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The essential oil composition of *Centaurea intricata* Boiss. flowering aerial parts

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Abstract
The composition of the essential oil of *Centaurea intricata* Boiss. flowering aerial parts from Iran was analyzed for the first time using gas chromatography (GC) and gas chromatography–mass spectrometry (GC–MS). Thirty four constituents consisting 90.1% of the total oil were identified. The major ingredients were *β*-Caryophyllene (18.1%), Germacrene D (14.9%) and Caryophyllene oxide (11.8%). The volatile oil of *Centaurea intricata* Boiss. flowering aerial parts was characterized by the high content of sesquiterpene hydrocarbons (49.6%).
Keywords: *Centaurea intricata* Boiss., Asteraceae, *β*-Caryophyllene

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Introduction:

The family Asteraceae is one of the largest angiosperm families and comprises about 1300 genera and 25000 species which distributed over three subfamilies and 17 tribes (1).

Centaurea genus (Asteraceae) is a polymorphous genus and contains more than 500 species that are widespread all over the world, in particular around the Mediterranean area and western Asia (2-4).

Iran is the major center of diversity for the genus *Centaurea* (5). Seventy four species of this genus are found in Iran which among them thirty eight species are endemic and *Centaurea intricata* Boiss. is one of them (6,7).

Reviewing literature revealed that essential oil compositions of many species of *Centaurea* genus have been extensively studied in various areas throughout the world (8-18).

While there are several reports on *Centaurea* species volatile constituents, there is no investigation of *Centaurea intricata* Boiss. and in this article essential oil compounds of this endemic species is researched for the first time.

Materials and Methods

Plant Material

Flowering aerial parts of *Centaurea intricata* Boiss. were collected in July 2013 from Arghavan Valley (Ilam Province, Iran). A voucher specimen has been deposited at the herbarium of Payame Noor University of Ilam, Iran.

Essential Oil Isolation

The air-dried crushed flowering aerial parts of *Centaurea intricata* Boiss. were subjected to hydrodistillation using a Clevenger-type apparatus for 4 hrs. The obtained volatile oil was dried over anhydrous sodium sulphate and stored at 4-6°C.

Essential Oil Analyses

Chemical composition of the oil was investigated by gas chromatography (GC) and gas chromatography–mass spectrometry (GC–MS).

Centaurea intricata Boiss. volatile oil was analyzed by GC–MS using a Hewlett-Packard 6890 gas chromatograph with DB-5 capillary column (30 m x 0.25 mm; film thickness 0.25 µm). The carrier gas was helium with a flow rate of l ml/min. The column temperature was programmed from 60°C to 220°C at 6°C/min. The gas chromatograph was coupled to a Hewlett-Packard 5973 mass selective detector. The MS was operated at 70 eV ionization energy. The retention indices were calculated by using retention times of *n*-alkanes that were injected after the essential oil at the same conditions. The components were identified by comparison of retention indices with those reported in the literatures and also by comparison of their mass spectra with the published mass spectra or Wiley library (19,20).

Gas chromatography using flame ionization detection (GC–FID) analysis was carried out under the same experimental conditions with the same column as described for the GC–MS. The relative percentage of the identified compounds was computed from the GC peak area without applying correction factors.

Results and Discussion

No.	Compound	RI *	Content (%)
1	*n*-Hexanal	800	0.1
2	(*E*)-2-Hexenal	854	Tr.†
3	*α*-Pinene	939	1.2
4	*α*-Fenchene	953	0.5
5	Sabinene	976	0.1
6	*α*-Terpinene	1020	0.7
7	*p*-Cymene	1027	0.8
8	*γ*-Terpinene	1063	1.1
9	Linalool	1102	0.7
10	Myrcenol	1124	0.3
11	Camphor	1147	Tr.
12	*α*-Terpineol	1191	0.1
13	Carvone	1244	0.2
14	*α*-Copaene	1378	1.4
15	*α*-Gurjunene	1410	0.7
16	*β*-Caryophyllene	1421	18.1
17	(*Z*)-*β*-Farnesene	1443	1.2
18	*α*-Humulene	1455	2.3
19	*γ*-Gurjunene	1477	Tr.
20	Germacrene D	1483	14.9
21	*β*-Selinene	1487	4.6
22	*α*-Muurolene	1501	2.5
23	Germacrene A	1510	0.9
24	*γ*-Cadinene	1513	1.1
25	Myristicin	1520	0.1
26	*α*-Calacorene	1546	1.9
27	Spathulenol	1578	6.3
28	Caryophyllene oxide	1584	11.8
29	Junenol	1619	0.4
30	*β*-Eudesmol	1652	9.6
31	Hexadecanoic acid	1695	6.4
32	*n*-Pentadecanol	1777	Tr.
33	Pentadecanoic acid	1868	0.1
34	*n*-Nonadecane	1900	Tr.

* Retention indices; relative to *n*-alkane series on DB-5 capillary column.

† trace (<0.05%).

Table 1. Volatile constituents of *Centaurea intricata* Boiss. flowering aerial parts

The dried flowering aerial parts of *Centaurea intricata* Boiss. yielded 0.07% V/W of a light yellow volatile oil.

Thirty four constituents consisting 90.1% of the total oil was identified which are presented in Table 1.

Essential oil of *Centaurea intricata* Boiss. flowering aerial parts was characterized by the high amount of sesquiterpene hydrocarbons (49.6%) with *β*-Caryophyllene (18.1%) and Germacrene D (14.9%) as main compounds, another component with considerable quantity was *β*-Selinene (4.6%). Oxygenated sesquiterpenes constituted 28.1% of the volatile oil which dominated by Caryophyllene oxide (11.8%), *β*-Eudesmol (9.6%) and Spathulenol (6.3%). Monoterpene hydrocarbons and oxygenated monoterpenes amounted to only 4.4% and 1.3%, respectively. Fatty acids added up to 6.5% with Hexadecanoic acid (6.4%) as the major ingredient.

Essential oil compositions of numerous species of the genus *Centaurea* were previously studied. Same as this research results, *β*-Caryophyllene was determined as a principle volatile constituent of *C. raphanina* subsp. *mixta* and *C. spruneri* (8), *C. cineraria* subsp. *umbrosa* and *C. napifolia* (9), *C. mucronifera* and *C. chrysantha* (10), *C. pseudoscabiosa* subsp. *pseudoscabiosa* and *C. hadimensis* (11), *C. kotschyi* var. *kotschyi* and *C. kotschyi* var. *decumbens* (12), *C. solstitialis* (13-15), *C. aucheri* (16), *C. iberica* and *C. virgata* (17), Also Germacrene D was detected as the main essential oil compound of *C. pseudoscabiosa* subsp. *pseudoscabiosa* and *C. hadimensis* (11), *C. kotschyi* var. *kotschyi* and *C. kotschyi* var. *decumbens* (12), *C. cineraria* subsp. *umbrosa* (9), *C. mucronifera* and *C. chrysantha* (10), *C. drabifolia* subsp. *detonsa* (18).

Regarding to our literature survey, there was no report on volatile composition of *Centaurea intricata* Boiss. and this article describes essential oil isolation and identification of this endemic species for the first time.

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