

COMPOSITION OF THE ESSENTIAL OIL OF *Artemisia ciniformis*, *A. kopetdaghensis*, and *A. khorasanica* IN IRAN

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The genus *Artemisia* (Asteraceae tribe Anthemideae) belongs to the family of useful aromatic and medicinal plants which comprises 300 species found in the northern hemisphere [1].

Thirty-four species of this genus are found in Iran, among which two are endemic: *A. melanolepis* Boiss. and *A. kermanensis* Podl [2].

In contrast to the oils of many *Artemisia* species [3–15], the essential oils of *Artemisia ciniformis* and *A. kopetdaghensis* have not been analyzed until now. In addition, as there has only been one report describing the volatile constituents of *A. khorasanica*, we also decided to include it in our analysis [16].

The composition of the essential oils of *Artemisia ciniformis* Krasch. & M. Pop. ex Poljak, *Artemisia kopetdaghensis* Krasch., M. Pop. & Lincz. ex Poljak, and *Artemisia khorasanica* Podl are listed in Table 1, in which the percentage and relative retention indices of the components are given.

As it is shown, the oil of *Artemisia ciniformis*, grown in northern Khorassan Province, consisted of ten monoterpene hydrocarbons (35.5%), seven oxygenated monoterpenes (23.1%), and four sesquiterpenes (33.9%). Davanone (29.6%), myrcene (14.4%), camphor (10.6%), *p*-cymene (9.6%), and linalool (8.6%) were found to be the major components among the 22 constituents characterized, comprising 92.5% of the total components detected.

As a result of the above studies, it was shown that monoterpenes and sesquiterpenes made up 63.3% and 36.7% of the oil, respectively.

Twenty-three constituents, representing ca. 98% of the total components in the oil of *Artemisia kopetdaghensis*, consisted of eleven monoterpene hydrocarbons (46.3%), six oxygenated monoterpenes (46.5%), and six sesquiterpenes (5.5%) with the major constituents being myrcene (30.4%), linalool (21.9%), camphor (16.8%), camphene (6.1%), and 1,8-cineol (4.8%).

The main constituents of *Artemisia khorasanica* were found to be 1,8-cineol (33.9%), β -thujone (20.1%), α -thujone (11.9%), and camphor (8.2%) among the 12 compounds characterized, representing 87% of the total components. In *Artemisia khorasanica* seven oxygenated monoterpenes (52.9%) predominated over the five monoterpene hydrocarbons (35.6%).

Previous investigations on the oil of the *Artemisia khorasanica* showed a different percentage composition for the major components 1,8-cineol (17.7%) and camphor (13.9%) [16].

The aerial parts of *Artemisia ciniformis*, *A. kopetdaghensis*, and *A. khorasanica* were collected from the Bojnourd area of Iran in November 2005.

Voucher specimens have been deposited at the Herbarium of the Research Institute of Forests and Rangelands (TARI) in Tehran, Iran.

Air-dried aerial parts of *A. ciniformis*, *A. kopetdaghensis*, and *A. khorasanica* were separately subjected to hydrodistillation for 3 hours using a Clevenger-type apparatus.

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TABLE 1. Composition of the Essential Oil of *Artemisia ciniformis*, *A. kopetdaghensis*, and *A. khorasanica*

Compound	RRI	Percentage		
		<i>A. kopetdaghensis</i>	<i>A. ciniformis</i>	<i>A. khorasanica</i>
Tricyclene	926	0.33		
α -Pinene	939	2.99	1.19	
Camphene	953	6.08	2.85	1.23
Sabinene	976	0.24		1.07
β -Pinene	980	1.69	0.67	
Myrcene	991	30.40	14.45	
Yomeghi alcohol	998			2.35
α -Terpinene	1018	0.49	1.08	
<i>p</i> -Cymene	1026	1.22	9.62	1.31
β -Phellandrene	1031	1.69	1.84	
1,8-Cineol	1033	4.82	0.78	33.92
γ -Terpinene	1062	0.50	1.88	
Artemisia alcohol	1083			1.21
Terpinolene	1088	0.71	1.23	
Linalool	1098	21.94	8.57	
<i>cis</i> -Thujone	1102			20.13
<i>trans</i> -Thujone	1114			11.93
Camphor	1143	16.82	10.65	8.15
Pinocarvone	1162			1.34
Borneol	1165	0.88	0.33	3.74
Terpinen-4-ol	1177	1.08	1.61	1.50
α -Terpineol	1189		0.51	
Citral	1247		0.66	
Bornyl acetate	1285	0.99		
<i>cis</i> -Jasmone	1294		0.64	
β -Caryophyllene	1418	0.29		
β -Farnesene	1443	0.25		
γ -Curcumene	1480		0.80	
Bicyclogermacrene	1494	0.40		
α -Zingiberene	1495		1.07	
β -Bisabolene	1504	0.42	1.03	
β -Sesquiphellandrene	1524	0.64	1.42	
Davanone	1586	3.51	29.60	

RRI: relative retention indices were calculated against *n*-alkanes (C₉-C₁₈) on a nonpolar HP-5 column.

Percentage: calculated from TIC data.

After decanting and drying the oil solutions over anhydrous sodium sulfate, the corresponding yellowish colored oils were recovered. The recovered oil yields of the three *Artemisia* species, *A. ciniformis*, *A. kopetdaghensis*, and *A. khorasanica*, were 0.60%, 0.50%, and 0.30% (W/W), respectively.

GC analysis was performed on a Shimadzu 15 A gas chromatography apparatus equipped with a split/splitless injector (25°C) and a flame ionization detector (250°C). T₂ was used as a carrier gas (1 mL/min) and the capillary used was DB-5 (50 m × 0.20 mm, film thickness 0.32 μm). The column temperature was kept at 60°C for 3 min and then heated to 220°C with a 5°C/min rate and kept constant at 220°C for 5 min. Relative percentage amounts were calculated electronically from TIC data by computer.

GC-MS analysis was performed using a Hewlett-Packard 5973 with a HP-5MS column (30 m × 0.25 mm, film thickness 0.25 μm).

The column temperature was kept at 60°C for 3 min and programmed to 220°C at a rate of 5°C/min and kept constant at 220°C for 5 min. The flow rate of helium as the carrier gas was 1 mL/min, and MS was taken at 70 eV.

Identification of the constituents of each oil was made by comparison of their mass spectra and relative retention indices (RRI) with those given in the literature and those of authentic samples [17, 18].

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