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Effect of Habitat on Essential Oil of *Achillea filipendulina* L. in Iran

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Abstract: *Achillea filipendulina* L. was collected in full flowering stage from 3 different habitats in north-west of Iran. Essential oil of flowers was obtained using cellevenger apparatus and chemical composition were analyzed by GC and GC/MS and identified in comparison with authentic compounds. The objectives of this research were to describe the habitat conditions and to determine the chemical composition and the percent of essential oils in these three habitats and finding the effect of habitat on the yields of essential oils. The average yields of essential oils were to 0.53 v/w% and the major compounds in 3 habitats were: Santolina triene, α-pinene, Camphene, Ortho-cymene, 1, 8-cineole, Santolina alcohol, Pinocarvone, Borneol, Terpinen-4-ol, Bornyl acetate and Neryl acetate.

Key words: *Achillea filipendulina* L., essential oil, santolina alcohol

INTRODUCTION

Achillea filipendulina L. (Fernleaf Yarrow) is a perennial plant in the Asteraceae family. This plant that locally named BUMADARAN, grows 80-100 cm and flowered from June to August. The stem is elevated, numerous longitudinally stripped, often simple and thickened at base. The leaves are green, linear, pinnate, lobed and serrated, hairy and rough (Rechinger, 1986). It is herbaceous and comes from the Caucasus. The flowers are somewhat singular, arranged in corymbs of a multiplex character; about 10 cm diameter. The smaller corymbs are arched or convex, causing the cluster or compound corymbs to present an uneven surface; the small flowers are of rich old gold color (Diasabato, 2006).

Literature review showed that there is not any study on medicinal uses of this species, but this plant is traditionally used as: emmenagogue, expectorant and antitussive. Since this plant growth in different habitats we aimed to study the essential oil composition of this plant in 3 main habitats in Iran at full flowering stage and compared with each other. These habitats including, Khalkhal area (52 km Southwest of Ardabil) with 1595.0 m elevation above sea level, 422.43 mm annual precipitation, 8.82°C mean annual temperature and 0.669 dS m^{-1} soil salinity, Onar area (112 km Northwest of Ardabil) with 1311.5 m elevation above sea level, 391.75 mm annual precipitation, 10.32°C mean annual temperature and 0.417 dS m^{-1} soil salinity and Qasabeh area (82 km Northwest of Ardabil) with 971.0 m elevation above sea level, 355.97 mm annual precipitation, 12.07°C mean annual temperature and 0.623 dS m^{-1} soil salinity.

MATERIALS AND METHODS

Plant material and essential oil: Flowers of the plant were collected at full flowering stage in 2007 from 3 mentioned habitats in Iran. Plant materials were dried at ambient temperature and shade condition. Plant specimen is identified and deposited under No. 1107 at the herbarium of Ardabil-Iran. The essential oil of air-dried samples (100 g) of each site was isolated by hydro distillation for 3 h, using a Clevenger-type apparatus. The distillated oils were dried over anhydrous sodium sulfate and stored in tightly closed dark vials at 4°C (Amin *et al.*, 2005) until analyzing time.

GC analysis: GC analysis was performed by using a thermoquest gas chromatography Shimadzu 9A, with a Flame Ionization Detector (FID) and carried out using fused silica capillary DB-5 column (60 m×0.25 mm i.d., film thickness 0.25 μm). The operating conditions were as

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follows: Injector and detector temperatures were 250 and 300°C, respectively. Nitrogen was used as carrier gas at a flow rate of mL min^{-1}; oven temperature programmed 60-250°C at the rate of 5°C min^{-1} and finally held isothermally for 10 min.

GC-MS analysis: GC-MS analysis was performed by using a thermoquest-finigan gas chromatograph Varian 3400, equipped with above mentioned column and coupled to trace Mass quadrupled detector. Helium was used as carrier gas with ionization voltage of 70 eV. Ion source and interface temperature were 200 and 250°C, respectively. Mass range was form m/z 43-456. Gas chromatographic conditions were as given for GC. Identification of compound: The chemical compounds of essential oil were identified by calculation of their retention indices under temperature-programmed conditions for n-alkanes (c8-c24) and the oil on DB-5 column under the same chromatographic conditions. Identification of individual compounds was made by comparison of their Mass spectra with those of the internal reference Mass spectra library or with authentic compounds and confirmed by comparison of their retention indices with authentic compounds in literature (Adams, 2001; Connolly and Hill, 1991). For quantitative purpose, relative area percentages obtained by GC/FID were used without the use of correction factors.

RESULTS AND DISCUSSION

The average yield of essential oil in 3 areas was 0.5 to 0.7% (Khalkhal = 0.7%, Onar = 0.5%, Qasabeh = 0.5%). The identified compounds of essential oil were different in these 3 habitats (Khalkhal 66, Onar 61 and Qasabeh 60 compounds) and were shown in Table 1. Based on identified compounds, we recognized 91.40 to 97.29% of total oil of *Achillea filipendulina* L. in 3 mentioned areas (Khalkhal 97.29%, Onar 91.40 % and Qasabeh 93.41%).

Overall, 87 components were identified over 95% of total essential oil of *Achillea filipendulina* L. (Table 1) based on GC.MS data of three habitats (Khalkhal 66, Onar 61 and Qasabeh 60 compounds). The major common components of three areas were Santolina alcohol (43.63-47.76%), 1, 8-Cineole (4.14-8.14%), Borneol (3.87-9.14), Santolina triene (3.61-4.81%), α-Pinene (1.32-2.36%), Bornyl acetate (0.66-1.74%), Ortho-Cymene (0.86-1.65 %), Camphene (1.58-1.85%), Terpinen-4-ol (1.13-1.42%), Pinocarvone (0.61-2.36%) and Neryl acetate (0.15-3.15%). These results are in consistence with the results of Sadyrbekov *et al.* (2006) and different from Maffei *et al.* (1994).

Table 1: Chemical composition and percent of the essential oil of *Achillea filipendulina* L. in 3 studying habitats of Iran

			GC (%)		
Compounds	RT	RRI	KH	Q	O
Santolina triene	14.917	909	3.61	3.74	4.81
Tricyclene	15.757	924	0.13	0.31	0.37
Thujene<alpha->	16.001	929	0.11	0.37	0.44
Pinene<alpha->	16.456	937	1.32	2.36	1.90
Camphene	17.296	952	1.85	1.58	1.70
Pinane <trans->	17.958	964	0.15	0.20	0.44
Sabinene	18.634	976	0.23	1.61	0.64
Pinene<beta->	18.851	980	0.67	0.64	0.77
Isolimonene<trans->	19.898	998	0.41	0.42	1.06
Yomogi alcohol	20.142	1003	0.37	0.30	0.79
Terpinene<alpha->	21.020	1019	0.64	0.55	1.16
Cymene<ortho->	21.496	1028	0.86	1.65	1.31
Cineole<1,8->	21.993	1037	6.92	8.14	4.14
Santolina alcohol	22.723	1051	47.76	43.63	46.63
Terpinene<gamma->	23.431	1064	0.04	0.04	0.26
Mentha-3,8-diene<para->	23.997	1075	0.57	0.04	-
Artemisia alcohol	24.658	1087	0.58	0.52	1.19
Terpinolene	24.960	1093	0.17	0.15	0.31
Isopentyl 2-methyl butanoate	25.472	1102	0.13	-	0.69
Isopentyl isovalerate	25.716	1107	0.38	-	-
Myrcenol	25.880	1110	0.75	-	-
Rose oxide<trans->	26.107	1115	0.32	-	-
Thujone<trans->	26.467	1122	-	0.49	-
Mentha-2,8-dien-1-ol<trans-para->	26.742	1127	-	-	0.96
Menth-2-en-1-ol<cis-para->	26.758	1128	-	0.70	0.31
Compholenal<alpha->	26.969	1132	-	0.29	0.37
Limonene oxide<cis->	27.588	1144	0.23	-	0.57
Pinocarveol<trans->	27.779	1148	0.62	0.87	1.02
Camphor	28.032	1153	0.30	0.26	0.82
Isopulegol <iso->	28.736	1167	0.28	1.01	0.77
Pinocarvone	28.937	1170	0.61	2.36	1.79
Borneol	29.370	1179	9.14	5.14	3.87
Terpinen-4-ol	29.719	1186	1.13	1.42	1.25
Thuj-3-en-10-al	30.110	1194	0.10	-	-
Terpineol<alpha->	30.322	1198	0.10	0.26	0.16
Myrtenal	30.640	1204	0.36	0.35	0.25
Piperitol<trans->	31.116	1214	0.32	0.05	0.25
Carveol<trans->	31.671	1226	0.17	0.06	0.23
Fenchyl acetate <endo->	31.967	1232	0.10	0.17	0.18
Isobornyl formate	32.152	1236	0.13	0.19	0.21
Piperitone	33.120	1256	1.50	-	-
Myrtanol<cis->	33.347	1261	0.17	-	0.39
Piperitone epoxide<cis->	33.422	1262	-	0.12	-
Chrysanthenyl acetate<cis->	33.612	1266	0.05	0.11	0.26
Menthyl acetate<neo->	33.998	1274	-	0.09	-
Citronellyl formate	34.183	1278	-	-	0.18
Thujyl acetate<neo-3->	34.468	1284	-	-	0.10
Isopulegyl acetate<iso->	34.485	1285	-	1.60	-
Isopulegyl acetate	34.579	1287	0.10	-	-
Bornyl acetate	34.886	1293	1.74	0.66	1.29
Thujyl acetate<3->	35.077	1297	-	0.47	0.27
Dihydro carveol acetate	35.484	1306	0.09	-	-
Ascaridole<iso->	36.008	1317	-	-	1.38
Myrtenyl acetate	36.663	1332	0.08	-	-
Carvyl acetate<trans->	37.076	1341	0.05	2.45	-
Neryl acetate	38.165	1365	0.15	0.20	3.15
Allylnonanoate	38.626	1376	-	0.05	-
Isobornyl propanoate	38.975	1383	3.42	0.14	0.36
Isocomene<alpha->	39.096	1386	-	-	0.04
Elemene<beta->	39.741	1400	0.09	3.97	0.07
Citronellyl oxy-acetaldehyde	40.027	1407	0.08	-	-
Ylangene<beta->	41.042	1431	-	-	0.07
Caryophyllene<(E)->	41.116	1433	0.11	0.32	-

Table 1: Continued

Copaene<beta->	41.487	1441	1.99	0.11	0.16
Pentadecanone<2->	42.153	1457	0.05	-	-
Acoradiene<beta->	42.735	1471	0.25	0.17	-
Curcumene<gamma->	43.411	1487	0.23	0.05	0.05
Cubebol<epi->	43.538	1490	0.06	-	-
Pentadecane<n->	43.898	1498	0.08	0.05	0.44
Epizonarene	44.337	1509	0.20	-	-
Cadinene<gamma->	44.998	1525	0.10	-	-
Cadinene<delta->	45.321	1533	-	0.44	0.05
Himachalene<gamma-dehydro-ar->	46.014	1551	0.32	0.12	-
Cadinene ether<trans->	46.141	1554	0.18	0.05	0.04
Arteannuic alcohol<cis->	47.743	1594	-	-	0.06
Isoeugenol acetate<Z->	47.880	1597	1.93	-	-
Hexadecane<n->	47.923	1598	-	0.16	0.33
Humulene epoxide II	48.409	1611	-	-	0.17
Salvial-4(14)-en-1-one	48.441	1612	0.18	-	-
Cedrene epoxide<beta->	48.832	1622	-	0.15	0.27
Isolongifolanone <trans->	49.018	1627	-	0.15	0.14
Cadin-4-en-7-ol<cis->	49.917	1650	1.44	0.81	0.14
Gossonorol	50.028	1653	-	-	0.07
Eudesmol<beta->	50.636	1669	0.18	0.20	0.11
Intermedeol	50.842	1675	-	0.16	0.10
Longiborneol acetate	51.302	1687	0.52	0.24	-
Heptadecane<n->	51.747	1698	0.41	0.47	0.10
Total Percentage of dentified compounds			97.29	93.41	91.40

RT: Retention Time, RRI: Relative Retention Indices, (GC%): Percentage according to GC spectrum, KH: Khalkhal, Q: Qasabeh, O: Onar

Comparison of the percentage of 11 major compounds based on GC.FID data showed that these compounds are in higher amount with Khalkhal area, while it has the higher elevation (1595 m) and amount of annual precipitation (422.43 mm) among these three areas (Table 1).

Santolina alcohol with the amount of 43.63-47.76% of the total essential oil is the major chemical component of these 3 areas (Table 1) that the higher amount belong to khalkhal area and the lower amount belong to Qasabeh area. Onar area, is the second one in this comparative stage while it has the second range of elevation (1311 m), annual precipitation (391.75 mm), annual temperature (10.32 mm) and soil nutrient elements (NPK), but the lower amount of soil salinity (0.417 dS m^{-1}) and the least amount of chemical components (60 compounds). It is mentioned that the number of components were increased with increasing of elevation and annual precipitation (66 components for Khalkhal) and decreased based on increasing of annual temperature (8.82°C for Qasabeh and 12.07°C for Khalkhal). Geographic distribution of *Achillea filipendulina* L. in 3 habitats show that this species grow in the soils with igneous origin parent material mainly. Three habitats are located in the SABALAN volcano.

Since there is no report about the medicinal uses of essential oil of *Achillea filipendulina* L. we recommend the *in vivo* and *in vitro* experiments for determining the medicinal activity of this plant.

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