Available online at www.sciencedirect.com

ScienceDirect

Chinese Journal of Natural Medicines 2013, **11**(5): 0553−0559

Chinese Journal of Natural Medicines

Investigating the altitude effect on the quantity and quality of the essential oil in *Tanacetum polycephalum* Sch.-Bip. *polycephalum* in the Baladeh region of Nour, Iran

Mahdavi, M. [1], Jouri, M.H [1*], Mahmoudi, J. [1], Rezazadeh, F. [2], Mahzooni-Kachapi, S.S. [2]

[1]*The Natural Resources Department, The Islamic Azad University, Nour Branch, Nour, Mazandaran, Iran;*
[2]*The Natural Resources Department, The Islamic Azad University, Nour Branch, Nour, Mazandaran, Iran*

Available online 20 Sept. 2013

[ABSTRACT] Medicinal plant are grown and produced in different ecosystems and sites under the influence of different potential factors, including the altitude as one of the vital determinants in the quantity and quality of the plants. One of the species that grows in the highlands is *Tanacetum polycephalum*, an aromatic perennial of the Asteraceae. This species is characterized to be antiseptic, analgesic, anesthetic, disinfective, expectorant, anti-cancer, anti-allergic, and conducive to low blood pressure. The purpose of this study is to investigate the essential compositions in the aerial parts of *T. polycephalum* at the time of flowering, and in three different altitudes of the Baladeh region of Nour. Thus, the essential oil was extracted from the aerial parts in the flowering stage of the plant at three altitudes of 1 600, 2 400 and 3 200 m using a water distillation method, and the essential oil compositions were identified using GC and GC/MS instruments. One-way ANOVA method was conducted to analyze the obtained data using SPSS, and a Duncan test was administered to compare the means. The results indicated that the essential output obtained from the altitudes of 1 600, 2 400 and 3 200 m was (0.74 ± 0.01)%, (1.09 ± 0.02)%, and (1.32 ± 1.2)%, respectively, so that the altitude of 3 200 m revealed the greatest quantity, and the altitude of 1 600 m represented the smallest quantity. Moreover, the essential oil compositions showed the highest percentage in the altitude of 3 200 m and the lowest percentage at the altitude of 1 600 m. The results showed that as the altitude increases, the essential oil compositions revealed the greater quantity and percentage in the aerial parts of *T. polycephalum*.

[KEY WORDS] Essential oil; *Tanacetum polycephalum*; Essential oil production; Essential oil composition

[CLC Number] R917 **[Document code]** A **[Article ID]** 1672-3651(2013)05-0553-07

1 Introduction

There are 7 500−8 000 plant species in Iran, a country with different climates and areas that have brought about a variety of ecotypes of different plant species [6]. Plants may contain naturally-produced medicines for human diseases, which nature has made available for humans. Despite the great developments in modern pharmaceutical drugs that have saved human beings from different kinds of illnesses, it is impossible to overlook the role of the plants and their positive effects. The active agents present in plants have always been, and will continue to be, used as irreplaceable substances [6].

Although the growth and the increase in the quantity and quality of the substance in medicinal plants takes place mainly due to genetic processes, environmental factors also play a major role in this regard. Such factors help to bring about certain changes in the growth of medicinal plants, as well as changes in the quantity and quality of the active substances [16]. The growth and function of medicinal plants in the ecosystems are influenced by different factors, such as the species, climate, soil, altitude, and geographical area, and each factor has a substantial effect on the quantity and quality. Altitude has a vital role in the growth and production of medicinal plants in a variety of natural ecosystems and areas [8], and is also among the determinants in their quantity and quality [11]. Similarly, physiographical factors, capable of

[Received on] 21-Jun.-2012
[Research funding] This project was supported by the research fund from the Research Deputy section.
[*Corresponding author] Jouri, M.H.: Assistant prof., E-mail: mjouri@gmail.com
These authors have no conflict of interest to declare.

influencing the amount of moisture, chemical properties of the soil, and others effects, play an important role in the distribution of medicinal plant species [6].

The plants of the *Tanacetum* genus (Asteraceae) are perennials and forb types, and have covers with simple corks. A strong, peppermint-like scent is detectible from their aerial parts [12]. Plants of this genus have been used medicinally for two centuries and have anti-tumor and antiseptic properties [2, 7]. In Iran, there are 26 species of this genus known as permanent forb, and sometimes bush, types. One of these is *Tanacetum polycephalum* Sch.-Bip., an aromatic perennial [12]. It has antiseptic, analgesic, anesthetic, disinfective, expectorant, anti-cancer, anti-allergic, and anti-irritant properties, and can also reduce blood pressure [3, 15]. The herb is geographically distributed in Europe, Iran, Iraq, Anatolia, Caucasia, Turkmenistan, Siberia, Afghanistan, Mongolia, Tibet, Himalaya, and Turkey [18]. Studies (e.g. [9]) that explored the altitude effect on the *Thymus kotschyanus* Boiss. & Hohen. (Lamiaceae) in its natural habitats (1 800 to 2 800 m) in the southern flank of the Elborz Mountain revealed that the amount of extracted essential oil differed at different altitudes. It was shown that the altitude of 2 800 m showed the highest essential oil composition, while the altitude of 1 800 m indicated the least amount, and as the altitude increased, the essential oil percentage decreased, but the total essential oil compositions rose. Moreover, the results of other studies (e.g., [9]) that investigated the quantity and quality of essential oil in three different regions of Damavand demonstrated that the amount of essential oil in thyme (*T. kotschyanus*) was different in the various regions, and it was reported that as the altitude increased, the percentage, as well as the total essential oil composition decreased. The study carried out by Kazemizadeh *et al*. [10] reported differences in the quantity and quality of the essential compositions in the aerial parts of *Teucrium hyrcanicum* Steud. (Lamiaceae) in two regions (Khalkhal Road to Asalem and Rostamabad in Guilan province) and at two altitudes, 1 000 and 1 300 m, which arose from the ecologic differences in the growing areas (climate and altitude).

In an investigation of the effect of environmental factors on *Cymbopogon olivieri* (Boiss.) Bor (Poaceae) in four regions, Sarbaz, Jiruft, Dezfool, and Masjid Soleiman, Mirjalili *et al* [12] concluded that the nearby altitudes of 300−600 m in the regions of Masjid Soleiman and Jiruft had a greater effect on the function of the essential oil in the lemongrass. It was demonstrated by Yazdani *et al* [22] that the percenttage essential oil of *Mentha piperita* Stokes (Lamiaceae) from six growing areas depended on the environmental conditions and varied from 1.45% to 3.2%, and was influenced by different environmental factors, such as altitude and the daylight period. The identification of the chemical composition of *Ziziphora clinopodioides* Lam. (Lamiaceae) in different altitudes in several areas indicated that there were different composition percentages at different altitudes and areas, and that other environmental factors, such as soil, also had a role in the differences [4]. The present report attempts to identify the altitude factors that influence the quantity and quality of the essential oil of *T. polycephalum*, as well as the optimal altitude to produce the greatest amount of active substances.

2 Materials and Procedures

2.1 *Plant collection and essential oil extraction*

In this study, the aerial parts of *T. polycephalum* were collected at a time of flowering from three natural areas located in the Baladeh region of Nour (Mazadaran Province) at three altitudes of 1 600, 2 400, and 3 200 m, and in two replications in June-July, 2011. The freshly extracted herb was dried in the laboratory setting. A sample (65 g) of the aerial parts of the plant was extracted using a Clevenger apparatus through water distillation for 3 hours. In order for the essential oil not to be mixed with water, 1 liter of pentane was poured into the storage inlet of the essential oil. Considering the moisture percentage, the essential output was measured in dry weight (*W*/*W*). The essential oil, when extracted, was collected and distilled using sodium sulfate, and kept at 4 °C until it was injected into GC.

2.2 *Essential analysis*

The extracted essential oil was first injected into the GC; then, the most suitable programing of thermal column was obtained for complete separation of the essential oil. In addition, the relative percentage of each component was measured with respect to the peak level in the GC chromatogram. Then, the essential oil was analyzed using GC/MS in order to identify its composition [14, 19]. The components were identified using deterrence indices and mass spectrometry, and were compared with the standard compositions and the data in the mass database Wiley275.L [1]. One-way ANOVA was conducted on the data obtained from the essential oil percentage and the chemical compositions using SPSS, and a Duncan test was administered to compare the means at the 0.01 level.

2.3 *Characteristics of the apparatus*

2.3.1 *Clevenger apparatus* The experiment used a Clevenger apparatus from the Goldis Company in Iran to extract the essential oil from the sample herb.

2.3.2 *Gas Chromatography* The experiment employed a 6890N Gas Chromatograph (Agilent, US), with FID detector, with HP-5 column of 30 m length and 0.25 mm internal diameter, plus with constant phase layer in 0.25 micron. The conveyer gas was helium and the temperature of the injection port was 250 °C. Thermal programing was used from 50−250 °C with an increase of 5 °C per minute.

2.3.3 *GC/MS* In this study, a 5975B GC/MS instrument (Agilent, US), with 70 volt-electron as detector was also used. The employed column was a HP-5 with the same thermal programing as the GC analysis. Relative percentages of each component were obtained by the area below the curve from the GC spectrum.

3 Results

3.1 *The efficiency of extraction and percentage of the essential oil components*

The components of the essential identified from the aerial parts of the *T. polycephalum* at the three altitudes 1 600, 2 400, and 3 200 m are shown in Table 3. The percentages of identified components in the essential of the plant at the three altitudes were 76.59%, 80.78%, and 87.62%, respectively. The key components of which are α-pinene, camphene, camphor, cineole, terpinen-4-ol, santolina triene, borneol, and chrysanthenone. In general, as the altitude increased, the percentage of essential content and the number of components also rose. The mean of the essential oil levels in the *T. polycephalum* samples is shown in Fig. 1, the analysis of variance in Table 1, and the mean comparison in Table 2 and Fig. 2. As indicated in Table 2, the essential oil levels at the altitudes of 1,600, 2,400, and 3,200 m are (0.74 ± 0.01)%, (1.09 ± 0.02)%, and (1.32 ± 1.2)%, respectively. This is the case where the essential oil level produced in the given plant at the altitude of 3 200 m showed the greatest amount (1.32 ± 1.2)% and there was a statistically significant difference between this altitude and the other altitudes, while the lowest level of oil occurred at the altitude of 1 600 m. Overall, as the altitude increased, the essential oil level rose as well.

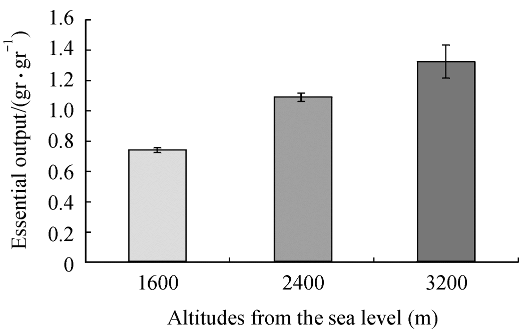

Fig. 1 Mean of the essential oil level of *Tanacetum polycephalum* at three altitudes, in Baladeh, Nour

3.1 *Secondary medicinal constituents*

In this study, α-pinene varied between (1.67 ± 0.03)% and (3.38 ± 0.14)%. The mean comparison conducted through the Duncan test divided the α-pinene concentrations into two groups, the greatest of which is at the altitude of 1 600 m, and is statistically significant. As described in Table 2, the mean comparison conducted through the Duncan test divided the percentage of camphene into three groups, the greatest of which was at the altitude of 1 600 m, and was statistically significant. 1, 8-Cineole levels varied between (14.6 ± 0.09)% and (26.52 ± 0.67)%. It represented the greatest amount compared to the other components, and was the dominant component of the plant essential oil. The mean comparison conducted through the Duncan test divided 1, 8-cineole into three groups, the greatest of which was at the altitude of 1 600 m, and was statistically significant. The composition percentage of santolina triene varied between (0.50 ± 0.007)% and (2.3 ± 0.03)%. The mean comparison conducted through the Duncan test divided the percentage of santolina triene into three groups, the greatest of which was at the altitude of 2 400 m and was statistically significant. Another main component of the essential oil is terpinen-4-ol, which varied between (1.09 ± 0.02)% and (2.83 ± 0.04)%. The mean comparison conducted through the Duncan test divided terpinen-4-ol into three groups, the greatest of which was at the altitude of 3 200 m, and was statistically significant. Borneol is another main component identified at two altitudes of 1 600 and 2 400 m, but it was not detected at samples from 1 600 m. Moreover, chrysanthenone was among the fundamental components at the altitudes of 1 600 and 2 400 m, but was not identified at the altitude of 3 200 m, and therefore was not a common component (Table 3).

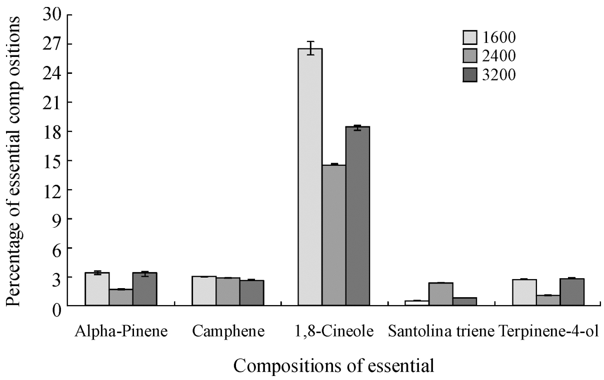

Fig. 2 Effect of altitude on the percentage of shared and main compositions of *T. polycephalum* in Baladeh, Nour

Table 1 ANOVA results from the effect of altitude on essential oil level and percentage of common and main components in the essential oil of *T. polycephalum*

F	Variable Sources	Source of changes
42.445**	Essential oil level	
87.948**	α-Pinene	
106.167**	Camphene	Altitude
448.445**	1, 8-Cineole	
3 497.600**	Santolina triene	
1 016.167**	Terpinen-4-ol	

**$P < 0.01$ *vs* three level of altitude

Table 2 Mean comparisons of essential oil level and percentage of common and main compositions of *T. polycephalum* at three altitudes of Baladeh, Nour (Mean ±SD, *n* = 36)

Altitudes/m	Number of components	Total percentage of components/%	Essential oil level/%	*α*-Pinene/%	Camphene/%	1, 8-Cineole/%	Santolina triene/%	Terpinen-4-ol/%
1 600	40	76.59	0.74 ± 0.01^c	3.38 ± 0.14^a	2.99 ± 0.007^a	26.52 ± 0.67^a	0.50 ± 0.007^c	2.74 ± 0.04^a
2 400	48	80.78	1.09 ± 0.02^b	1.67 ± 0.03^b	2.8 ± 0.03^b	14.6 ± 0.09^c	2.3 ± 0.03^a	1.09 ± 0.02^b
3 200	51	87.62	1.32 ± 1.2^a	3.35 ± 0.2^a	2.62 ± 0.02^c	18.36 ± 0.19^b	0.8 ± 0.02^b	2.83 ± 0.04^a

$^{**}P < 0.01$; a, b, and c are used to distinguish the differences between altitude levels. Common letters indicate that there are no significant differences between two levels.

Table 3 Identification of essential oil compositions of *T. polycephalum* at three altitudes of Baladeh, Nour (Mean ± SD, *n* = 36)

No.	Name of component	Deterrence index	Percentage of component at altitudes		
			1 600 m	2 400 m	3 200 m
1	Santolina triene	873	0.50 ± 0.007	2.3 ± 0.03	0.8 ± 0.02
2	Tricyclene	895	0.21 ± 0.007	0.26 ± 0.05	0.57 ± 0.10
3	*α*-Thujene	905	0.23 ± 0.021	0.13 ± 0.04	0.26 ± 0.05
4	2, 3-Dehydro-1, 8-cineole	909	0.27 ±0.04	–	–
5	*α*-Pinene	915	3.38 ± 0.14	1.67 ± 0.03	3.35 ± 0.2
6	Camphene	936	2.99 ± 0.007	2.8 ± 0.03	2.62 ± 0.02
7	Verbenene	945	–	–	0.47 ± 0.13
8	*cis*-Epoxy-ocimene	952	0.87±0.01	–	–
9	Sabinene	976	–	0.76 ± 0.12	1.89 ± 0.15
10	*β*-Pinene	979	1.37 ± 0.53	0.33 ± 0.06	0.8 ± 0.19
11	α-Terpinene	1002	–	0.34 ± 0.05	1.74 ± 0.10
12	*O*-cymene	1014	–	0.5 ± 0.09	1.09 ± 0.09
13	1, 8-Cineole	1022	26.52 ± 0.67	14.6 ± 0.09	18.36 ± 0.19
14	2, 7-Dimethyl-4(*E*), 6-octadien-2-ol	1029	–	-	2.86 ± 0.18
15	Yomogi alcohol	1035	0.28 ± 0.03	0.3 ± 0.10	0.26 ± 0.13
16	*γ*-Terpinene	1049	0.84 ± 0.07	0.69 ± 0.12	1.28 ± 0.24
17	*trans*-Sabinene hydrate	1060	–	0.35 ± 0.04	1.05 ± 0.11
18	*cis*-Verbenol	1076	–	–	0.35 ± 0.11
19	2, 7-Dimethyl-2, 6-octadien-4-ol	1079	–	–	1.77 ± 0.12
20	1, 5-Heptadien-4-ol, 3, 3, 6-trimethyl	1080	–	0.13 ± 0.04	–
21	*cis*-Linalool oxide	1083	–	–	0.37 ± 0.10
22	*cis*-Sabinene hydrate	1094	1.96 ± 1.32	0.8 ± 0.07	1.68 ± 0.16
23	Filifolone	1098	1.01 ± 0.02	0.86 ± 0.08	–
24	*Z*-*β*-Terpineol	1106	–	0.6 ± 0.02	–
25	Linalool	1111	–	0.15 ± 0.07	–
26	2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)	1128	0.35 ± 0.11	–	–
27	Chrysanthenone	1129	4.9 ± 0.14	4.91 ± 0.12	–
28	1, 3-Cyclohexadiene, 2-methyl-5-(1-methylethyl)-, monoepoxide	1149	–	–	10.99 ± 0.16
29	Camphor	1150	18.51 ± 0.54	–	–
30	4, 5-Epoxy-1-isopropyl-4-methyl-1	1156	–	18.2 ± 0.3	–
31	Bicyclo[2.2.1]heptan-3-one, 6, 6-di methyl-2-methylene	1162	–	–	1.82 ± 0.21
32	Pinocarvone	1164	–	0.78 ± 0.02	1.2 ± 0.13
33	Borneol	1168	–	16.88 ± 0.31	12.49 ± 0.14
34	Isobornyl	1172	–	–	0.23±0.13
35	Sabinol	1173	–	–	1.22±0.12

(Contour 3)

No.	Name of compositions	Deterrence index	Percentage of compositions		
			1 600 m	2 400 m	3 200 m
36	Terpinene-4-ol	1179	2.74 ± 0.04	1.09 ± 0.02	2.83 ± 0.04
37	*α*-Thujenal	1184	0.49 ± 0.53	0.14 ± 0.06	0.29 ± 0.13
38	*α*-Terpineol	1191	1.32 ± 0.24	0.81 ± 0.09	0.66 ± 0.13
39	Myrtenal	1195	–	–	0.4 ± 0.12
40	Myrtenol	1197	0.52 ± 0.24	1.29 ± 0.04	0.43 ± 0.10
41	Bicyclo[3.1.1]hept-2-ene-2-carboxaldehyde, 6, 6-dimethyl	1200	1.27 ± 0.25	0.37 ± 0.11	–
42	Verbenone	1210	–	–	0.24 ± 0.07
43	*trans*-Piperitol	1214	0.18 ± 0.08	–	–
44	*trans* carveol	1232	0.14 ± 0.06	0.17 ± 0.01	–
45	*trans*-Pinocarveol	1233	–	–	0.17 ± 0.09
46	*cis*-Ocimene	1240	0.22 ± 0.14	–	–
47	Cuminyl aldehyde	1241	0.3 ± 0.28	0.15 ± 0.04	–
49	Carvol	1249	0.14 ± 0.03	0.08 ± 0.02	–
50	Chrysanthenyl acetate	1263	–	0.19 ± 0.04	–
51	Bornyl acetate	1284	0.51 ± 0.22	–	1.71 ± 0.14
52	Iso-bornyl acetate	1286	–	1.68 ± 0.11	0.35 ± 0.10
53	Sabinyl acetate	1292	0.31 ± 0.18	–	0.29 ± 0.09
54	Thymol	1300	0.64 ± 0.05	0.59 ± 0.13	–
55	Benzenemethanol, 4-(1-methylethyl)	1302	–	0.1 ± 0.02	–
56	1, 3-Cyclopentadiene, 5, 5-dimethyl- 2-ethyl	1322	0.23 ± 0.16	–	–
57	Menthofuran	1398	–	0.32 ± 0.04	–
58	*cis*-Jasmone	1402	–	0.24 ± 0.06	–
59	Davana furan	1414	0.85 ± 0.07	–	0.08 ± 0.03
60	Propanoic acid	1419	–	–	1.29 ± 0.12
61	Hexahydrofarnesyl acetone	1442	–	–	0.17 ± 0.07
62	Homoadamantane	1472	–	–	1.24 ± 0.09
63	4-Methyl-2-(3-methyl-2-butenyl)-furan	1483	–	0.07 ± 0.01	0.18 ± 0.07
64	Davana ether	1516	0.47 ± 0.14	0.85 ± 0.18	0.64 ± 0.11
65	2, 3, 4, 5-Tetramethylthiophene	1528	–	0.49 ± 0.10	–
66	2-Fluoro-4-methylanisole	1535	0.41 ± 0.02	–	0.36 ± 0.07
67	Bicyclo[7.2.0]undec-4-ene-trimethyl-8-methylene	1578	–	0.31 ±0.06	–
68	Spathulenol	1581	0.07 ± 0.02	0.31 ± 0.05	–
69	*cis*-Davanone	1588	0.1 ± 0.02	1.08 ± 0.05	2.38 ± 0.09
70	5-*epi*-Neointermedeol	1600	0.65 ± 0.16	0.73 ± 0.07	–
71	Cyercene 4	1603	0.23 ± 0.02	0.25 ± 0.04	0.18 ± 0.05
72	Naphthalene, 1, 2, 3, 4, 4a, 7-hexahydr o-1, 6-dimethyl-4-(1-methylethyl)	1629	–	–	0.3 ± 0.09
73	10, 10-Dimethyl-2, 6-dimethylenebicy clo[7.2.0]undecan-5*β*-ol	1635	–	0.36 ± 0.4	0.22 ± 0.09
74	Caryophylla-4(12), 8(13)-dien-5*β*-ol	1640	0.14 ± 0.03	0.15 ± 0.05	0.87 ± 0.12
75	*β*-Eudesmol	1652	0.39 ± 0.07	–	0.13 ± 0.07
76	Caryophyllenol-II	1678	–	0.08 ± 0.01	–
77	Davanone	1693	–	–	1.65 ± 0.09
78	5-Acetyl-4, 7-dimethoxy-6-hydroxybe	1757	–	–	0.28 ± 0.09
79	Hexadecanoic acid	1968	0.08 ± 0.01	0.3 ± 0.05	0.76 ± 0.12
	Total		76.59	80.78	87.62
	Number of components		40	48	51

4 Discussion and conclusions

The growth and production of medicinal plants in natural ecosystems and in different areas, and the production of their secondary medicinal metabolites are considerably influenced by environmental conditions [6, 17]. This is an important factor that changes in altitude and habitat can alter many ecophysiological outcomes [20]. The results from this study indicated that as the altitudes in the Baladeh area increased, the essential oil level and the number of essential oil components also increased, which can be caused by the change in the amount of moisture and available water, x-rays, and temperature, as well as daylight period [20]. Concomitant with the present study, Habibi *et al*. [8] and Jamshidi *et al*. [7] also reported that the essential output of *Thymus kotschyanus* differed in different altitudes, but as the altitude increasesd, the amount of essential oil dropped. In a similar vein, Yazdani *et al*. [21] argued that the essential oil of peppermint (*M. piperita*) was different because of the altitude and irregular daylight. The results also showed that camphor was one of the main essential oil components at an altitude of 1 600 m, and was not identified at other altitudes. Borneol was also characterized as the main composition at 2 400 and 3 200 m, and it was not identified in the sample at from 1 600 m. In addition, chrysanthenone was found to be a key component in two altitudes of 1 600 and 2 400 m, but it was not detected at an altitude of 3 200 m, and was not a common component either.

Findings from the present study that explored the effect of altitude on the percentage of essential compositions revealed that the altitude effect on the percentage of composition is statistically significant at the 0.01 level, so that as the altitude increased and the sunlight intensity dropped, the percentage of camphene, α-terpineol, and hexadecanoic acid were also reduced. Moreover, the greatest increase in active medicinal reagent consistent with the increase due to the altitude concerned 1, 8-cineole, and the smallest increase was associated with santolina triene. At all three altitudes in Baladeh, 1, 8-cineole showed the highest percentage and was the prototypical composition of the medicinal plant. The difference in the type and percentage of components was very distinct because of the difference in temperature, relative moisture, wind speed, the amount of the available water, the degree of gained sunlight and x-rays in three altitudes. The altitude effects on plant have been seen in the studies of Habibi *et al*. [8] and Jamshidi *et al*. [7] on *T. kotschyanus*, Kazemizadeh et al.'s [10] on *T. hyrcanicum*, and Dehghan *et al*. (2010) on blue mint bush (*Ziziphora clinopodioides*). They demonstrated similar results, and in line with the present research, reported different percentage of essential oil compositions at different altitudes. Knowledge of the compositions of the indigenous medicinal plants in Iran can assist in employing the medicinal plant resources. For example, the results obtained from investigating the essentials oils can assist in standardizing the medicinal products. In addition, further studies are recommended because of the geographical variations in Iran, and the vast distribution of *T. polycephalum* in Mazandaran province, as well as the various applications of the medicinal plant.

Acknowledgement

We appreciate Mr. Ali Falah, Research Vice Chancellor, and Dr. Sadrodin Motevali, as principal of Islamic Azad University of Nour branch for their support.

References

[1] Adams RP. Identification of Essential Oil Components by Gas Chromatography/Mass Spectrometry, 4th Edition. Allured Publishing Corporation, USA. 2007. pp. 804.

[2] Bagci E, Kocak A. Essential oil composition of two endemic *Tanacetum* (*T. nitens* and *T. argenteum*) (Asteraceae) taxa, growing wild in Turkey [J]. *Indust Crops Prod*, 2010, **31**(3), 542-545.

[3] Barazandeh M. Quantitative and qualitative investigation of essential oil of *Tanacetum polycefalum* [J]. *Iran J Med Aromat Plants*, 2003, **19**(2), 111-116.

[4] Dehghan Z, Sefidkon F, Bakhshi khaniki GH. Effects of some ecological factors on essential oil content and composition of (*Ziziphora clinopodioides*. Suamb sp. *rigida* Boiss.) [J]. *Iran J Med Aromat Plants*, 2010, **26**(147): 49-63.

[5] Enright NJ, Miller BP, Akhter R. Desert vegetation environment relationships in Kir Thar National Park. Pakistan [J]. *Arid Environ*, 2005, **67**: 397-478.

[6] Golmohammadi F, Rakhshanipour G. *A review of the importance and applications of the herbs (emphasizing the saffron and its exports in Southern Khorasan)* [C]. National Conference on Herbs and Identification of their Economic and Employment Potentialities, Islami Azad University, Birjand Branch, 2010. 186.

[7] Gören N, Demirci B. Baser KHC, Composition of the essential oils of *Tanacetum* spp. from Turkey [J]. *Flav Fragr J*, 2001, **16**: 191-194.

[8] Habibi H, Mazaheri D, Majnoon-Hassani N, *et al.* Investigating the effects of altitudes on the essential oil and herbal compositions of *Thymus kotschyanus* in Taleghan [J]. *J Res Construct*, 2006, **19**(4): 2-10.

[9] Jamshidi AM, Aminzadeh M, Azarnivand H, Abedi M . Effect of evaluation for quality and quantity of essential oil Thymus kotschyanus (Damavand-Tar). J. Med. Plants. 2006, **5**(18): 17-22.

[10] Kazemizadeh Z, Habibi Z, Moradi A. investigating the chemical compositions in the essential of two species of *Teucrium hyrcanicum* in two different sites [J]. *Quart J Iran Aromat Herbs*, 2010, **9**(34): 67-73.

[11] Kouchaki A, Hosseini M. *The Ecology of Agriculture* [M]. Mashad, Iran: Ferdowsi University Press, 1995: 164.

[12] Mirjalili M, Fakhr Tabataba'ie M, Omidbeigi R. Study of compatibility and evaluation of the essential function in the indigenous biomass of the Iranian lemongrass [J]. *Mag Agric Sci*, 2005, **36**(1): 33-41.

[13] Mozaffarian VA. *Dictionary of the Iranian Plants* [M]. Tehran, Iran: Farhang Mo'aser Publishers, 1996: 750.

[14] Nikavar B, Mojab F, Doulatabadi R. Investigating the components of the essential in thyme (*Thymus daenensis* Celak) [J]. *Quart J Iran Aromat Herbs*, 2004, **4**(13): 45-49.

[15] Nori-Shargh D, Norouzi D, Mirza M, *et al.* Chemical composition of the essential oil of *Tanacetum polycephalum* (Schultz Bip. ssp. *heterophyllum*) [J]. *Flav Fragr J*, 1999, **14**(2): 105-106.

[16] Omidbeigi R. *Production and Manufacturing the Herbs* [M]. Vol. 1. Mashhad, Iran: Beh-nashr Publication, 2005: 347.

[17] Palevitch D. Recent advances in cultivation of medicinal plants [J]. *Acta Horticult*, 1987, **208**: 29-34.

[18] Rechinger KH. Flora Iranica, Vol. 150, Austeria, 1982. 597p.

[19] Saharkhiz M, Sattari M, Goodarzi Gh, *et al*. Determining the effect of anti-bacterial essential of *Tanacetum parthenium* [J]. *J Sci Res Iran Aromat Herbs*, 2008, **24**(1): 47-55.

[20] Tajbakhsh M. *Ecology of Seeds* [M]. Urumia, Iran: Jehad-Daneshgahi Publication, 2008: 134.

[21] Yazdani D, Jamshidi A, Mojab F. Comparing the essential amount and the menthole in peppermint planted in different regions of the country [J]. *Quart J Iran Aromat Herbs*, 2002, **1**(3): 73-78.