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Chemical composition of the essential oil of *Verbascum songaricum* from Iran

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Abstract

The essential oil of the aerial parts of *Verbascum songaricum* Schrenk. ex Fisch. & C. A. Mey., growing wild in Iran, was extracted by hydrodistillation method and analyzed by GC and GC/MS. Eighteen components were identified in the essential oil of the plant, representing 97.8% of the total oil. The most abundant constituent of the oil was *n*-octane (61.2%), followed by *n*-decane (15.6%), *n*-dodecane (4.6%), 1-ethyl-3-methylcyclopentane (4.2%), and 6,10,14-trimethyl-2-pentadecanone (3.2%). Consequently, aliphatic hydrocarbons (88.5%) were the major group of compounds in the essential oil of *V. songaricum*.

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Introduction

Verbascum, commonly known as "mullein", is the largest genus of the Scrophulariaceae family, with about 2500 species worldwide (Tatli and Akdemir, 2004). The Iranian Flora consists of 41 species of the genus, including 17 endemics, and the popular Persian name of the species is "Gol-e-Mahour". *Verbascum songaricum* Schrenk. ex Fisch. & C. A. Mey. is a perennial herb growing wild mainly in different parts of Asia (Mozaffarian, 2006).

Plants of the genus *Verbascum* are a source of biologically active compounds such as saponins, iridoid and phenylethanoid glycosides, neolignan and monoterpene glucosides, phenolic and fatty acids, spermine alkaloids, steroids, and flavonoids (Süntar *et al.*, 2010; Akkol *et al.*, 2007; Tatli *et al.*, 2004; Abougazar *et al.*, 2003; Magiatis *et al.*, 2000).

Verbascum species have been used medicinally since ancient times in folk medicine as a remedy for respiratory problems such as bronchitis, dry coughs, whooping cough, tuberculosis, and asthma. The species are also used to treat hemorrhoids, rheumatic pain, superficial fungal infections, wounds, and diarrhea (Georgiev *et al.*, 2011; Tatli and Akdemir, 2006). In addition, several species of the genus have been reported as anodyne, astringent, demulcent, emollient, diuretic, sedative, antiseptic (Emam, 2010; Akdemir *et al.*, 2005; Tatli and Akdemir, 2004), antimicrobial (Ozcan *et al.*, 2011; Tatli and Akdemir, 2005; Dülger *et al.*, 2002), antifungal (Tatli *et al.*, 2003), antioxidant (Georgiev *et al.*, 2011; Ozcan *et al.*, 2011; Emam, 2010; Tepe *et al.*, 2006), anti-inflammatory (Dimitrova *et al.*, 2012; Tatli *et al.*, 2008), antimalarial (Tatli and Akdemir, 2005; Akdemir *et al.*, 2003), and antitumor (Panchal *et al.*, 2010).

The volatile constituents of the essential oils of *V. undulatum* Lam. from Greece (Melliou *et al.*, 2007), *V. wiedemannianum* Fisch. & Mey from Turkey (Iskender *et al.*, 2009), and *V. thapsus* L. from Iran (Morteza-Semnani *et al.*, 2012) have been previously reported. To the best of our knowledge, there is no published report on the composition of *V. songaricum* essential oil. However, several triterpenoid saponins (Hartleb and Seifert, 1995; Seifert *et al.*, 1991) and flavonoids (Yuldashev, 1996) have been isolated and identified from the species. The present work reports the chemical composition of the essential oil from the aerial parts of *V. songaricum* for the first time.

Materials and methods

Plant material

The aerial parts of *Verbascum songaricum* were collected during the flowering phase from Gavehsoltani (at an altitude of 2900–3000 m), the Gughar area, Kerman Province, Iran in June 2014. A voucher specimen (No. 8640) has been deposited in the Herbarium of the Research Center of Agriculture and Natural Resources of Kerman, Iran. The plant material was air-dried at room temperature, protected from light, for 1 week.

Isolation of the essential oil

The air-dried aerial parts of the plant (150 g) were crushed and subjected to hydrodistillation using a Clevenger-type apparatus for 3 hours. The distilled oil was dried over anhydrous sodium sulfate and stored in a tightly closed dark vial at 4 °C until the GC and GC/MS analyses. The yield of the oil was calculated based on dried weight of plant material.

GC and GC/MS analyses

The constituents of the oil were analyzed by GC and GC/MS. GC analysis of the volatile components was carried out using a Hewlett-Packard 6890 instrument coupled to a flame ionization detector (FID). Compounds were separated on a HP-5 capillary column (30 m × 0.25 mm, film thickness 0.25 µm). Helium was used as the carrier gas at a constant flow of 1 mL/min. The column temperature was kept at 60 °C for 3 min and programmed to 220 °C at a rate of 5 °C/min. Injector and detector temperatures were kept at 250 °C and 270 °C, respectively. A mixture of aliphatic hydrocarbons (C_6–C_{23}) in hexane was

directly injected into the GC injector under the above temperature programme in order to calculate the retention indices of each compound.

GC/MS analysis was performed using an Agilent 5975C mass spectrometer coupled to an Agilent 7890A gas chromatograph equipped with a HP-5MS capillary column (30 m × 0.25 mm, film thickness 0.25 μm). The carrier gas was helium, and the chromatographic conditions were as above. Spectrometer was scanned over the 40-400 amu range with an ionization voltage of 70 eV and an ionization current of 150 μA.

Identification of the components

The constituents of the oil were identified by comparison of their retention indices with those reported in the literature and by comparison of their mass spectra with the Wiley and NIST libraries or with the published mass spectra (Adams, 2004; Massada, 1976). The percentage composition of the individual components was computed from the GC-FID peak areas without the use of correction factors.

Results and discussion

The yield of the essential oil obtained from the aerial parts of *V. songaricum* was 0.4% (w/w). The identified compounds of the oil are listed in Table 1, in which the percentage and retention indices (RI) of the components are given.

Table 1. Identified compounds in the essential oil of *Verbascum songaricum*.

Compound	RI*	Percent (%)
1-Ethyl-3-methylcyclopentane	781	4.2
3,4-Dimethyl-2-hexene	788	0.6
n-Octane	795	61.2
(*E*)-4-Octene	802	0.3
(*E*)-2-Hexenal	850	0.3
3-Methylnonane	970	0.9
1-Octene-3-ol	979	0.9
n-Decane	997	15.6
n-Nonanal	1102	1.8
Isophprone	1120	0.6
n-Dodecane	1197	4.1
4-a*α*,7*α*,7a*α*-Nepetalactone	1360	0.7
4-a*α*,7*α*,7a*β*-Nepetalactone	1387	0.8
n-Tetradecane	1396	1.1
(*E*)-*β*-Ionone	1486	0.7
n-Hexadecane	1596	0.5
6,10,14-Trimethyl-2-pentadecanone	1843	3.2
Diisobutyl phthalate	1868	0.3
Total identified	–	97.8

*Retention indices, experimentally determined.

Constituents are arranged in order of their elution from the HP-5MS column. As is shown, 18 compounds were identified in the essential oil of the plant, representing 97.8% of the total oil. The most abundant constituent of the oil was *n*-octane (61.2%), followed by *n*-decane (15.6%), *n*-dodecane (4.6%), 1-

ethyl-3-methylcyclopentane (4.2%), and 6,10,14-trimethyl-2-pentadecanone (3.2%). The other components were present in less than 2%.

1-Octen-3-ol (22.5%), *α*-bisabolol (10.6%), and nonanal (9.0%) were reported as the main constituents of the essential oil of the aerial parts of *V. undulatum* from Greece (Melliou *et al.*, 2007). In another research, the major components of the flower, leaf, and stem oils of *V. wiedemannianum* grown in Turkey were petadecane (58.2%), (2*E*)-hexenal (33.2%), and hexadecanoic acid (24.6%), respectively. Aliphatic hydrocarbons were the most abundant compounds in the flower and stem oils of the plant (Iskender *et al.*, 2009). In addition, The essential oil of the aerial parts of *V. thapsus* from Iran had 6,10,14-trimethyl-2-pentadecanone (14.3%) and (*E*)-phytol (9.3%) as the main constituents (Morteza-Semnani *et al.*, 2012). Unlike *V. thapsus* and *V. undulatum*, the essential oil of *V. songaricum* contained significant amounts of aliphatic hydrocarbons.

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