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Volatile Components of Aerial Parts of *Delphinium Speciosum* M.B. Growing In Iran

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The chemical composition of the essential oil from aerial parts of *Delphinium speciosum* (Family: Ranunculaceae) occurring in the Northwest of Iran (collected from Kandovan village, East Azarbaijan province) was analyzed for the first time by GC-FID and GC-MS. A total of 32 components were identified, accounting for 98.25% of the total oil. The major fraction of the volatile oil was represented by linear hydrocarbons (84.22%) with tricosane (29.32%), pentacosane (23.81%) and heneicosane (8.17%) as the main representatives in this fraction. In addition, the oil contained moderate amount of oxygenated compounds (14.03%), with hexahydrofarensyl acetone or phytone as the most abundant representative (8.87%).

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Introduction

The genus *Delphinium*, belonging to the family of Ranunculaceae, comprises approximately 300 species growing widely in the northern hemisphere including Asia, Europe, and North America [1, 2]. This genus represented in Iranian flora by 28 species which 9 of them are endemic to Iran [1]. *D. speciosum* is a perennial herb distributed in the North-west of Iran, with villous stems up to 80 cm, simple or branched and with woody roots. Leaves are rounded-pentagonal, 3-12 mm wide, with villous hairs in both sides. Inflorescences are black-purple raceme with the calyx densely villous [3]. Plants of genus *Delphinium* have been used for many years as herbal remedies as insecticides, antirheumatics, antipyretics, anti-inflammatory and analgesic drugs [2, 4, 5]. Various phytochemical studies on *Delphinium* species revealed the presence of alkaloids especially C_{18}, C_{19} and C_{20}- diterpenoid alkaloids or norditerpenoid alkaloids [2, 6-12], acylated flavonol glycosides [2, 13-15] and banzoxepine derivatives [16]. In the case of essential oils, only a few number of plants from this genus such as *D. formosum*, *D. elatum* and *D. consolida*, have been investigated [17]. The present work deals with the analysis of the volatile oil from the flowering aerial parts of *D. speciosum* collected from East Azarbaijan province, Iran.

Materials and methods

Materials

Plant Material

Flowering aerial parts of *D. speciosum* were collected at the end of the June 2013 from Arshad chamani, Kandovan village (in Sahand rural district, central district of Osku, East Azarbaijan province, Iran). The plant material was identified by the herbarium of Faculty of Pharmacy, Tabriz University of Sciences, Iran, and a voucher specimen has been deposited under the accession code Tbz-Fph-757.

Essential oil Extraction

The air-dried aerial parts of *D. speciosum* (50 g) were cut into small pieces and the essential oil was obtained by hydrodistillation (4h) in a Clevenger-type apparatus. The pale-yellow-colored oil was dried over anhydrous sodium sulphate and stored in a sealed vial at -4 °C before analyses.

GC-MS and GC-FID analysis

The analysis of the essential oil was carried out using a Shimadzu GCMS-QP5050A gas chromatograph-mass spectrometer (GC-MS) equipped with a fused methyl silicone DB-1 column (1% phenyl methylpolysiloxane, 60 m, 0.25 mm i.d., 0.25 µm film thickness) and coupled to a mass selective detector. Helium was used as carrier gas at a flow rate of 1.3 mL/min. The column temperature was held three min at 50°C, increased to 270°C at a rate of 3.0°C/min, and finally 4 min at 270°C. The injector temperature was 250°C and split ratio was adjusted at 1:20. The injection volume was 1 µL. The mass spectrometer was run in the electron impact (EI) mode with electron energy at 70 ev, scanning area the 30-600amu, ion source temperature 260°C; quadrupole temperature 100°C; solvent delay 8.0 min; *electron multiplier* (EM) voltage 3000 volts. Moreover, flame ionization detector (FID) which was operated in ionization potential mode at 70 ev, was utilized to calculate the relative area percentage (area %) without the use of correction factors.

Identification of Volatile Components:

The volatile components of the oil were identified by comparing and matching their fragmentation pattern of mass spectra with those of the spectrophotometer database using the NIST10, NIST 21, NIST 69, Wiley 229 and ADAMS [18] libraries along with comparing their Kovats retention indices relative to the series of *n*-alkanes (C8-C20) with literature data.

Results and discussion

The chemical composition of the essential oil obtained from the aerial parts of *D. speciosum* is given in *Table 1,* where the volatiles are listed in order of their elution on the DB-1 column.

A total of 32 components were identified, amounting to 98.25% of the total oil. As can be seen in *Fig 1* and *Table 1*, linear hydrocarbons, particularly long chain *n*-alkanes showed the highest contribution and comprised 84.22% of the total oil with *n*-tricosane (29.32%), *n*-pentacosane (23.81%), *n*-heneicosane (8.17%) and 2-methyldocosane (6.12%) as the most abundant components. Furthermore, the oil presented moderate amount of oxygenated compounds (14.03%), with hexahydrofarensyl acetone or phytone as the most abundant representatives (8.87%). Apart from the main constituents mentioned above, only isotetradecane or 2-methyltetradecane (3.30%) and *n*-tetracosane (2.39%) surpassed a content of 2% of the total oil composition, whereas the other constituents (25) were present in values less than 2%.

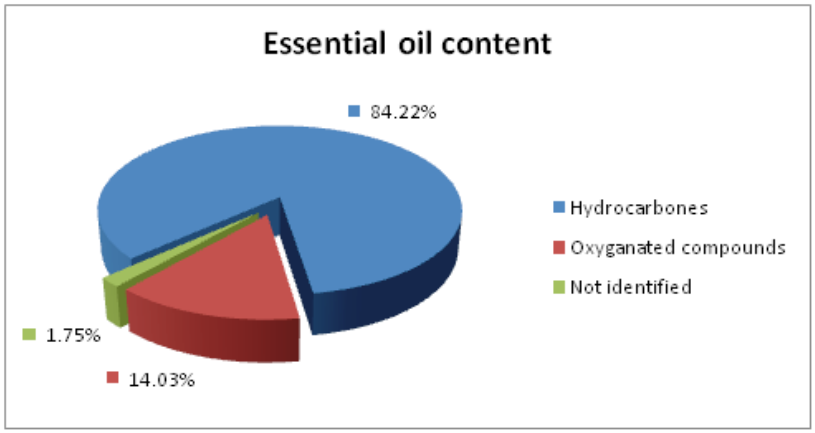

Fig. 1. Identified chemical groups from the essential oil of *Delphinium speciosum*.

Literature survey revealed that there are no available reports on the chemical composition of *D. speciosum* but volatile oils of some other species of this genus have been investigated. Preceding studies on the volatile oil extracted from the flowers of *D. formosum* showed that tricosane (30.90%), heneicosane (8.20%) and pentacosane (6.60%) comprised the main components of this oil [5]; therefore, our findings were in consistent with that obtained in previous investigation. Moreover, Linalool and Phytol were found at a reasonable level in essential oil of *D. formosum* whereas they were not detected in our examined oil. According to other report by Kokoska et al. octadecadienoic acid (42.83 %), hexadecanoic acid (23.87 %) and octadecenoic acid (21.67 %) were the major compounds of the essential oil from seeds of *D. elatum* [17], but the percentage of fatty acid derivatives (totally 1.63%) was quite lower in our tested oil. The difference might result from difference in species, seasonal variations, altitude, climatic conditions, choice of plant organ and extraction method [19-21]. Furthermore, according to *Table 1*, it can be seen that long chain *n*-alkanes contribute the highest level in the total oil, with the linear odd carbon atom series C23-C27 as dominant (*n*-heneicosane, *n*-tricosane, *n*-pentacosane). Previous studies showed that two different patterns (A and B) were observed in distribution of *n*-alkanes in different organs of plants especially in waxy coatings on leaves. In the case of A pattern, a Gaussian-like distribution of even and odd *n*-alkanes at equivalent proportions, often around C22-C28, was observed which was produced by paranchymatic parts while pattern B indicates an alternation in chain length

distribution which the odd *n*-alkanes are present in dominance (C25-C33) and originated from epidermis tissues [22,23]. It is obviously seen that the distribution of *n*-alkanes of *D. speciosum* oil follows B pattern.

Table 1. Composition of the essential oil isolated from the aerial parts of *Delphinium speciosum.*

Compound [a]	KI	%	Identification method [b]
1-octanol	1053	0.48	GC/MS, I_b
α-terpineol	1172	0.84	GC/MS, I_s
dodecane	1198	0.21	GC/MS, I_s
E-geraniol	1233	1.11	GC/MS, I_s
3,8-dimethylundecane	1284	0.23	GC/MS, I_s
E,Z-nepetalactone	1326	0.53	GC/MS, I_s
tetradecane	1400	0.29	GC/MS, I_s
geranyl acetone	1428	0.24	GC/MS, I_s
isotetradecane(2-methyltetradecane)	1465	3.30	GC/MS, I_s
β-selinene	1493	1.14	GC/MS, I_s
pentadecane	1500	0.29	GC/MS, I_s
hexadenane	1600	0.22	GC/MS, I_s
1-tetradecanol	1658	0.33	GC/MS, I_s
7-ethylhexadecane	1725	0.21	GC/MS, I_s
hexahydrofarensyl acetone(phytone)	1830	**8.87**	GC/MS, I_s
nonadecane	1900	0.22	GC/MS, I_s
hexadecanoic acid methyl ester(palmitic acid methyl ester)	1907	0.49	GC/MS, I_s
hexadecanoic acid	1944	0.89	GC/MS, I_s
Z-Biformene	1972	0.93	GC/MS, I_s
2-Methyleicosane	2060	0.30	GC/MS, I_s
linolenic acid, methyl ester([Z,Z,Z]-9,12,15-octadecadienoic acid methyl ester)	2078	0.25	GC/MS, I_s
***n*-heneicosane**	2100	**8.17**	GC/MS, I_b
9-ethyleicosane	2113	1.66	GC/MS, I_b
n-docosane	2200	1.72	GC/MS, I_b
2-methyldocosane	2263	6.12	GC/MS, I_b
***n*-tricosane**	2300	**29.32**	GC/MS, I_b
3-methyltricosane	2373	1.12	GC/MS, I_b
n-tetracosane	2400	2.39	GC/MS, I_b
2-methyltetracosane	2461	1.40	GC/MS, I_b
***n*-pentacosane**	2500	**23.81**	GC/MS, I_b
n-hexacosane	2600	0.45	GC/MS, I_b
n-heptacosane	2700	0.72	GC/MS, I_b
Total compounds		32	
Total identified		**98.25**	

[a]Compounds listed in order of elution from a *DB-1* column, [b] Identification Method (I_s = Kovats retention index according to authentic standard, I_b = Kovats retention index according to bibliography).

Conclusion

To sum up, the current work represented the chemical composition of the volatile oil obtained from the flowering aerial parts of *D. speciosum* for the first time. Tricosane (29.32%), pentacosane (23.81%), hexahydrofarnesyl acetone (8.87%) and heneicosane (8.17%) were identified as the main components.

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Conflict of interest

Authors certify that there is no actual or potential conflict of interest in relation to this article.

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