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CHEMICAL COMPOSITION OF THE ESSENTIAL OILS OF TWO *Ferula* SPECIES FROM IRAN

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The genus *Ferula*, which belongs to the Umbelliferae family, has 133 species distributed throughout the Mediterranean area and Central Asia [1]. The Iranian flora consists of 30 species of *Ferula*, including 15 endemics, and the popular Persian name of most species is "Koma" [2]. Due to some biological activities, several species of this genus have been used in folk medicine [3]. Many reports on phytochemical analyses of this genus, including essential oil analysis, can be found in the literature [3–12].

Our previous study was carried out on water-distilled essential oils obtained from the aerial parts of *Ferula microcolea* (Boiss.) Boiss. and *Ferula hirtella* Boiss. Results showed that the major components of the first one were α-pinene (19.2%), nonane (13.2%), and β-phellandrene (13.0%), whereas α-pinene (15.4%) and thymol (14.9%) were identified for the latter [10].

The present study describes the constituents of the essential oils from the aerial parts of *Ferula kashanica* Rech.f. (endemic to Iran) and *Ferula diversivittata* Regel. et Schmalh., which have not been studied previously. For this purpose, the aerial parts of the two wild-growing *Ferula* species were collected during the flowering stage at the following places: *F. kashanica* was collected from Mouteh Mountain, Isfahan Province, Iran, in June 2009; and *F. diversivittata* from Bazagh Mountain, Khorasan-Razavi Province, Iran, in July 2009. Voucher specimens of the plants (No. 115 and 116, respectively) were deposited in the Herbarium of the Department of Microbiology, Islamic Azad University, Kerman Branch, Kerman, Iran. The air-dried aerial parts of the plants were crushed and separately subjected to hydrodistillation using a Clevenger-type apparatus for 3 h. The clear yellowish oils of *F. kashanica* and *F. diversivittata* were isolated in yields of 1.2 and 1.4% (w/w), respectively. The constituents of the volatile oils were analyzed by GC and GC/MS [13].

The chemical components identified in the two oils are listed in Table 1, in which the percentage and retention indices of the components are given. Constituents are listed in order of their elution from an HP-5MS column [10]. As is shown, 11 components were identified in the oil of *F. kashanica*, representing 96.2% of the oil composition. The main constituents were α-pinene (33.21%), limonene (20.30%), and camphene (16.82%), followed by myrcene (8.66%) and bornyl acetate (6.22%). Thus, this oil consists of six monoterpene hydrocarbons (83.52%), three oxygenated monoterpenes (11.31%), one sesquiterpene hydrocarbon (0.20%), and one oxygenated sesquiterpene (1.17%).

Furthermore, 22 components were identified in the oil of *F. diversivittata*, making up 98.1% of the total composition. The major components were α-pinene (25.80%), limonene (15.42%), bornyl acetate (11.61%), and camphene (11.38%), followed by myrcene (7.90%) and β-pinene (6.34%). Apparently, this oil contains eight monoterpene hydrocarbons (68.81%), twelve oxygenated monoterpenes (27.19%), and two sesquiterpene hydrocarbons (2.10%).

As the results indicate, both oils are rich in monoterpenes. It is conceivable that some of the identified monoterpenes in the two mentioned oils, such as α-pinene, β-pinene, limonene, camphene, and myrcene, were those that were reported to be present in the essential oil of most Iranian *Ferula* species [5, 6, 10]. However, many sesquiterpenes previously reported in the essential oil of some Iranian *Ferula* species were not identified in this study [6, 7, 10].

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TABLE 1. Percentage Composition of the Essential Oils of *F. kashanica* and *F. diversivittata*

Compound	RI	*F. kashanica*	*F. diversivittata*	Compound	RI	*F. kashanica*	*F. diversivittata*
α-Thujene	922	–	0.55	Citronellal	1148	–	0.17
α-Pinene	936	33.21	25.80	Borneol	1164	–	0.68
Camphene	951	16.82	11.38	α-Terpineol	1188	–	0.39
β-Pinene	976	4.16	6.34	Fenchyl acetate	1218	1.64	2.46
Myrcene	990	8.66	7.90	Citronellol	1231	–	3.06
α-Phellandrene	1002	–	0.13	Bornyl acetate	1285	6.22	11.61
δ-3-Carene	1008	–	1.29	Citronellyl acetate	1350	–	2.18
p-Cymene	1021	0.37	–	Geranyl acetate	1378	–	0.39
Limonene	1030	20.30	15.42	β-Caryophyllene	1418	–	1.79
Fenchone	1085	3.45	3.35	γ-Elemene	1433	–	0.31
Linalool	1098	–	1.69	Epizonarene	1442	0.20	–
Fenchyl alcohol	1112	–	0.90	Carotol	1602	1.17	–
Camphor	1142	–	0.31	Total percentage		96.2	98.1

RI: retention indices as determined on an HP-5MS capillary column using the homologous series of *n*-alkanes.

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