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The Essential Oil Composition of *Arctium lappa* Root and Leaf

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Abstract

Using plants and natural products as medicine is increasing every day. The reason might be a tendency that the societies mostly have toward natural and original products especially natural drugs. Essential oils are referred to aromatic composition found in different parts of a plant and can be used for different remedial and hygienic purposes. One of the plants which have been used a lot in folk medicine is *Arctium lappa*. This study is aimed at identifying the composition of its root and leaf essential oils. The essential oils from the roots and leaves of *A. lappa* (Asteraceae), collected from Mashhad (Farms of Agriculture School, Ferdowsi University), were extracted by hydrodistillation and then the composition was determined by GC/MS. Totally, 31 and 57 components (92.4 and 93.2% of essential oils of root and leaf) were identified, respectively. The root oil contains mainly 1, 3 cyclo-octadiene (33.2%), *E*-caryophllene (6.8%), β-selinene (5.6%) and 9, 10-dehydro-isolongifolene (5.5%), whilst β-thujone (11.6%), caryophyllene oxide (8.3%), cuminaldehyde (7.7%), comphor (5.3%), dihydroEdulan II (5.3%), β -ionone (4.7%), and α- Thujone (3.4%) were major components in the leaf oil. Identification of the components was based on comparison of their mass spectra with standards. The chemical composition of essential oils from the herbs is being reported for the first time in Iran.

Key words: Essential oil composition, *Arctium lappa*, root, leaf, GC/MS, 1,3-cyclooctadiene, *E*-caryophyllene, β-Thujone.

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1. Introduction

The use of essential oils backs to ancient times, so that the ancient Egyptians of the year 4500 years BC used the vegetable oils to make religious occasions, rituals, and treatment.
Essential oils are found in different organs of the plant. Essential oils are essentially a mixture of different materials with very different chemical compositions and very strong odors.

Arctium lappa L. (syn. *A. vulgaris* Hill., *A. major* Gaertn.) commonly called greater burdock, gobo, edible burdock, lappa, beggar's buttons [1], thorny burr, or happy major [2] is a member of the Compositae (Asteraceae) family. The flowers are purple and grouped in globular capitula, united in clusters. They appear in mid-summer, from July to September [3]. The capitula are surrounded by an involucre made out of many bracts, each curving to from a hook, allowing them to be carried long distances on the fur of animals. The fruits are achenes, and they are long, compressed with short pappus hair. These are a potential hazard for humans, horses, and dogs. The minute, sharply-pointed, bristly pappus hairs easily detach from the top of the achenes and carried by the slightest breeze-attaching to skin, mucous membranes, and eyes where they can cause severe dermal irritation possible respiratory manifestations and ophthalmia [4]. The fleshy tap-root can grow up to 1m deep [5]. It's carrot like root that is commonly cooked and eaten as a vegetable in Asia. *A. lappa*, which can be found worldwide, and used therapeutically as a depurative, diuretic, and digestive stimulant.

It has also been historically used to treat hairless and used both internally and externally for many conditions of the skin, such as acne, boils, abscesses and eczema and for situation of chronic inflammation such as rheumatism and gout. The root of burdock has longbeen cultivated as a common plant for dietary use and folk medical uses [6]. In Japan, *A. lappa* is known as Gobo and has been used as food for about 1,000 years after Buddhist monks brought the plant into the country. They used the root to cure such thing as constipation and mercury poisoning and the leaves externally to heal rashes and burns. In Europe during the world wars *A. lappa* was used as a treatment for wounds.

Some Bioactive lignans and other phenolics (such as caffeic acid, genistein, biochanin A, luteolin, chlorogenic acid, materisenol, arctigenin, quercetin, cynarin, arctiin, lappaol A, rutin and lappaol F) were reported from the roots, leaves and seeds of *Arctium lappa* grown in Egypt [7].

The volatile constituents of the roots and leaves of Egyptian *Arctium lappa* were analyzed by GC/MS. GC/MS of the volatile constituents from the leaves showed 19 identified compounds, the major being caryophyllene oxide (54.2%), followed by β-elemene (6.2%) and β-costol (4.0%). Analysis of the volatile constituents of the roots revealed 14 identified compounds, the major being caryophyllene oxide (51%), followed by aromadendrene (16%) and isoaromadendrene epoxide (6.4%) [8].

In a continuation of our studies on the composition of oils from plants species to Iran [9-11], we have analyzed the oil of *A. lappa*.

A thorough literature review showed that there was no report on volatile components of Iranian *Arctium lappa* (leaf and root) and this article is the first investigation on this species.

2. Materials and Methods

2.1. Plant Material and Oil Extraction

The roots and leaves of *A. lappa* were collected from Mashhad (Farms of Agriculture

School, Ferdowsi University) in Augest 2016. The oils were extracted for 3 h by hydrodistillation in clevenger–type apparatus. The oils were dried over anhydrous sodium sulfate and stored at 4°C in the sealed brown vials until required.

2.2. Analysis of the Oil

GC-FID analysis of the oils was carried out on a HP-6890 gas chromatograph equipped with a FID and a DB-5 capillary column (30 m × 0.25 mm; 0.25 mm film thickness). The oven temperature was held at 50°C for 0.5 min. then programmed at 2.5°C/min to 265°C. Other operating conditions were as follows: carrier gas, N_2 with a flow rate of 1.5 ml/min; injector temperature, 250°C; detector temperature, 300°C; split ratio, 1:10. GC-MS analysis of the oil was performed on a Thermoquest 2000 GC coupled with Thermofinnigan Mass system and a DB-5 capillary column (30 m × 0.25 mm; 0.25 µm film thickness). The operating conditions were the same conditions as described above but the carrier gas was He. Mass spectra were taken at 70 eV. Mass range was from *m/z* 35-375 amu.

The volatile components of the oils were identified by comparison of their fragmentation patterns in the mass spectra and retention indices with those published in the literature 13-14 and presented in the WILEY275 L library. The quantification of the components was performed on the basis of their GC-FID peak areas.

3. Results and Discussion

The analysis of the *A. lappa* root and leaf oil allowed the identification of 31 and 57 compounds, which represented 92.4 and 93.2% respectively of the total detected constituents. The identified compounds of the oils, the percentage content of the individual components, and theretention indices are summarized in table 1.

1, 3 cyclo-octadiene (33.2%), *E*-caryophllene (6.8%), β-selinene (5.65) and 9, 10-dehydro-isolongifolene (5.5%) were the major component whilst β-thujone (11.6), caryophyllene oxide (8.3), cuminaldehyde (7.7), comphor (5.3), dihydroedulan II (5.3), β -ionone (4.7) and α- thujone (3.4) were major components in the leaf oil.

The main class of the compounds in the root was found to be aliphatic components (4.8 %), sesquiterpenes (41.4 %) and phenyl propanes (7.5 %), the proportion for leaf oil were monoterpenes (36.0 %), sesquiterpenes (43.4 %), phenyl propanes (3.2 %) and aliphatic components (3.3 %). No monoterpenes was detected in the root oil; it was rich of hydrocarbon sesquiterpenes. Some bridged terpenoides (dihydro edulans, theaspiranes and β –damascenone) were existed in the leaf oil (8.6%) (Table 2).

1, 3-cyclo octadiene is dedicated highest percentage in the *Arctium lappa*. It has been reported in Iranian snake grass and also there are Chinese plants named *Schisandra propinqua* and *Teucriam polium* [12-13].

E-caryophyllene is found in a large amount of cannabis and 9,10-dehydro- isolongifolene is found in many plants in china [14-15].

Major compounds in leaves oil of *A. lappa* are

Table 1.Chemical constituents of the oil leaf and root from *A. lappa*.

No	Name	% Leaf	% root	KI
1	octane	0.4	-	800
2	*m*-xylene	0.2	-	866
3	2-penthyl furan	0.7	-	992
4	octanal	1.5	-	999
5	1,8-cineole	1.2	-	1031
6	Phenyl ethanol	0.3	0.3	-
7	γ-terpinene	0.2	-	1060
8	linalool	2.5	-	1097
9	β-thujone	11.6	-	1102
10	α- thujone	3.4	-	1114
11	β -fenchyl alcohol	0.3	-	1123
12	comphor	5.3	-	1146
13	borneol	2.2	-	1169
14	nonanol	0.2	-	1169
15	4-terpineol	0.3	-	1177
16	methyl salicylate	0.4	-	1192
17	decanal	0.4	-	1202
18	β -cyclocitral	0.5	-	1220
19	cuminaldehyde	7.7	-	1242
20	piperitone	0.3	-	1253
21	dihydro edulan I	5.3	-	1284
22	carvacrol	0.5	-	1299
23	theaspirane B	1.0	-	-
24	theaspirane A	0.6	-	1315
25	dihydro edulan II	0.2	-	1318
26	hexyl tiglate	0.3	-	1333
27	β -damascenone	1.5	-	1358
28	2,6,10-trimethyl dodecane	0.6	-	1379
29	β -maaliene	-	1.0	1382
30	β -panasinsene	-	1.7	1383
31	β -elemene	-	1.0	1391
33	cyperene	-	2.5	1399
34	isocaryophyllene	4.6	-	1409
35	*E*-caryophyllene	3.0	6.8	1419
36	α -bergamotene	-	1.7	1440
37	α-humulene	5.1	2.2	1455
38	γ - gurjunene	2.3	-	1477
39	γ -muurolene	0.4	-	1480
40	γ -selinene	0.3	-	1481
42	β -ionone	4.7	-	1482
43	β -selinene	-	5.6	1490
44	valencene	0.2	-	1496
45	α-selinene	-	3.4	1498
46	Z-α-bisabolene	-	1.2	1507
47	γ -cadinene	0.4	1.3	1514
48	δ-cadinene	-	0.8	1523
49	9,10-dehydro-isolongifolene	0.3	5.5	1558
50	caryophyllene oxide	8.3	-	1583
51	benzophenone	0.2	-	1621
52	isospathulenol	0.2	-	1630

53	7-methyl 3,4-octadiene	-	3.3	-
54	1,3-cyclooctadiene	-	33.2	-
55	edusema-4,11,dien-2ol	-	2.0	-
56	15-copaenol	-	0.8	-
57	Allo-aromadendrene	-	0.8	1641
58	β -eudesmol	1.6	-	1651
61	α-bisabolol	-	3.1	1686
62	santalol	0.8	-	1713
63	2, 6,14-trimethyl pentadecanone	2.0	-	1846
64	methyl linolenate	0.5	-	1893
66	diisobutyl phthalate	1.5	3.4	1938
67	phytol	-	1.4	1943
68	butyl isobutyl phthalate	0.6	-	1961
69	*n*-butyl phthalate	-	3.8	1967
70	4,4-dimethyl-3-(3-methylbut-3-enylidene)-2-methylenebicyclo[4.1.0]heptanes	-	1.0	-
71	(3*E*,5*E*,8*E*)-3,7,11-trimethyl-1,3,5,8,10-dodecapentaene	-	1.5	-
72	2-methoxy-3,5,5-trimethyl-2-cyclohexene- 1,4-dione	0.3	-	-
73	7-tricyclo [5.3.2.0(1,6)] dodecan-7-ol	1.5	-	-
74	3,4-dimethyl-cyclohexen-l-carboxaldehyde	3.6	-	-
75	Z-11(13,14-epoxy)tetradecene acetate	1.2	-	-

Table 2. Category of major components in *A. lappa*.

Plant part	Monoterpenes (%)	Sesquiterpenes (%)	Phenyl propanes (%)	Aliphatic components (%)
Root	0	41.4	7.5	4.8
leaf	36.0	43.4	3.2	3.3

as follows: β-thujone (11.6%), caryophyllene oxide (8.3%), cuminaldehyde (7.7%), and dihydro edulan II (5.3%).

β-Thujone was reported in many plants [16, 17]. Cuminaldehyde is the major component in cumin (*Cuminum cyminum*) [18]. Dihydroedulan II has been reported in passion flower [19], too.

Caryophyllene oxide that is reported in the 8.34% in leaves, previously had been reported in Egyptian burdock in leaves (54.18%) and in roots (51.07%). β –elemene has been reported in leaves a few (1.06%) but in Egyptian burdock leaves was 6.16% (8).

4. Conclusion

The result of hydrodistillation of roots and leaves *Arctium lappa* plant, which was first performed in Iran, was a light yellow oil. Total of 92.4% of essential oil of root components and 93.2% of essential oil of leaves components were identified. 31 substances and 57 substances were identified respectively which were mainly of the type of sesquiterpenes and monoterpenes, respectively. 1, 3- cyclo-octadiene (33.2%) and β-thujone (11.6) were major components in the root and leaf oil, respectively. Although there are minor differences between the components of the essential oil of the two parts of the plant, the components are completely different and the components are not identical.

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