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Investigation of Chemical Composition of *Anthemis coelopoda* Boiss. Essential Oil from Three Regions in Gilan Province

Kamkar Jaimand*, Mohammad-Bager Rezaee, Fatemeh Sefidkon, Razieh Azimi, Aube Morady, Mahmood Nadery, Someyeh Fekry, Shahrokh Karimi and Firoozeh Hatami

Research Institute of Forests and Rangelands, Agricultural Research, Education and Extension Organization, Tehran, Iran

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Abstract

The genus *Anthemis* L. belongs to the family Asteraceae, is the second largest genus in the Compositae family, tribe Anthemideae, about 130 species of genus *Anthemis* occur throughout the world consists of 39 annual and perennial species distributed all over of Iran. According to literature, this species was not the subject of research up to now and therefore its chemical composition is not well known. In this research three samples of *Anthemis coelopoda* Boiss. were collected from Gilan province, in the 2020. The specimen is deposited in Central Herbarium of Research Institute of Forests and Rangelands. The secondary metabolites and volatile constituents of *A. coelopoda* Boiss. were isolated by water distillation (celevenjer apparatus) and analyzed by GC and GC/MS. Main secondary metabolites components from sample one Gilan: Loshan, before Hanifa Imamzadeh, near the cement mine, 801 meters high, in flower were β- calacorene 35.9%, Elemicin 24.0% and n-dodecanol 8.8% and in leaf were β-calacorene 26.8%, elemicin 13.9% and n-dodecanol 11.8%, and essential oil yield from flower were 0.04% and leaf were 0.03%. Main components from sample two Gilan: southwest of Rudbar, Lake 1181 meters high, in flower were γ- cuprenene 18.2%, n-dodecanol 13.8% and geranyl propanoate 7.4% and in leaf were n-dodecanol 13.5%, α- terpinen-7-al 10.8% and geranyl propanoate 10.2%, and essential oil yield from flower were 0.10% and in lead were 0.07%. Main components from sample thee Gilan: Loshan, before Hanifa Imamzadeh, near the cement mine, 801 meters high, in flower were n-dodecanol 11.8%, α- terpinen-7-al 9.3% and Cumin aldehyde 8.8% and in leaf were n-dodecanol 14.9%, α- terpinen-7-al 11.1% and 5-hydroxy isobornyl isobutanoate 10%, and essential oil yeild from flower were 0.09% and in leaf were 0.06%. Sampling simultaneously on one day from three different areas (Samples 1 and 3 were collected from one area but at a great distance) their essential oils were examined for chemical composition and the results indicate different combinations and amounts in a species. This difference can be the result of differences in soil type and different plant water uptake.

1. Introduction

The genus Anthemis L. belongs to the family Asteraceae, is the second largest genus in the Compositae family, tribe Anthemideae, about 130 species of genus *Anthemis* occur throughout the world consists of 39 annual and perennial species distributed all over of Iran (Rechinger, 1986). According to literature, this species was not the subject of research up to now and therefore its chemical composition is not well known. However, flavonoids, polyphenolic acids, terpene and sesquiterpene compounds were reported to be the major constituents of some other species of the genus Anthemis (Klimes *et al*., 1981). The species of the Anthemis genus are widely used in the pharmaceutics, cosmetics and food craft. The flowers of the genus have well-documented use as disinfectant and healing herbs, the main components being natural flavonoids and essential oils (Uzel *et al*., 2004). Some Anthemis spp. Essential oils contain anti-aging activity (Baytop, 1984). While *Anthemis cotula* essential oil has been proved to possess antioxidant confidants and essential oil from *A. nobilis* flowers is generally used for pharmaceuticals, food additives, as well as a main source in aromatic and cosmetic industries (Baytop, 1984).

Many *Anthemis* sp. are used as an herbal tea and for food flavoring, as well as in cosmetics and in the pharmaceutical industry (Baytop, 1984; Rudzki & Jalblonska, 2000). Extracts, tinctures, salves, and tisanes

*Corresponding author: Research Institute of Forests and Rangelands, Agricultural Research, Education and Extension Organization, Tehran, Iran
E-mail Address: camcarjaimand@yahoo.com

are widely used as antispasmodic, anti-inflammatory, and antibacterial in Europe. The occurrence of sesquiterpene lactones, flavonoids, and essential oils in various *Anthemis* species has been reported in previous works (Bulatovic, *et al*., 1997; Rezaee & Jaimand, 2006). Rezaee and *et al.,* 2007 reported on the volatile constituents of *A. coelopoda* Boiss. were isolated by water distallation and analyzed by GC and GC/MS. In this study samples were collected from Gilan province in Rodbar on late May 2003. The major constituents of *A. coelopoda* Boiss. flower oil was cis-chrysanthenyl acetate (27.3%), hexyl butanoate (16%), and myrcene (7%), while the leaf oil contained isobornyl formate (30.6%), Trans-ethyl chrysanthemumate (15%) and p-mentha-1,5-diene-8-ol (13.7.4%) (Rezaee & Jaimand, 2008). Gülden Doğan, *et al*. 2015, study, hydro distilled essential oils derived from the aerial parts of *A. coelopoda* var. *coelopoda* (Asteraceae) grown in Turkey were analysed by GC and GC-MS system. Fifty-seven components were identified representing 90.7% of the oils. It was determined that *A. coelopoda var. coelopoda* essential oil contained β-caryophyllene (21.8%), nerolidol (10.8%), azulene (9.5%), borneol (5.5%), linalool (4.3%) and cyclopentadecane (4.2%) as major compounds (Rezaee & Jaimand, 2007).

A. gayana Boiss. is an annual endemic plant of Asteraceae family (Rezaee *et al*., 2008). This plant grows in the Isfahan west region from Iran. Essential oil leaves were first investigated by Sonboli *et al*, 2005 and more than 34 compounds of the leaves oil representing 92.4% of total oil were identified, germacrene-D (30.2%), geranyl isovalevate (7.4%), bicyclogermacrene (6.7%) and _–caryophyllene (5.5%) as the major compounds (Rezaee *et al*., 2008). Amjad *et al*. (2013) reported that methanolic extract of *A. gayana* flowers and leaves were not active against Candida glabrata CBS 2175 and Candida albicans ATCC 62061, ATCC 1677. Flowers and leaves methanolic extract had more effect against Candida parapsilosis (Rudzki & Jalblonska, 2000), Thus, leaves methanol extract had more effect against Candida albicans ATCC 3153 (Doğan *et al*., 2015). Rezaee and Jaimand in 2006, reported on the volatile constituents of *A. altissima* L. var. *altissima* were isolated by hydrodistillation and analyzed by GC and GC/MS. The major constituents of *A. altissima* flower oil were spathulenol (18.7%), caryophyllene oxide (9.3%), 1-eicosene (7%) and sabinene (6.2%), while the leaf oil contained spathulenol (18.2%), caryophyllene oxide (9.5%), methyl hexadecanoate (8%) and isocaryophyllene (7.4%) (Sonboli *et al*., 2005). Rezaee and Jaimand in 2008, reported on the volatile constituents of *A. triumfettii* (L.) subsp. *triumfettii* were isolated by hydrodistillation and analyzed by GC and GC/MS. The major constituents of *A. triumfettii* flower oil were elemol (15.8%), α- copaene (8.6%), elemicin (7. 9%), and humulene oxide II (8.0%), while the leaf oil was rich in α -copaen-8 –ol (7.6%), β- eudesmol (7.2%), α -fenchene (5%), ledol (4.2%) and elemol (4%) (Amjad *et al*., 2013). Rezaee and Jaimand in 2007, reported on the Chemical Composition of Essential Oils from Leaves and Flowers of *A. cotula* L. from Gilan Province, the major constituents of flower oil were n-nonadecane (10.8%), cedrane (9.2%) and (E, E) -α-farnesene (6%), while the leaf oil contained 1-eicosane (11%), benzyl salicylate (8.9%) and aromadendrene (7.1%) (Rezaee & Jaimand, 2008). Rezaee and *et al*., 2007 reported on the volatile constituents of *Anthem; $ kotschyanaBoiss.* Var. *discoides* (Borron.) Grierson were isolated by hydrodistillation and analyzed by GC and GC/MS. In this study samples were collected from west Azarbaigan province between Orumieh and Shahpur on 1at May 2003. The major constituents of *A. kolschyanaBoiss.* Var. *discoides* (Borron.) Grierson from flower head were β-acorenol (11.9%), artemisia alcohol (9.4%), ethyl hexanoate (8.8%) and n-nonadecane (5.6%) (Rezaee & Jaimand, 2008). Rezaee and *et al*., 2010. reported on the volatile constituents of *A. Hyalina* DC. were isolated by hydrodistallation and analyzed by GC and GC/MS. In this study samples were collected from Qazvin province in2010. The major constituents of *A. Hyalina* DC. were α- terpinene 58.5%, trans-chrysanthenyl acetate 5.3%, β-calacorene 4% (Rezaee & Jaimand, 2007). The aim of the study was investigation of secondary metabolites composition in *A. coelopoda* Boiss. essential oil from three regions in Gilan province in the 2020.

2. Material and Methods

2.1. Collection of Plant

In this research three samples *A. coelopoda* Boiss. were collected from Gilan province, Sample one were collected from Gilan: Loshan, before Hanifa Imamzadeh, near the cement mine, 801 meters high, N 37 09 75 E 40 60 740 collected on 2 May 2020, second sample were collected from Gilan: southwest of Rudbar, Lake 1181 meters high, N 35 13 64 E 40 80 789 collected on 2 May 2020, and the third sample from Gilan: Loshan, before Hanifa Imamzadeh, near the cement mine, 801 meters high, N 37 09 75 E 40 60 740 collected on 2 May 2020. Samples 1 and 3 were collected from one area but at a great distance.

2.2. Essential Oil Preparation

Three samples of *A. coelopoda* Boiss. were collected from three location in Gilan province, and essential oil extracted by water distillation and essential oil yields from sample one Gilan: Loshan, before Hanifa Imamzadeh, near the cement mine, 801 meters high , in flower were 0.04%, in leaf were 0.03% and seond sample essential oil yield from Gilan: southwest of Rudbar, Lake 1181 meters high in flower were 0.10% and in leaf were 0.07% and third sample essential oil yield from Gilan: Loshan, before Hanifa Imamzadeh, near the cement mine, 801 meters high, in flowere were 0.09% and in leaf were 0.06%, respectively. The volatile constituents of *A. coelopoda* Boiss. and analyzed by GC (Ultera Fast Module, Italia) and GC/MS (Varian Model 3400, USA).

2.3. Gas Chromatography

GC analyses were performed using a gas chromatography, Ultera Fast Module –GC, made in Italia. Profile column machine brand Ph-5 capillary column, manufactured by Shimadzu with Length of 30 mm and an inner diameter of 1/0 mm thick 25/0 mm, the inner surface of the stationary phase material is covered Phenyl Dimethyl Siloxane 5%. Column temperature program: initial temperature 60 °C to start the final temperature of 285 °C. The initial 3 °C per minute to be added and then injected into the chamber to a temperature of 280 °C. The carrier gas inlet pressure to the column: helium with a purity of 99/99% of the inlet pressure to the column equal to 5/1 kilogram per square centimeter is set.

2.4. Gas Chromatography-Mass Spectrometry

The GC/MS unit consisted of a Varian Model 3400 gas chromatograph coupled to a Saturn II ion trap detector was used. The column was same as GC, and the GC conditions were as above. Mass spectrometer conditions were: ionization potential 70 eV; electron multiplier energy 2000 V. The identity of the oil components was established from their GC retention indices, relative to C7- C25 n-alkanes standards mixture, and by comparison of their mass spectra and retention indices with those reported in the literature (Rezaee *et al*., 2007; Rezaee *et al*., 2010; Shibamoto, 1987), and by computer matching with the Wiley 5 and NIST mass spectra library, whenever possible, by co-injection with standards available in the laboratories.

3. Results

As you can see in Table 1, the major compounds are as follows. Main components from sample one were from Gilan: Loshan, before Hanifa Imamzadeh, near the cement mine, 801 meters high, in flower were β-calacorene 35.9%, Elemicin 24.0% and n-dodecanol 8.8% and in leaf were β- calacorene 26.8%, elemicin 13.9% and n-dodecanol 11.8%, and essential oil yield from flower were 0.04% and leaf were 0.03%. Main components from sample two Gilan: southwest of Rudbar, Lake 1181 meters high, in flower were γ-cuprenene 18.2%, n-dodecanol 13.8% and geranyl propanoate 7.4% and in leaf were n-dodecanol 13.5%, α- terpinen-7-al 10.8% and geranyl propanoate 10.2%, and essential oil yield from flower were 0.10% and in lead were 0.07%. Main components from sample theewere from Gilan: Loshan, before Hanifa Imamzadeh, near the cement mine, 801 meters high, in flower were n-dodecanol 11.8%, α- terpinen-7-al 9.3% and Cumin aldehyde 8.8% and in leaf were n-dodecanol 14.9%, α- terpinen-7-al 11.1% and 5-hydroxy isobornyl isobutanoate 10%, and essential oil yeild from flower were 0.09% and in leaf were 0.06%.

4. Discussion

As you can see in table 1, the essential oils from sample one from Gilan: Loshan, before Hanifa Imamzadeh, near the cement mine, 801 meters high, were characterized by a high percentage of β- calacorene (flowere 35.9% and leaf 26.8%), also Elemicin (flowere 24% and leaf 13.9%), β- calacorene is a sesquiterpene compound, and elemicin is an olefinic compound. Elemicin is a phenylpropene, a natural organic compound, and is a constituent of several plant species' essential oils (Villanueva *et al*., 1993; Leela, 2008). Elemicin is a constituent of the oleoresin and the essential oil of Canarium luzonicum (also referred to as elemi). Elemicin is named after this tree. One study found it to compose 2.4% of the fresh essential oil (Villanueva *et al*., 1993). Elemicin is also present in the oils of the spices nutmeg and mace, with it composing 2.4% and 10.5% of those oils respectively (Leela, 2008). Structurally, elemcin is similar to myristicin, differing only by myristicin's methyl group that joins the two oxygen atoms that make up its dioxymethy moiety, with both constituents being found in nutmeg and mace. Elemicin has been used to synthesize the proto-alkaloid mescaline (Hahn & Wassmuth, 1934). Raw nutmeg causes anticholinergic-like effects, which are attributed to elemicin and myristicin (McKenna & Nordt, 2004; Shulgin, *et al*., 2015).

The essential oils from sample two from Gilan: Southwest of Rudbar, Lake 1181 meters high, were characterized by a high percentage of γ- cuprenene in flowere (18.2%), and n- dodecanol in leaf (13.5%), and The essential oils from sample three, Gilan: Loshan, before Hanifa Imamzadeh, near the cement mine, 801 meters high, were characterized by a high percentage of n-dodecanol (in flowere 11.8%, and in leaf 14.9%), Dodecanol or lauryl alcohol, is an organic compound produced industrially from palm kernel oil or coconut oil.

Table 1 Chemical composition of essential oil in *A. coelopda* Boiss

		A. coelopda Boiss.					
Compounds name	R.I.	Flower	Leaf	Flower	Leaf	Flower	Leaf
		Gilan: Loshan, before Hanifa Imamzadeh, near the cement mine, 801meters high		Gilan: Southwest of Rudbar, Lake 1181 meters high,		Gilan: Loshan, before Hanifa Imamzadeh, near the cement mine, 801meters high	
Camphene	946	-	-		0.8	-	-
α-phellandrene	1007	1.1	0.9	1.5	9.4	2.6	3.2
γ- terpinene	1053	-	-	-	0.5	-	-
Cis-sabinene hydrate	1065	0.7	0.7	0.7	0.8	1.1	0.8
(2Z)- Hexenal	1081	-	-	0.5	-	-	-
2-ethyl hexanoic acid	1115	-	0.5	-	0.8	-	0.8
Octanol acetate	1211	0.4	1.0	-	-	1.5	-
Methyl nonanoate	1222	0.3	0.4	-	-	0.7	-
Trans-chrysanthenyl acetate	1235	3.1	3.5	3.4	1.8	-	3.7
Cumin aldehyde	1238	-	-	-	-	8.8	-
(2E, 4E)- hexadienol butanoate	1248	0.7	1.9	0.5	1.1	0.8	0.9
α- terpinen-7-al	1284	2.6	4.9	6.2	10.8	9.3	11.1
Dihydro citronellol acetate	1319	0.5	1.2	-	0.8	-	-
3-oxo-p-menth-1-en-7-al	1329	-	-	0.9	1.0	1.1	0.9
Linalool propanoate	1333	1.3	2.6	3.4	6.8	5.2	6.4
(2E)- undecanol	1364	0.9	-	0.7	-	2.3	-
α- copaene	1375	-	-	-	1.1	-	0.6
Hexyl hexanoate	1382	-	-	-	1.4	-	-
Sesquithujene	1406	-	0.8	-	-	-	-
(E)- caryophyllene	1418	-	-	1.0	1.2	-	1.1
Methyl undecanoate	1428	-	-	1.9	-	-	1.3
β-gurjunene	1431	-	-	0.5	0.9	-	-
n-dodecanol	1467	8.8	11.8	13.8	13.5	11.8	14.9
Geranyl propanoate	1476	0.4	0.6	7.4	10.2	2.3	3.7
Germacrene D	1482	-	-	-	0.45	-	-
Lavandulyl 2-methyl butanoate	1511	-	-	1.3	1.6	0.4	0.9
(2E, 4E)- dodecadienal	1517	0.5	0.4	0.4	-	-	-
Trans-calamenene	1522	1.5	1.2	-	-	-	-
γ- cuprenene	1534	1.0	1.0	18.2	3.70	6.6	0.6
α-cadinene	1537	0.6	-	-	-	-	-
Elemol	1548	1.0	1.4	2.2	0.7	0.7	0.8
Elemicin	1553	24.0	13.9	1.5	1.4	3.5	-
Germacrene B	1559	-	-	0.5	-	-	-
β- calacorene	1564	35.9	26.8	-	-	6.5	-
1-hexadecene	1589	-	-	1.84	1.30	-	1.38
Tetradecanal	1610	0.5	-	-	-	-	-
10-epi- γ-eudesmol	1623	0.9	-	-	-	-	-
β- eudesmol	1647	2.0	2.8	1.7	1.5	1.9	4.7
5-hydroxy-isobornyl isobutanoate	1657	1.0	2.8	4.0	6.5	2.4	10.0
Epi- β- bisabolol	1670	-	-	-	2.5	-	0.7
(2Z, 6Z)-farnesal	1687	-	-	0.5	1.0	-	2.1
n-heptadecane	1703	0.7	1.7	4.8	3.6	5.2	6.2
14-hydroxy-4,5-dihydro-Caryophyllene	1706	-	-	-	-	1.2	-
(2E, 6Z0- farnesal	1712	-	-	0.9	-	1.1	1.6
Methyl eudesmate	1719	-	-	1.1	-	1.2	1.4
(E)- nuciferal	1728	1.5	4.0	1.9	4.3	2.0	2.5
Oplopanone	1735	-	-	-	1.5	-	0.6
2E,^E- farnesol	1744	2.9	3.7	-	0.9	1.0	0.8
Cedryl acetate	1769	-	-	0.9	-	1.0	1.9
14-hydroxy- δ- cadinene	1803	-	3.1	-	-	1.1	-
(Z, Z)- farnesyl acetone	1859	0.3	0.8	0.9	1.7	-	1.5
(E)- β- santalol acetate	1867	0.4	-	-	1.0	-	0.7
n-nonadecane	1903	-	-	-	-	0.91	-
Occidol acetate	1974	1.8	-	-	1.3	-	-
Bifloratriene	1977	-	3.3	5.4		7.0	8.0
Isopropyl hexadecanoate	2025	-	-	0.6	0.7	0.6	-
Abietadiene	2084	-	-	-	-	-	0.6
Methyl octadecenoate	2125	-	-	2.4	-	2.1	1.3
n-tricosane	2300	2.5	1.9	6.4	1.2	5.7	1.9

It is a fatty alcohol. Sulfate esters of lauryl alcohol, especially sodium lauryl sulfate, are very widely used as surfactants. Sodium lauryl sulfate, ammonium lauryl sulfate, and sodium laureth sulfate are all used in shampoos. Lauryl alcohol is tasteless and colorless with a floral odor (Ford & Marvel, 1930). In 1993, the European demand of dodecanol was around 60 thousand tons per year (Tt/a). It can be obtained from palm kernel or coconut oil fatty acids and methyl esters by hydrogenation (Noweck, 2006). It may also be produced synthetically via the Ziegler process. A classic laboratory method involves Bouveault-Blanc reduction of ethyl laurate (Ford & Marvel, 1930). Dodecanol is used to make surfactants, lubricating oils, pharmaceuticals, in the formation of monolithic polymers and as a flavor enhancing food additive. In cosmetics, dodecanol is used as an emollient. It is also the precursor to dodecanal, an important fragrance, and 1-bromododecane, an alkylating agent for improving the lipophilicity of organic molecules. The chemical composition of the oil varies depending on the season, it is necessary to pay attention to the period during which the plant is obtained, to ensure that the oil is active. For the great majority of aromatic species, contents and composition of essential oils vary according to the season, either by the change of the ontogenetic phases, temperature variation, solar radiation levels or by the humidity that characterizes each station. However, these variations in the essential oils do not follow a pattern and, therefore, it is necessary to investigate the influence of seasonality on each species of interest to establish the best period for harvesting for obtaining both an oil of therapeutic value and economic importance (Curado, *et al*., 2006; Marzoukia, *et al*., 2009). Samples 1 and 3 were collected from one area but at a great distance, but the difference in the amount of their compounds is large and this can be due to the type of soil.

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References

1. Rechinger KH. Akademische Druck-u. Verlagsanstalt, Graz, Austria. Flora Iranica. 1986; 158: 1-44.
2. Klimes J, Lamparsky D, Scholz E. Vorkommen neuer bifunktioneller Ester im Romisch- kamillenol *(Anthemis nobilis L.)*. Helv. Chem. Acta. 1981; 64: 2338-2349.
3. Uzel A, Guvensen A, Cetin E. Chemical composition and antimicrobial activity of the essential oils of *Anthemis xylopoda* O. Schwarz from Turkey. J Ethno. 2004; 95: 151-54.
4. Baytop T. Therapy with Medicinal Plants in Turkey (past and present), Publication of Istanbul University (first edition), Istanbul. 1984.
5. Mann C, Staba EJ. The Chemistry, Pharmacology, and Commercial Formulations of Chamomille, in: Craker L. E.; Simon J. E. (eds., Herbs, Spices, and Medicinal Plants: Recent Advances in Botany, Horticulture, and Pharmacology, 1, Oryx Press Phoenix, AZ.1986.
6. Rudzki E, Jalblonska S. Kamillosan is a safe product of camomile for topical application: Results of patch testing consecutive patients with contact dermatitis. J Dermatol Treat. 2000; 11: 161-163.
7. Bulatovic VM, Menkovic NR, Vajs VE, Milosavljevic SM, D jokovic DD. *Essential oil of Anthemis carpatica. J Essent. Oil Res.* 1997; 9: 397–400.
8. Vajs V, Todorovic N, Bulatovic V, Menkovic N, Macura S, Juranic N, Milosavljevic, S. Further sesquiterpene lactones from *Anthemis carpatica*, Phytochemistry, 2000;54: 625Ð633.
9. Bruno M, Bondi ML, Vassallo N, Gedris TE, Herz W. Phytochemistry. 1997; 45: 375.
10. Bruno M, Maggio A, Arnold NA, Diaz JD. W, Herz W. Phytochemistry. 1998; 46: 1739.
11. Juranic M, Juranic N, Milosavljevic S. Phytochemistry. 2000; 54: 625.
12. Amjad L, Madani M, Rezvani Z. Potential activity of the *Anthemis gayana* leaves on fungi, Proceedings of International Conference on Biological, Ecological and Environmental Sciences, and Engineering (ICBEESE), Dubai, United Arab Emirates. 2012; 61: 901-902.
13. Rezaee MB, Jaimand K. Chemical Constituents of the Leaf and Flower Oils from *Anthemis altissima* L. var. *altissima* from Iran, J Essential Oil Research. 2006; 18: 1-2.
14. Rezaee MB, Jaimand K. Chemical Constituents of the leaf and flower Oils from *Athemis triumfettii* (L.) All. subsp. *triumfettii* from Iran. J Essen Oil Res. 2008; 20;172-173.
15. Rezaee MB, Jaimand K. Chemical Composition of Essential Oils from Leaves and Flowers of *Anthemis cotula* L. from Gilan Province, Medicinal Plants J. 2007; 2: 99- 105.
16. Rezaee MB, Jaimand K, Mozaffrian V. Essential oil composition of *Anthemis coelopoda* Boiss., Iranian J Med Aroma Plants.2008; 24:271-277.
17. Doğan G. Azize Demirpolat and Eyüp Bağcı. Composition of the Volatile Oils of Anthemis coelopoda var. coelopoda from Turkey, Hacettepe J Biol Chem. 2015; 43:259-265
18. Sonboli A, Kanani MR, Salehi P. Volatile constituents of the leaves and flowers of Anthemis gayana from Iran. Dig 1th Sem Med Nat Prod Chem Iran. 2005; 74.
19. Amjad L, Rezvani Z, Madani M. The effect of methanolic extract of *Anthemis gayana* on Candida spp. Inter J Agric Crop Sci. 2013; 5: 1140-1144.
20. Rezaee MB, Jaimand K. Chemical Constituents of the Leaf and Flower Oils from *Anthemis altissima* L. var. *altissima* from Iran. J Essen Oil Res. 2006; 18:1-2.

21. Rezaee MB, Jaimand K. Chemical Constituents of the leaf and flower Oils from *Athemis triumfettii* (L.) All. subsp. *triumfettii* from Iran, J Essential Oil Research. Allured Publishing Corp. 2008; 20: 172-173
22. Rezaee MB, Jaimand K. Chemical Composition of Essential Oils from Leaves and Flowers of *Anthemis cotula* L. from Gilan Province, Medicinal Plants J. 2007;2: 99- 105.
23. Rezaee MB, Jaimand K, Mazandarani M. Investigation on essential oils of *Anthemis kotschyana Boiss.* Var. *discoides* (Bornm.) Grierson. J Plant Sci Res. 2007; 1:61-65.
24. Rezaee MB, Jaimand K, Mozaffrian V. Investigation of chemical composition of *Anthemis Hyalina* DC essential oil. From Qazvin province, J Herbal Medicine. 2010; 2:25-30.
25. Shibamoto T. Retention Indices in Essential Oil Analysis. In: Capillary Gas Chromatography in Essential oil analysis. Edits., Sandra P, and Bicchi C, Dr. Alfred Huethig Verlag, Heidelberg.1987; 259-274.
26. Davies NW. Gas Chromatographic Retention Index of Monoterpenes and Sesquiterpenes on Methyl silicone and Carbowax 20 M phases. J Chromatography. 1990; 503:1- 24.
27. Adams RP. Identification of essential oils by Ion trap Mass Spectroscopy. Academic Press, San Diego, CA.2017.
28. Villanueva MA, Torres RC, Baser KH, Özek T, Kürkçüoglu M. The Composition of Manila Elemi Oil. Flavour Fragrance J. 1993; 8: 35–37.
29. Leela N. Chemistry of Spices. Calicut, Kerala, India: Biddles Ltd. 2008; 170:165–188.
30. Hahn G, Wassmuth H. Über β-[Oxyphenyl]-äthylamine und ihre Umwandlungen, I. Mitteil.: Synthese des Mezcalins. Berichte der Deutschen Chemischen Gesellschaft (A and B Series). 1934; 67: 696–708.
31. McKenna A, Nordt SP, Ryan J. Acute nutmeg poisoning. European J Emergency Med. 2004; 11: 240–1.
32. Shulgin AT, Sargent T, Naranjo C. The chemistry and psychopharmacology of nutmeg and of several related phenylisopropylamines. Psychopharmacology Bulletin. 1967; 4: 5615546.
33. Ford SG, Marvel CS. Lauryl Alcohol. Organic Syntheses.1930; 10: 62.
34. Noweck K, Grafahrend W. Fatty Alcohols. Ullmann's Encyclopedia of Industrial Chem.2006.
35. Curado MA, Oliveira CBA, Jesus JG, Santos SC, Seraphin JC, Ferri PH. Environmental factors influence on chemical polymorphism of the essential oils of *Lychnophora ericoides*. Phytochem. 2006; 67: 2363-2369.
36. Figueiredo AC, Barroso JG, Pedro LG, Scheffer JJC. Factors affecting secondary metabolite production in plants: volatile components and essential oils. Flavour Fragr J.2008; 23: 213-226.
37. Marzoukia H, Elaissib A, Khaldic A, Bouzidd S, Falconierie D, Marongiu B, Pirasa A, Porceddaa S. Seasonal and geographical variation of *Laurus nobilis* L. essential oil from Tunisia. Open Natural Products J.2009; 2: 86-91.