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Essential Oil Composition of Root of *Ferula assa-foetida* from Two Iranian Localities (Gonabad and Tabas)

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Hydrodistilled oils of *Ferula assa-foetida* root were collected from two Iranian ecotypes (Gonabad and Tabas) and analyzed by GC and GC/MS system. The results of essential oils analysis showed the presence of 32 compounds. A total of 26 compounds constituting of 98.5 % oil were characterized in Gonabad sample and 26 compounds constituting of 93.3 % oil identified in Tabas sample. According to present results, both samples showed similar chemical compositions, the dominant components in both samples were E-1-propenyl *sec*-butyl disulfide (30.7 and 18.8 % in Gonabad and Tabas samples, respectively), Z-1-propenyl *sec*-butyl disulfide (12.4 and 9.2 % in Gonabad and Tabas samples, respectively), eudesmol (10-epi-γ) (12.7 and 18.7 % in Gonabad and Tabas samples, respectively), methyl 1-(methylthio) propyl disulfide (10.9 and 4.3 %), eudesmol (7-epi-α) (4.8 and 8.2 % in Gonabad and Tabas samples, respectively) and agarospirol (2.8 and 5.1 % in Gonabad and Tabas samples, respectively).

Key Words: *Ferula assa-foetida*, Essential oil, GC/MS.

INTRODUCTION

The genus *Ferula*, which belongs to the Umbelliferae family, is widespread in the Mediterranean area and Central Asia[1]. Thirty species of genus *Ferula* are found in Iran, among which 15 are endemic[2]. Some species of genus *Ferula* have been used in the folk medicine as sedative, antispasmodic, against teeth pain, asthma, cough, epilepsy, fever, irritable colon, as an antihysterie, for feminine sterility, against rheumatism and to treat diabetes[3-6]. *Ferula assa-foetida* is an herbaceous, monoecious and perennial and grows up to 2 m high. It is native to center Asia, eastern Iran to Afghanistan where it grows from 600 to 1200 m above sea level[7]. In Iran *F. assa-foetida* is commonly known as "Anguze". Iranian farmers extract oleo gum resin (Anguze) by cutting the living rhizome of *F. assa-foetida*[8]. The oleo gum resin and remaining root export to other countries.

Volatile components of the essential oils *Ferula* species: *F. orientalis, F. elaeochytris, F. stenocarpa, F. galbaniflua, F. persica* were evaluated previously[9-14]. The major components of essential oil of *F. orientalis* arial part from Iran were 2-ethyl-1-octen-3-one (13.88 %), *cis*-verbenol (9.03 %), caryophyllene oxide (5.02 %), *p*-mentha-

1,5-dien-8-ol (2.38 %) and myrtenol (2.38 %) while in similar study reported that the oil of *F. orientalis* from Turkey contained β-phellandrene (23.6 %), (E)-β-ocimene (13.8 %), α-pinene (12.5 %), α-phellandrene (11.5 %) and dehydro-sesquicineole (10.1 %) as main constituents. The dominant components of the essential oil of *F. elaeochytris* were nonane (27.1 %), α-pinene (12.7 %) and germacrene B (10.3 %). On the other hand, the main components of *F. stenocarpa* oil were α-pinene (48.8 %) and β-pinene (30.1 %). In another study, chemical composition of essential oils of the stem and root of *F. galbaniflua* examined by Rustaiyan *et al.*[12,13] and β-pinene was the major component in both oils: stem (46.4 %) and root (58.8 %). Dimethyl trisulphide (18.2 %), myristicin (8.9 %) and dimethyl tetrasulphide (7.6 %) were the main components in the essential oil of the root of *F. persica* from Iran.

In past, several workers reported the chemical composition of the essential oil of *F. assa-foetida* and the major constituents were sulphur containing compounds with disulfides as major components and various monoterpenes.

The major components of essential oil of *F. assa-foetida* oleo gum was collected from Pakistan were phelandrene (6.49 %), propenyl *sec*-butyl disulfide (51.9 %) and undecyl sulfonyl acetic acid (18.8 %), while dominant components at same experiment in Iran were Z-1-propenyl *sec*-butyl disulfide (35.1 %) and E-1-propenyl *sec*-butyl disulfide (22.1 %)[15,16]. A literature survey showed that chemical composition of the essential oil of *F. assa-foetida* seed has been reported by Ashraf *et al.*[17], which geraniol acetate (7.71 %), myristic acid (21.23 %), phellanderene (5.48 %) and α-tepineol (12.71 %) were detected as main constituents. In an earlier investigation on the essential oil composition of *F. assa-foetida* arial part was obtained by hydrodistillation and supercritical fluid extraction methods. In both extraction methods Z-1-propenyl *sec*-butyl disulfide, E-1-propenyl *sec*-butyl disulfide and germacrene B were as major components[18].

As is observed, short review showed variation between the chemical compositions of species *Ferula* from different regions. A literature search revealed that the chemical composition of root essential oils of *F. assa-foetida* were collected from Gonabad (F.a.G) and Tabas (F.a.T) have not been previously reported therefore we decided to evaluate them.

EXPERIMENTAL

Plant materials and oil isolation: The root of *F. assa-foetida* was collected from two locations in Iran: Gonabad (Province of Khorassan Razavi, 1150 m above sea level) and Tabas (Province of Yazd, 690 m above sea level). These two localities are situated in the eastern part of Iran and about 420 kms from each other. The samples were collected in July 2007 after oleo gum resin extraction of the plants. Air-dried roots of two samples (100 g) were powdered and the oils were obtained by hydrodistillation using a clevenger-type apparatus for 3 h. The distillated oils were dried over anhydrous sodium sulfate and stored at 4 °C until analyzed. Colour of the oils was greenish and had bad odour.

Gas chromatography: GC analysis was conducted using a Varian CP-3800 instrument equipped with a capillary VF-5 fused silica column (30 m × 0.25 mm i.d., film thickness 0.25 μm). Helium was used as the carrier gas at the constant flow of 1.1 mL/min; split ratio, 1/50. The oven temperature was held at 60 °C for 1 min, then programmed to 250 °C at a rate of 3 °C/min and held for 10 min. The injector and detector (FID) temperatures were kept at 250 and 280 °C, respectively.

Gas chromatography-mass spectrometry: A GC/MS analysis was performed on a Varian CP-3800 GC coupled with Varian 4000 (Ion trap) Mass system. The operating conditions were the same conditions as described above but the carrier gas was helium. Mass spectra were taken at 70 ev. Mass range was from m/z 35-400 amu.

Identification of the compounds: The chemical composition of the essential oils were identified by calculation of their retention indices under temperature-programmed conditions for *n*-alkanes (C6-C24) and the oil on a VF-5 column under the same chromatographic conditions. The compounds were identified by comparison of their mass spectra with those of the internal reference mass spectra library (Wiley 7) or with authentic compounds and confirmed by comparison of their retention indices with authentic compounds or with those reported in the literature[9,19,20]. For quantification purpose, relative area percentages obtained by FID were used without the use of correction factors.

RESULTS AND DISCUSSION

The essential oil contents of F.a.G and F.a.T samples were 0.8 and 1.6 % (v/w), respectively. The analyses of essential oils of *F. assa-foetida* root from two Iranian habitats are indicated in Table-1. In total 26 constituents were identified and quantified in F.a.G oil and 26 in F.a.T oil, representing 98.5 and 93.3 % of the total oil, respectively. The oil of F.a.G consisted of 11 disulfide components (64 %) 4 sesquiterpenes hydrocarbons (1.9 %) and 8 oxygenated sesquiterpenes (30.4 %). On the other, the oil of F.a.T consisted of 9 disulfide components (40.5 %) 3 sesquiterpenes hydrocarbons (2.6%) and 7 oxygenated sesquiterpenes (44.7 %). A comparison among the compositions of the essential oils revealed both quantitative and qualitative are close, which seems to indicate that the two samples present a similar chemotype. According to present results, the dominant components in both samples were E-1-propenyl *sec*-butyl disulfide (30.7 and 18.8 % in the F.a.G and F.a.T samples, respectively), Z-1-propenyl *sec*-butyl disulfide (12.4 and 9.2 % in the F.a.G and F.a.T samples, respectively), eudesmol (10-epi-γ) (12.7 and 18.7 % in the F.a.G and F.a.T samples, respectively), methyl-1-(methylthio)propyl disulfide (10.9 and 4.3 % in the F.a.G and F.a.T samples, respectively), eudesmol (7-epi-α) (4.8 and 8.2 % in the F.a.G and F.a.T samples, respectively) and agarospirol (2.8 and 5.1 % in the F.a.G and F.a.T samples, respectively).

TABLE-1
CHEMICAL COMPOSITION OF THE ESSENTIAL OIL OF ROOT OF *Ferula assa-foetida*

Compd. No.	Compound	Kovatas constant	F.a.G %*	F.a.T %**
1	Z-Propenyl methyl disulfide	931	0.3	-
2	E-Propenyl methyl disulfide	940	0.2	0.2
3	*n*-Propyl *sec*-butyl disulfide	1164	0.3	0.4
4	Z-1-Propenyl *sec*-butyl disulfide	1169	12.4	9.2
5	E-1-Propenyl *sec*-butyl disulfide	1175	30.7	18.8
6	*bis*(1-Methylpropyl)disulfide	1213	0.5	1.3
7	*bis*[1-(Methylthio)ethyl]disulfide	1352	0.1	-
8	α-Elemene	1378	-	0.5
9	Methyl 1-(methylthio) ethyl disulfide	1392	0.4	-
10	Tetradecane	1399	-	0.5
11	2,2-*bis*(Methylthio)propan	1423	0.5	0.3
12	*bis*[1-(Methylthio)propyl]disulfide	1429	5.8	3.2
13	Methyl 1-(methylthio)propyl disulfide	1432	10.9	4.3
14	γ-Gurjunene	1446	0.3	-
15	2-Methyl 2-methylthiopropanal	1469	1.4	2.5
16	β-Selinene	1489	-	0.3
17	Pentadecane	1499	0.3	0.8
18	Methyl penthyl tetrasulfide	1505	2.4	3.1
19	∞-Cadinene	1518	0.5	-
20	Z-Asarone	1548	-	0.9
21	Germacerene B	1559	0.8	0.7
22	Guaiol	1597	2.6	4.6
23	Hexadecene	1599	-	0.2
24	Carotol	1603	0.3	1.1
25	α-Eudesmol	1608	1.5	2.5
26	Eudesmol(10-epi-γ)	1623	12.7	18.7
27	Guaia-3,9-diene	1631	0.3	0.6
28	(-)-Aristolene	1635	-	0.8
29	Hinesol	1637	2.9	4.5
30	Agarospirol	1648	2.8	5.1
31	Eudesmol(7-epi-α)	1655	4.8	8.2
32	Guaiol acetate	1727	2.8	-
	Total		98.5	93.3

**Ferula assa-foetida* Gonabad, ***Ferula assa-foetida* Tabas.

The present data indicated that the disulfide compositions were the principal components corresponding to half of the total oil content in both samples. Z-1-Propenyl *sec*-butyl disulfide and E-1-propenyl *sec*-butyl disulfide has frequently been reported as a typical, mostly principal, constituent of *F. assa-foetida* oil[15-18].

In summary, disulfide components are the main constituents of the essential oil of *F. assa-foetida* different part from different area. Whereas sulphur-containing compounds show various biological activities therefore this species can be worth.

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