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Essential Oil Composition of Hydroponically Grown *Chrysanthemum balsamita* L.

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Abstract: Essential oil composition of *Chrysanthemum balsamita* L., Asteraceae, was evaluated in response to hydroponic production system. Hydrodistilled essential oil of air dried aerial parts has been studied for their constituents by GC-MS. Twenty two components were identified representing 94.52 % of the oil. Oxygenated monoterpens (79.03 %) and sesquiterpene hydrocarbons (13.59 %) were the major class of identified compounds occurring in higher proportions. The main components of the essential oil were carvone (42.53 %), α-thujone (21.3%) and β-bisabolene (10.56 %). *Trans*-p-mentha-2,8-dienol (3.0 %), β-thujone (2.21 %) and β-cubebene (2.21 %) were also present in significant amount. According to the volatile oil profile, hydroponic production system was comparable with previously reported field grown plants.

Key word: *Chrysanthemum balsamita* L., Asteraceae, essential oil, hydroponic, GC-MS, carvone, α-thujone.

Introduction: Costmary (*Chrysanthemum balsamita* L.) is a medicinal plant, belonging to the Asteraceae family. It is native to Mediterranean region and is cultivated in Eurasia from medieval times [1-7]. The Persian name of this plant is 'Shahesparam' [8]. This plant is a perennial rhizomaceous plant with erect hairy stem, complete shiny leaves, highly branched from the base and 70-120 cm height [2,3,8]. The flowers are in corymb inflorescences with yellow tubular flowers [3,7,8]. The characteristic spicy odor and taste of costmary results

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from the volatile oil accumulated in the glandular trichomes of abaxial surface of leaves and flowers [1,9]. This plant is propagated by rhizome cuttings or division and propagation by seed is not satisfactory [2,9,10]. Costmary and its preparations are commonly used as herbal tea, flavoring agent, and for medicinal purposes [1,5,7,9,10]. Infusion, decoction and floral water of aerial parts of costmary is used as hepatoprotective, antibacterial, antiallergic, sedative, cardiotonic, carminative and for the treatment of indigestion in Iranian folk medicine [2,3,4,8,10].

Costmary has different phytochemicals such as; essential oil, phenylpropane derivatives, flavones, sesquiterpene lactones, tannins and oligo-elements from which essential oil is widely used phytochemical of this plant [5,6,11]. Recent studies showed that essential oil of costmary has strong antibacterial and insecticidal activity [12,13]. This later characteristic is due to the presence of monoterpens carvone and α-thujone in the essential oil [11,13]. In addition, Teixeira da Silva reported that sesquiterpene components of essential oil have allelopathic properties [14]. The divergent medicinal and aromatic properties of costmary have made it one of the most popular plants throughout the world. Therefore, there is considerable research interest towards the compositional analysis of costmary essential oil. The different studies reported that approximately 200 constituents were identified from the aerial parts extracted essential oil of costmary from which the major volatile constituents were camphor, carvone, α-thujone, β-thujone, 1,8-cineole, germacrene D, different carvone derivatives, β-bisabolene and etc [1,3,4,9,13,15].

Hydroponic production of medicinal and aromatic plants is a new trend in agricultural systems especially in organic agriculture [16,17]. There are several reports about essential oil composition of wild and cultivated costmary [1,3,4,9,13,15]. In a recent study we reported carvone (49.11 %), α-thujone (24.6 %) and β-bisabolene (4.44 %) as the predominant constituents of this plant from one of its native habitats in north-west of Iran [3]. However to the best of our knowledge there is no previous report on the chemical composition of the essential oil of hydroponically grown *C. balsamita*.

The aim of the present work was to determine the essential oil composition of hydroponically grown *C.balsamita* L. from Iran.

Experimental

Plant material: The homogenous rhizomes (10 cm length and 1 cm diameter) of *Chrysanthemum balsamita* L. provided by Khalat pushan research center of Tabriz University, Iran, were cultivated in 5 L pots. The modified Hoagland's nutrient solution was used for regular irrigation of plants [2,3,10]. pH and EC of nutrient solution were adjusted at 6-6.5 and 2 dS/m by H_2SO_4 or KOH and water respectively.

This experiment was carried out in an one layer polyethylene covered greenhouse with ambient temperature, humidity and light intensity of 15-30°C, 40-50 % and 500 $\mu molm^{-2}s^{-1}$ respectively. The aerial parts of plants were harvested at the flowering stage and dried at room temperature for 4-5 days.

Isolation of essential oil: The air dried aerial parts of the plants (50g) were subjected to hydrodistillation in an all glass Clevenger type apparatus for 2 hrs. The oil was dried over anhydrous sodium sulphate and kept at 4°C in the sealed vials until required [1,2,3,9,10].

Gas chromatography-Mass spectrometry analysis: The oils were analyzed by GC-MS using a Shimadzu GC-MS – QP 5050 system equipped with an apolar DB-5 (5 % phenyl polymethyl siloxane) capillary column (60 m x 0.25 mm i.d. and 0.25 μm film thickness). The carrier gas was helium with a flow rate of 0.7 ml/min. Oven temperature was 80°C for 6 min, programmed at 2°C/min to 200°C with holding time of 2 min. in this temperature. Then 200°C to 290°C with 1°C/min., and finally kept constant at 290°C for 2 min. Injector and detector temperatures were 260°C and 300°C respectively. Injection volume was 1 μL of oil in n-hexane (3 % solution of essential oil in n-hexane). Split ratio was 1:60. The MS operating parameters were as follows: Ionization potential 70 eV; Ion source temperature: 200°C; Resolution: 1000; Solvent cut time: 3.0 min. The quadrupole mass spectrometer was scanned over the 30-600 amu.

Identification and quantification of constituents: Relative percentage amounts of essential oil constituents were calculated from peak total area by apparatus software. Identification of components in the essential oil was based on comparison of their mass spectra and retention time with those of the authentic compounds and in the literature and by computer matching with NIST and NBS54 library as well as by comparison of the fragmentation pattern of the mass spectral data with those reported in the literature [1,3,4,9,18].

Results and discussion: The hydrodistillation of the aerial parts of *C. balsamita* L. gave a pale yellow liquid with a yield of 0.57 ± 0.1 (v/w), on dry weight basis. The chemical profiles of the analyzed oil, the percentage composition of the individual components and retention indices are summarized in table 1. Table 2 shows the classes of identified constituents in the volatile oil. Twenty two components were identified in the essential oil of hydroponically grown costmary representing 94.52 % of the oil (Tables 1 and 2). The major constituents of oil were carvone (42.53 %), α-thujone (21.3 %), β-bisabolene (10.56 %), *trans*-p-mentha-2,8-dienol (3.0 %), β-thujone (2.21 %) and β-cubebene (2.21 %).

Other components lesser than 2 % were *cis*-p-mentha1 (7),8-dien-2-ol (1.82 %), *trans*-p-mentha1(7),8-dien-2-ol (1.77 %), 1,8-cineole (1.34 %) and *trans*-piperitol (1.26 %) (Table1). In particular oxygenated monoterpens (79.03 %) were the most abundant components of the oil followed by sesquiterpene hydrocarbons (13.59 %) (Table 1 and 2). Carvone and α-thujone (sum 63.83 %) were the predominant oxygenated monoterpene constituents of essential oil (Table 1). β-bisabolene, γ-cadinene and germecrene D were the identified sesquiterpene hydrocarbons of the oil (Table 1). In contrast oxygenated sesquiterpenes were very low with spathulenol (0.26 %) and viridiflorol (1.05 %) as the only representatives of this class (Tables 1 and 2). Therefore, essential oil of hydroponically grown *C. balsamita* L. is rich in oxygenated monoterpens and sesquiterpene hydrocarbons.

Comparison of the volatile constituents of hydroponically grown costmary with data that have been published on the oil composition of this plant from wild habitats and field grown plants shows that there are some qualitative and quantitative differences between the essential oil profiles of different plant origins [1,3,4,9,13,15]. In addition there were some differences between chemical profile of our present and previous study [7]. These chemical differences indicating that environmental factors and different growing systems and

conditions strongly influence essential oil profile of costmary. However essential oil content and volatile oil composition of hydroponically grown *C. balsamita* L. were comparable with those of wild and field grown plants. In conclusion hydroponic can be a promising production system for year-long production of this carvone rich plant for commercial utilization in pharmaceutical industries.

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Table 1. Volatile oil constituents of hydroponically grown *Chrysanthemum balsamita* L. from Iran

No	Compound	RI	%
1	1,8-Cineole	1033	1.34
2	α-Thujone	1102	21.3
3	β-Thujone	1114	2.21
4	*trans*-ρ-Mentha-2,8-dienol	1123	3.00
5	*cis*-ρ-Mentha-2,8-dienol	1138	1.1
6	*trans*-Pinocarveol	1139	0.37
7	*cis*-Verbenol	1141	0.5
8	Borneol	1169	0.37
9	*trans*-ρ-Mentha-1(7),8-dien-2-ol	1189	1.77
10	Myrtenol	1196	0.64
11	*cis*-Piperitol	1196	0.82
12	*trans*-Piperitol	1208	1.26
13	*cis*-ρ-Mentha-1(7),8-dien-2-ol	1231	1.82
14	Carvone	1243	42.53
15	*trans*-Carvyl-acetate	1342	0.25
16	*cis*-Carvyl-acetate	1368	0.34
17	β-Cubebene	1318	2.21
18	Germacrene D	1485	0.39
19	β-Bisabolene	1506	10.56
20	γ-Cadinene	1514	0.43
21	Spathulenol	1578	0.26
22	Viridiflorol	1593	1.05

Compounds are reported according to their elution order on DB-5 column.

Table 2. Different classes of essential oil constituents of hydroponically grown *Chrysanthemum basamita* L. from Iran

Class of constituents	%
Oxygenated monoterpens	79.03
Sesquiterpene hydrocarbons	13.59
Oxygenated sesquiterpenes	1.31
Others	0.59
Total identified	94.52