International Journal of Herbal Medicine
Available online at www.florajournal.com

I J H M International Journal of Herbal Medicine

E-ISSN: 2321-2187
P-ISSN: 2394-0514
IJHM 2015; 2 (6): 34-37
Received: 08-01-2015
Accepted: 12-02-2015

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Chemical composition of essential oil of *Zygophyllum fabago* L. from North-West Iran

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Abstract
Essential oils from the aerial parts of *Zygophyllum fabago* L. (Zygophyllaceae) were obtained by hydrodistillation and were analysed by GC-MS system. Mass fraction of oils was 0.6% on a dry weight basis. Twenty-seven compounds representing 82.6% of the isolate were identified, among which sesquiterpenes dominated. The most abundant components were (Z)- lanceol acetate (11.9%), geranyl valerate (8.1%), (6E,10Z)-pseudo phytol (7.4%).

Keywords: *Zygophyllum fabago L.*, aerial part, essential oil, GC-MS, hydrodistillation.

1. Introduction
The Syrian beancaper *Zygophyllum fabago* L. (*Zygophyllaceae*) is a member of the genus *Zygophyllum*. The plant is a succulent, perennial and multi- branched shrub and found in disturbed sites and waste areas. The species of *Zygophyllum* found in Mediterranean region, central Asia, Australia and southern, northern and north-eastern Africa [1, 2]. Study on essential oils of this genus was limited to *Z. album L.* [3].
Phytochemical investigation of the genus *Zygophyllum* shows that it's very rich in saponins [4-8] and quinovic acids [9-11] Beside this compounds, several other one's such as flavonoids [12-14] and alkaloids [15] are also identified from this genus.
Some species of *Zygophyllum* used in traditional medicine. *Z. cornutum* can be used for it's hypoglycemic potency and used for lower lipid and cholesterol in blood contents [14] the leaves of *Z. simplex* used for skinning cleaning [9] *Z. gesilini* treat diabetic disease [16] in folk medicine *Z. geatulum* used in liver and stomach disease and have anti-diabetic properties [17] *Z. coccineum* used for cure various disease like diabetes, asthma, gout, rheumatism and hypertension [18] In Iran the seeds of *Z. fabago* used for digestive problems and diarrhea [19].
Some studies have shown various activities for *Z. fabago L.* such as anti-fungal and anti-bacterial activities (20) and anti-cholinesterase properties (21). Also in china it used as an anti-tussive, expectorant and anti-inflammatory agents [22].
In this paper we report for first time chemical composition of essential oils *Zygophyllum fabago L.* from North-West Iran (Malekan) extracted by hydrodistillation.

2. Materials and Method
2.1 Plant materials
The leaves of *Z. fabago L.* were collected at Malekan province of East Azarbaijan, Iran in June 2012.
Voucher specimens (GUE 2312) have been deposited at herbarium of the Faculty of Pharmacy University of Tabriz.

2.2 Isolation of essential oils
50 g of air dried of *Z. fabago L.* aerial part were grossly pulverized and the essential oil fraction was isolated after hydrodistillation using a Clevenger- type apparatus. After decanting and drying of oils using anhydrous sodium sulfate, the corresponding oils were stored under nitrogen gas in sealed vials at -20 ˚C.

2.3 Gas chromatography /Mass spectrometry analysis
Essential oils of *Z. fabago L.* were analyzed by a Hewlett-Packard5973 mass selective detector connected with a HP 6890 gas chromatoggraph. The separation was achieved by use of a HPMS (5% phenylmethyl sil-oxane) capillary column (60×0.25; film thickness 0.25 µM). The column temperature was held at 60 °C for 3 min and programmed up to 220 °C at

rate of 5 °C/min, and kept constant at 220 °C for 3 min. Helium was used as carrier gas. (1 ml/min) Mass spectra were taken at 70eV. Relative percentage amounts were calculated using Schimadzu CR4A chromatopac.

2.4 Identification of compounds

Retention indices of the components were calculated using retention times of n-alkanes that were injected after the oil at the same chromatographic condi- conditions. The compounds were identified by comparison of their mass spectra and retention indices (RI) with those reported in the literature [23] and of the authentic samples or by comparison with those held in a computer library (Wiley 275.L).

3. Results and discussion

The chemical composition of the essential oil of *Z. fabago L.* is shown in Table 1. The various components are listed in order of their elution from HMPS column. The oil yield was 0.6% (w/w) calculated on dry weight basis. GC-MS analysis led to the identification of 27 components accounting for 82.6% of total oil composition. The oil composition is dominated by the presence of sesquiterpenes accounting for 30.5%, while as diterpenes constitute 13.9% of the total oil composition. The principal components found were Z-lanceol acetate and geranyl valerate together constituting 20% of the total volatile constituents. Some other constituents identified were (E,Z)-geranyl linalool (5.2%), β-bisabolenol (4.9%), menthol (4.7%), α-cardinol (3.2%).

Futhermore, previous investigation on the oil of *Z. album L.* shows that the oils were a complex mixture of monoterpenes and sesquiterpenes with the large fraction of miscellaneous compounds. The major identified compounds were (E)-β-damascenone (11.8%), σ-decalactone (7.8%), α-inone (7.1%), butylated hydroxytoluene (6.4%) and (E)-2-hexen-1-ol (3.8%) [3].

This sesquiterpene is a common constituent of essential oils that showed anti-inflammatory activity in several animal models, including carrageenan- and PGE-induced hindpaw oedema, and seems to have gastric cytoprotective effects in rats [24]. Commercially, this compound is a fragrance ingredient used in decorative cosmetics, fine fragrances, shampoos, toilet soaps and other toiletries as well as in non-cosmetic products such as household cleaners and detergents [25].

Other chemical class in *Zygophyllum fabago L.* was monoterpenes. Antibacterial activities of numerous oxygenated monoterpenes have extensively been studied [26]. Based on previous data, it can be concluded that alcohol derivatives of oxygenated monoterpenes had greater antibacterial activities those of ketone derivatives. For instance menthol had inhibitory effects on the growth of 24 bacterial strains, whereas menthone showed activity only against four bacteria. According to these results, it can be concluded that alcohol derivatives of oxygenated monoterpenes were more active than their acetate derivatives [27].

The presence of β-Damascenone and phytol in *Zygophyllum fabago L.* indicated that the essential oil could have interesting anti-inflammotory activity.

Antispasmodic activity of β-Damascenone and E-phytol have previously reported [26]. The potencies of β-damascenone and E-phytol were in the same range as that of papaverine [27]. However, no pharmacological data have been reported in the literature. The phytol is a part of the ubiquitous chlorophyll molecule and constitutes the isoprenoid side chain of tocopherols. The substance has been reported to possess antitumor effects [28] to inhibit Ca^{+2} induced cytosolic enzyme effluxes and to inhibit the activity of soya-bean-derived lipoxygenase [29].

3.1 Tables

Table 1: chemical composition of essential oils in the aerial part of *Zygophyllum fabago L.*

NO	Compound[a]	RI[b]	RI[c]	%Composition[d]	Methods of identification
1	Cyclohe xanol <3-methyl->	945	943	3.40 ±0.01	MS,RI
2	Decene	987	989	3.30 ±0.02	MS,RI
3	Lavandulol	1171	1169	1.60 ±0.01	MS,RI
4	Menthol	1187	1186	4.70 ±0.06	MS,RI
5	Isoamyl benzyl ether	1312	1311	2.10 ±0.04	MS,RI
6	(Z)-Hasmigone	1332	1329	0.80 ±0.01	MS,RI
7	(Z)-α-Damascone	1359	1358	0.80 ±0.07	MS,RI
8	(E)-Undecanol	1367	1367	1.40 ±0.01	MS,RI
9	(Z)-β-Damascenone	1385	1384	1.50 ±0.05	MS,RI
10	(Z)-β-Damascone	1386	1387	3.8 0±0.09	MS,RI
11	(E)-α-Damascone	1392	1393	0.90 ±0.04	MS,RI
12	(E)-β-Damascone	1415	1414	2.10 ±0.03	MS,RI
13	Massoia lactone	1474	1472	0.70 ±0.06	MS,RI
14	Liguloxide	1537	1536	2.40 ±0.09	MS,RI
15	Diethyl phatalate	1591	1590	1.40 ±0.04	MS,RI
16	α-Cadinol	1641	1640	3.20 ±0.03	MS,RI
17	Geranyl valerate	1657	1656	8.10 ±0.10	MS,RI
18	trans-Methyl dihydro jasmonate	1681	1682	0.90 ±0.04	MS,RI
19	Massoia dodecalacton	1687	1686	0.80 ±0.01	MS,RI
20	Eremophilone <8-hydroxy-dihydro->	1758	1757	1.20 ±0.04	MS,RI
21	β-Bisabolenol	1788	1789	4.90 ±0.08	MS,RI
22	Octadecane	1801	1800	3.50 ±0.05	MS,RI
23	Z-Lanceol acetate	1856	1855	11.90 ±0.11	MS,RI
24	Phytol	1944	1943	1.30 ±0.02	MS,RI
25	(E,Z)-Geranyl linalool	1988	1987	5.20 ±0.03	MS,RI
26	Eicosane	2002	2000	3.30 ±0.04	MS,RI
27	(6E,10Z)-Pseudo phytol	2017	2018	7.40 ±0.07	MS,RI

Total	82.6%
Monoterpenes	6.3%
Sesquiterpenes	30.5 %
Diterpenes	13.9%
Nonterpenes	31.9 %

[a] Order of elution given on HP5MS columns.
[b] Calculated relative to C_5-C_{32} n-alkanes ;figures within parentheses are literature retention indices on similar phase columns.
[C] Linear retention index reported in literature (29).
[d] Percentage calculated by GC-FID on HP5MS columns. Values represent the average of three measurements ;Peak area of constituent±SD, n=3;MS, by comparison of the MS whit those of the computer mass liberiesNIST 05 library, Wiley and Adams (29).

4. Conclusion

The present study is intended as a contribution to the better knowledge of the chemical composition of the essential oil of the aerial part of *Zygophyllum fabago* L.. However, it is obvious that further investigation are needed to elucidate the entire chemical composition and to determine the exact contribution of each component to the biological activities.
The essential oil may be produced by local population for application in folk medicine and aromatherapy, possibly by commercial exploitation as sustainable development.

5. Acknowledgments

This work supported by grants from the research council of Tabriz University. The GC-MS spectra were performed at the University of Tabriz, faculty of chemistry, The assistance of the staff is gratefully appreciated.

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