and to establish their relationship with environmental factors, it is necessary to take more samples and perform more tests.

The quantity of essential oil yield from different species of *Centaurea* is compared in Table 4. Generally, the essential oil yield was less than 0.1% in the *centaura* species. However, the essential oil yield of *C. depressa* and *C. behen* species was more than 0.1% .

Our results on oil yields are perfectly in agreement with previous study conducted by Askari et al., (2014) in terms of the essential oils observed in (SL and (IF) of *C. zuvandica* in different localities. Similarly, in a study performed by Askari et al., (2018) caryophyllene oxide was one of the main components in (SL) and (IF) essential oils of *C. pterocaula* and *C. urvillei*. Erel et al. (2013) also reported that caryophyllene oxide was a major constituent in essential oil of *C. athoa.* In our study, bornyl acetate was also a major constituent, in (SL) and (IF) oil of *C. hyrcanica* from Sangdeh.

As indicated in Table 3, spathulenol was another major compound in the essential oils of (SL), (IF) and (R) in *C. hyrcanica*. Previous studies showed that spathulenol was one of the main aroma profile in (SL) and (IF) of *C. pterocaula, C. urvillei*, and *C. zuvandicahas* (Askari et al., 2014; Askari et al., 2018).

The concentration of ethyl tetradecanoate was high in different essential oils of *C. hyrcanica* populations except Pol Sefid samples. In the

Table 4.
Comparison of the essential oil yield of various plant parts of the *Centaurea* species

Species	Locality	Essential Oil Yield				References
		Stem + Leaf	Inflor escence	Root	Arial Part	
C. behen	Iran	-	-	-	0.16	Esmaeili and khodadadi 2012
C. cuneifolia	Turkey	0.01>	-	-	-	Polatoglu, 2014
C. depressa	Iran, Damavand	0.18	0.07	0.13	-	Askari and Mirza, 2013
C. depressa	Iran, Botanical Garden	0.10	0.08	0.13	-	Askari and Mirza, 2013
C. intricate	Iran	-	-	-	0.07	Azadi and Nouri, 2014
C. kilaea	Turkey	0.01>	0.01>	-	-	Polatoglu, 2014a
C. polypodiifolia	Turkey	0.01	0.01	-	-	Yaglioglu and demirtas, 2015
C. pterocaula	Iran, Zanjan	0.06	0.09	-	-	Askari et al., 2018
C. pterocaula	Iran, Zanjan	0.04	0.06	0.06	-	Askari et al., 2018
C. stenolepis	Turkey	0.01>	0.01>	-	-	Polatoglu, et al. 2014b
C. urveilli	Iran, Uromieh	0.02	0.07	-	-	Askari et al., 2018
C. urveilli	Iran, Uromieh	-	0.06	-	-	Askari et al., 2018
C. zuvandica	Iran, Firoozkoh	0.07	0.04	-	-	Askari et al., 2014
C. zuvandica	Iran, Ghaemshahr	0.04	0.02	-	-	Askari et al., 2014
C. zuvandica	Iran, Chaloos Road	0.03	0.05	-	-	Askari et al., 2014

present study, the detected (E-E)-Farnesol makes up *C. hyrcanica* valuable for the perfume industries.This constituent was not found in other *Centaurea* essential oils. *Cis*-pinane was a major component only in the root oils of *C. hyrcanica*. Another major component in root essential oils was E-caryophyllene. The sample from Khatirkuh was rich in caryophyllene oxide, spathulenol, and ethyl tetradecanoate. It seems that the difference in the percentage of chemical compounds of *C. hyrcanica* essential oils can be attributed to environmental conditions (Emami Bistgani et al., 2017a; Emami Bistgani et al., 2017b; Emami Bistgani et al., 2018). The population of *C. hyrcanica* in Pol Sefid location proved to be superior in oil content and borneol in inflorescence essential oil and β-eudesmol in all essential oils. Substantial levels of aroma profile were seen in higher elevation and colder temperature such as in Khatirkuh and Pol Sefid, which provided a better growth condition and led to a higher accumulation of oil in various parts of *C. hyrcanica* Plants.

Conclusion

According to the results, the highest essential oil contents of inflorescence and root belonged to Pol Sefid location, and stem plus the leaf of Khatirkuh provided high essential oil. The major compounds that were identified in different plant parts and localities were Caryophyllene oxide, Spathulenol, and cis-pinene. Also, high elevation and cold temperature produced more essential oils and aroma profile in *C. hyrcanica*.

Acknowledgment

The authors would like to acknowledge the financial support provided by the Research Institute of Forests and Rangelands for this work. Furthermore, we would like to appreciate Dr. Fatemeh Dargahian for ecological data and map of the locations of study region.

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