Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 6, No. 6, p. 391-406, 2015
http://www.innspub.net

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RESEARCH PAPER
OPEN ACCESS

The review of ecological features effects (soil and height) on the essential oil chemical compounds of *Ziziphora clinopodioides* Lam. medicinal plant in Fars Province, Iran

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Article published on June 30, 2015

Key words: *Ziziphora Clinopodioides*, Essential oil, Soil, Chemical compounds, Fars province.

Abstract

Ziziphora is one genus of Lamiaceae family that includes annual and perennial plants. Considering the habitat features and position of the plant are in the nature is as a main factors that can affect the amount of plants essential oil. Hence in this paper, the effects of edifice and height factors on *Ziziphora clinopodioides* Lam. essential oil in Fars province have reviewed. To section aerial parts, the plant was collected in the flowering stage in 3 regions of Abadeh, Dasht Arzhan and Boul Mountain. The most important regions habitat conditions (annual rainfall average, average of temperature, the height from sea level and soil features) were recorded. Then the collected samples from each region were extracted in 3 times. The essential oils by GC and GC/MS machines were analyzed and finally the efficiency averages of essential oil were compared by Dankan test. The obtained results showed that the maximum percent of essential oil allocated to Boul Mountain region and the minimum of them allocated to Dash Arzhan and the compound of Pulegone ، p-Menth-3-en-8-ol and Menthone were as the main components of this plant. According to the habitat conditions of the studied specious plan, it grows in the height between 1900- 2500 m and in the soils with loamy – sandy texture and 1 to 1.4 EC and the pH between 7.5 to 8 in the studied regions. By calculating Pierson correlation coefficient, it was identified that among the different factors, just there is a correlation between height, pH and lime of soil. According to soil and height specifications of the habitat of this medicinal plant, it can be suggested as a corrective species in the same regions.

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Introduction

Ziziphora is one of the genuses of Lamiaceae family that includes annual and perennial plants. This genus includes 40 species in the Mediterranean, Iran region and Turan and especially center of Asia and 4 species are in Iran (Rechinger,1982). In traditional medicine is used as an appetizer, laxative, stomach tonic, carminative, antiseptic and is used for treatment of wounds as well (Beikmohammadi, 2011; Senejoux *et al.*, 2012). Considering the habitat features and position of plant in the nature is one of main factors that can have a great effect on the amount of essential oil and active ingredient. There are several reports about the relation between habitat conditions and chemical compounds of plants; and a high correlation has been observed between the geographical origin of plants and their active ingredient (Bertome *et al.*, 2007).Hence in this paper, the effect of ecological factors (soil and height from sea level) on the essential oil compounds of *Ziziphora clinopodioides Lam*. plant is studied. Several studies have conducted on the effect of ecological factors on the plants essential oil, that some of them are mentioned as follows: Verdianrizi (2008) by conducting a study on the essential oil compound of aerial parts of *Z. clinopodioides* Lam. plant; Dehghan *et al.* (2014) by reviewing the effect of climate conditions on the efficiency and quality of essential oil of *Z.clinopodioides* Lam. plant in different habitats of Hamedan province; and Beirami nia *et al.* (2014) by identifying the essential oil components of *Z.clinopodioides var. rigida* plant in Kerman province; and also Ozturk and Ercisli (2006) by doing a research on the essential oil compounds of *Z. Clinopodioides* plant, introduced Pogon (36.45%) as the main component of *Z. Clinopodioide*s plant essential oil.(Soltani Nejad, 2012; Behravan *et al.*, 2007 ; Amiri, 2009 ; Xing *et al.*, 2010 ; Sardashti *et al.*, 2012). Also there is a significant and negative correlation between pH, phosphor, humidity and soil temperature with the percent of medicinal active ingredient. Mir Azadi and Pilevar (2013) by doing a study on the effective ecological factors on the existed compounds in the essential oil of *Myrthus communis* L. found that the factors such as the height from sea level and soil elements such as phosphor, organic carbon, potassium and nitrogen have effect on the efficiency and essential oil compounds. Also according to the obtained results of a research done by Curado *et al.* (2006), it has been identified that between chemical compounds of *Lychnophora ericoide*s plant and soil factors is a significant relation. Azimii (2009) by reviewing the percent changes and essential oil active ingredients of *Z. Clinopodioides* plant affected by the height found that the maximum essential oil percent allocates to the height of 2200 m and the minimum amount is related to the height of 1450m. According to the obtained results of study on the effect of different height on the essential oil amount of *Z.Clinopodioides* plant, done by Fatehi *et al.* (2011) it was showed that the amount of essential oil in the height of 1900 m is 83% and in the height of 2100 m is 66%.So, the environmental factors can affect the active ingredient of plants; as these changes in some plants lead to increase of active ingredient and in some of them lead to decrease of that. Also Mir Azadi *et al.* (2012) by conducting a study of the effect of ecological factors on the essential oil percent of *Myrthus communis L.*plant in forests habitant in Lorestan province reported that there is a direct and significant relation between the height from sea level and the essential oil efficiency percent; and an inverse relation is between soil sodium amount and percent of essential oil efficiency. Azarnivand *et al.* (2009) by doing a study on the effect of ecological features (soil and height) on quantity and quality of *Achillea millefolium* L. essential oil found that there is a significant relation in 1% level between leave efficiency essential oil and elevational classes; and the maximum leave essential oil efficiency was related to the height of 2100 m and among soil and height features, only between soil nitrogen amount and this quantity a significant relation was seen. Finally, as the studied specious Z. *clinopodiodes* Lam. is important in terms of pharmaceutical and hygienic applications and orally uses, this study was done with the purpose of reviewing the effects of different habitats ecological

factors on the quality and quantity of mentioned plant essential oil.

Materials and methods

The introduction of studied regions

The aerial parts of *Ziziphora clinopodioides* Lam. plant in complete flowering stage from 3 regions were collected as follows:

1-Dasht Arzhan site: is located at 50 km from Shiraz in the height of 1950 and its geographical coordination is E58º 51´ N39º 29´ and its annual average rainfall is 350 mm and the average temperature is 34 ºC .

2- Abadeh county site: this site is located at the height of 2400 m and its geographical coordination is E53 º 45´ N 30 º 46´ that its annual precipitation is 185 mm and its average temperature is 15 ºC.

3-Bowl Mountain Eghlid: is located at Eghlid County region and has western slope. The geographical coordination of this mountain is N30 º 46´ 52 º 45´ E that the annual precipitation average is 320 mm and the mean temperature is 13 ºC.

Gathering and extraction of the plant

The samples of three regions after collecting were transferred to the lab and then in shadow and in a dry environment temperature were preserved and then were milled; and by using the distillation machine with water the Clevenger plan was done. In each iteration50 gr dried aerial parts of studied plant in flowering stage was extracted. The spend time for extracting all the samples was equally and 2 hours. Also to determine the exact essential oil yield of each sample, the percent of moisture of plants samples in extracting time was measured. By considering the humidity percent, essential oil yield according to dry weight was calculated. By adding a little sodium sulfate, the excess water was taken and the essential oil for injecting to GC and C/MS machines was prepared. In this time interval the essential oils were preserved in refrigerator.

Identification of essential oil component compounds

To identify the essential oil compounds, gas chromatography machine (GC) and gas chromatography machine connected to mass spectrometer were used. The GC/MS system, Agilent Technologies-7890A model equipped to hydrogen flam ionization detector, the column of HP-5machine with the length of 30cm, interior diameter of 25 micron, with stationary phase layer thickness of 0.25 micron. The helium carrier gas was at a speed of 1ml/min. The temperature of oven increased from 20 ºC to 280 ºC with the speed of 3 ºC /min. Finally, the obtained data by using the Excell and SPSS software was analyzed statistically.

Measurement of soil physical and chemical features

In each habitat from the depth of 30 cm, about 2 kg soil was removed and transited to the pedology lab. Some of soil physical and chemical features such as EC with saturation extract method, organic carbon by the method of wet oxidation, the soil phosphorus by the method of Olsen, limestone using the method of size analyses (calsiometery), soil texture (the percent of sand, clay and silt by using the method of hydrometer, pH by the method of pH method were studied.

Results

Essential oil efficiency

The average of efficiency essential oil ration to the dry weight in 3 regions was calculated and the results showed that the maximum percent of essential oil allocated to Boul Mountain and the minimum of them allocated to Dashte Argan (Fig. 1).

The comparison of photochemical compounds between difference populations of Z. clinopodioides in 3 considered habitats

According to the analysis of chemical compounds in 3 regions it was determined that the compound of Pulegon, p-Menth-3-en-8-ol and Menthone are as the major compound of this plant. According to the results of obtained data variances, it is observed that between the different populations of *Z. clinopodioides*

in term of many identified compounds in essential oil, there is a significant difference (table1).

Based on conducted studies it was shown that between the amount of Pulegone in 3 regions, there was a significant different. The maximum amount of Pulegone was allocated to Boul Mountai, Dashte Argan and Abodeh County respectively. Between the amounts of p-Menth-3-en-8-ol in 3 regions a significant difference was seen.

Table 1. The statistical analysis of data related to 3 compounds of Pulegone،p-Menth-3-en-8-ol and Menthone in 3 studied regions by using Dankan test in 5% level.

Compound		Sum of Squares	Df	Mean Square	F	Sig.
Pulegone	Between Groups	1075.079	2	537.539	941.144	.000
	Within Groups	3.427	6	.571		
	Total	1078.506	8			
p-Menth-3-en-8-ol	Between Groups	57.222	2	28.611	129.233	.000
	Within Groups	1.328	6	.221		
	Total	58.550	8			
Menthone	Between Groups	7.742	2	3.871	14.456	.005
	Within Groups	1.607	6	.268		
	Total	9.349	8			

Table 2. The chromatography results of *Z. clinopodioide*s plant essential oil in Boul Mountain region

NO	Compound(P920604)	Compound (%)	NO	Compound(P920604)	Compound (%)
□	□-Thujene	□□□□□	19	iso-Menthone	2.4
□	□-Pinene	□□□□	20	neo-Menthol	2.5
3	Camphene	0.14	21	Menthol	0.5
4	Sabinene	0.74	22	Terpinene-4-ol	1
□	□-Pinene	□□□□	23	iso-Menthol	0.33
6	Myrcene	0.46	24	neo iso-Menthol	0.31
□	□-Phellandrene	□□□□	25	Pulegone	50.9
□	□-Terpinene	□□□□	26	Bornyl acetate	0.016
9	p-Cymene	0.05	27	Iso Pulegone acetate	1.4
10	Limonene	3.2	28	Thymol	0.11
11	1,8-Cineole	6.59	29	Carvacrol	0.4
12	(E)-□-Ocimene	0.06	30	Piperitenone	1.9
□□	□-Terpinene	□□□□	31	Eugenol	0.02
14	p-Mentha-3,8-diene	0.28	□□	□-Bourbonene	□□□□
15	Terpinolene	0.02	33	(E)-Caryophyllene	0.03
16	Linalool	0.03	34	Germacrene D	0.29
17	p-Menth-3-en-8-ol	11.34	35	Spathulenol	0.014
18	Menthone	8.4	36	Caryophyllene oxide	0.039
			total		95.9

The maximum amount of p-Menth-3-en-8-ol in Abaseh County, Boul Mountain, Dashte Arzhan was observed. The amount of Menthone in 2 regions of Abadeh county and Dashte Arzhan had not any significant different. But in Boul Mountain the amount of Menthone in comparison with two studied regions had a significant decrease. (table 2, 3 and 4).

The compounds of Z. clinopodioides plant essential oil

The 2, 3 and 4 tables show the type and amount of component chemical compounds of *Z. clinopodioides plant* essential oil**.**

The habitat soil analysis of Z. clinopodioides plant

The habitats in terms of height, temperature average, humidity and the amount of raining are different. According to the habitats conditions the studied specious has spread between1900-2500 m height in studied region.

The specious of *Z. clinopodioides* grows in the soil with loamy- sandy texture and the EC from 1 to 1.4 and PH between7.5 to 8 in the studied regions. The obtained laboratory results of soil samples in terms of soil texture show the existing of soil with mean texture that for farming, all the samples have clay amount limitation; so, in this regard they are categorized in undesirable class.

Table 3. The chromatography results of *Z. clinopodioide*s plant essential oil in Abadeh county.

NO	Compound(P920604)	Compound (%)	NO	Compound(P920604)	Compound (%)
□	□-Thujene	0.49801	16	neo-Menthol	1
□	□-Pinene	0.87838	17	iso-Menthol	0.4
3	Camphene	0.72977	18	neo iso-Menthol	0.08
4	Sabinene	0.77687	19	Pulegone	26.3
□	□-Pinene	1.23516	20	Iso Pulegone acetate	0.32
6	Myrcene	0.21674	21	Thymol	6.9
7	p-Cymene	0.30772	22	Carvacrol	1.05
8	Limonene	5.09811	23	Piperitenone	0.53
9	1,8-Cineole	2	24	Bicyclo Germacrene D	5.4
10	(E)-□-Ocimene	0.3	□□	□-Bourbonene	2.3
□□	□-Terpinene	0.19	26	(E)-Caryophyllene	0.37
12	p-Mentha-3,8-diene	0.16	27	Germacrene D	5.44
13	p-Menth-3-en-8-ol	14.7	28	Spathulenol	0.37
14	Menthone	10.45	29	Caryophyllene oxide	2.7
15	iso-Menthone	4.5		total	95.73

Table 4. The chromatography results of *Z. clinopodioide*s plant essential oil in the site of Dashte Arzhan.

NO	Compound(P920604)	Compound (%)	NO	Compound(P920604)	Compound (%)
□	□-Thujene	□□□□	21	Menthol	1.4
□	□-Pinene	□□□□	22	Terpinene-4-ol	7.04
3	Camphene	0.27	23	iso-Menthol	0.72
4	Sabinene	□□□□	24	neo iso-Menthol	1.35
□	□-Pinene	0.72	25	Pulegone	47.47
6	Myrcene	□□□	26	N dodecane	2.1
□	□-Phellandrene	□□□□	27	Iso Pulegone acetate	0.09
9	p-Cymene	0.04	28	Thymol	0.97
10	Limonene	1.4	29	Carvacrol	0.21
11	1,8-Cineole	3.06	30	Piperitenone	0.5
12	(E)-□-Ocimene	0.1	31	Eugenol	1.0
□□	□-Terpinene	□□□□	□□	□-Bourbonene	□□□□□
14	p-Mentha-3,8-diene	0.6	33	Bicyclo Germacrene	0.41
15	Terpinolene	0.04	34	Germacrene D	0.4
17	p-Menth-3-en-8-ol	8.3	35	Spathulenol	0.006
18	Menthone	10	36	Caryophyllene oxide	0.2
19	iso-Menthone	4.35		total	95.7
20	neo-Menthol	1.48			

Table 5. The habitats soil features of Z. *clinopodioides* Lam.

site	sand(%)	Clay(%)	Silt(%)	OC	P	lime(%)	pH	ECdSm2
Dashte Arzhan	40	23	35	1.6	0.06	37±1.1	7.9±0.042	1.4±0.037
Abadeh county	42	23	37	1.6	0.085	37.9±0.6	7.7±0.008	1± 0.035
Boul Mountain	38	23	39	1.8	0.8	41±0.65	7.5±0.001	1.1±0.011

The analyzed samples in terms of EC have no any salt limitation and culturing agricultural products in this regard have no any limitation. Regarding pH, the soil analyzed sample are mainly categorized in neutral to alkaline class.

Table 6. The correlation between soil EC and the percent of essential oil in 3 regions of Abadeh county, Boul Mountain, Dashte Arzhan.

		percent of essential	EC
percent of essential	Pearson Correlation	1	-.504
	Sig. (2-tailed)	.	.166
	N	9	9
EC	Pearson Correlation	-.504	1
	Sig. (2-tailed)	.166	.
	N	9	9

Table 7. The correlation between EC and the amount of PULEGONE in 3 regions of Abadeh county, Boul mountain and Dashte Arzhan.

		EC	Pulegone
EC	Pearson Correlation	1	.493
	Sig. (2-tailed)	.	.178
	N	9	9
Pulegone	Pearson Correlation	.493	1
	Sig. (2-tailed)	.178	.
	N	9	9

Table 8. The correlation between soil EC and amount of p-Menth-3-en-8-ol in 3 regions of Abadeh county , Boul Mountain and Dashte Arzhan.

		EC	p-Menth-3-en-8-ol
EC	Pearson Correlation	1	-.870(**)
	Sig. (2-tailed)	.	.002
	N	9	9
p-Menth-3-en-8-ol	Pearson Correlation	-.870(**)	1
	Sig. (2-tailed)	.002	.
	N	9	9

** Correlation is significant at the 0.01 level (2-tailed).

Table 9. The correlation between soil EC and the amount of Menthone in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		EC	Menthone
EC	Pearson Correlation	1	.370
	Sig. (2-tailed)	.	.327
	N	9	9
Menthone	Pearson Correlation	.370	1
	Sig. (2-tailed)	.327	.
	N	9	9

The amount of lime in soil is so high and it shows that the region is limy. In terms of agricultural perspectives, the amount of carbon in organic material is so important. The analyzed soil samples in this regard have 1 percent organic carbon that is relatively appropriate. The amount of absorbable phosphor in analyzed soil samples are categorized in undesirable classes.

The effect of edafic factors on the active ingredients of Z.Clinopodioides plant essential oil

The effect of region soil EC on the plant active

ingredient (essential oil).

According to the obtained results, no any correlation was seen between the region soil EC and the percent of essential oil and the amount of PULEGONE and Menthone. While only between soil EC and the amount of p-Menth-3-en-8-ol a negative correlation was seen; it means by increasing of soil EC amount, this compound decreased. (tables 6,7,8 and9).

Table 10. The correlation between soil pH and the percent of essential oil in 3 regions of Abadeh county , Boul Mountain and Dashte Arzhan.

		PH	percent of essential
PH	Pearson Correlation	1	-.909(**)
	Sig. (2-tailed)	.	.001
	N	9	9
percent of essential	Pearson Correlation	-.909(**)	1
	Sig. (2-tailed)	.001	.
	N	9	9

** Correlation is significant at the 0.01 level (2-tailed).

Table 11. The correlation between soil EC and amount of Pulegone in 3 regions of Abadeh county , Boul Mountain and Dashte Arzhan.

		PH	Pulegone
PH	Pearson Correlation	1	-.240
	Sig. (2-tailed)	.	.533
	N	9	9
Pulegone	Pearson Correlation	-.240	1
	Sig. (2-tailed)	.533	.
	N	9	9

Tabel 12. The correlation between soil EC and the amount of p-Menth-3-en-8-ol in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		PH	p-Menth-3-en-8-ol
PH	Pearson Correlation	1	-.297
	Sig. (2-tailed)	.	.437
	N	9	9
p-Menth-3-en-8-ol	Pearson Correlation	-.297	1
	Sig. (2-tailed)	.437	.
	N	9	9

The effect of soil pH on active ingradients (essential oil)of Z. clinopodioides plant

According to the results fo tables (10,11,12 and 13) between soil pH and the percent of essential oil, a significant correaltion was seen; that the correlation was negative; it means by increasing pH, the percent of essential oil decreasesd. Among existing compounds, the only posetive correlation was seen between pH and amount of Menthone; it means by increasing pH, the amount of Menthone increased. And finally between the 2 other comounds and soil pH no any correlation was observed.

Table 13. The correlation between soil EC and the amount of Menthone in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		PH	Menthone
PH	Pearson Correlation	1	.835(**)
	Sig. (2-tailed)	.	.005
	N	9	9
Menthone	Pearson Correlation	.835(**)	1
	Sig. (2-tailed)	.005	.
	N	9	9

** Correlation is significant at the 0.01 level (2-tailed).

Table 14. The correlation between organic carbon density and the percent of essential oil in 3 regions of Abadeh county , Boul Mountain and Dashte Arzhan.

		oc	percent of essential
oc	Pearson Correlation	1	-.129
	Sig. (2-tailed)	.	.741
	N	9	9
percent of essential	Pearson Correlation	-.129	1
	Sig. (2-tailed)	.741	.
	N	9	9
		oc	Pulegone
oc	Pearson Correlation	1	.817(**)
	Sig. (2-tailed)	.	.007
	N	9	9
Pulegone	Pearson Correlation	.817(**)	1
	Sig. (2-tailed)	.007	.
	N	9	9

Table 15. The correlation between organic carbon density and the amount of PULEGONE in 3 regions of Abadeh county , Boul Mountain and Dashte Arzhan.

** Correlation is significant at the 0.01 level (2-tailed).

		oc	Pulegone
oc	Pearson Correlation	1	.817(**)
	Sig. (2-tailed)	.	.007
	N	9	9
Pulegone	Pearson Correlation	.817(**)	1
	Sig. (2-tailed)	.007	.
	N	9	9

** Correlation is significant at the 0.01 level (2-tailed).

The effect of organic carbon density on the active ingredients(essential oil) of Z. clinopodioides plant

According to the tabled (14,15,16 and 17) no any correlation was seen between soil organic carbon density and the percent of essential oil. While between the soil organic carbon density and the amount of p-Menth-3-en-8-ol there was a negative correlation; it means by increasing the amount of soil organic carbon, the amount of p-Menth-3-en-8-ol decreased; and a positive correlation was seen between the amount of soil organic carbon density and PULEGONE; it means by increasing of soil organic carbon density, the amount of PULEGONE increased as well.

Table 16. The correlation between soil organic carbon density and the amount of p-Menth-3-en-8-ol in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		oc	p-Menth-3-en-8-ol
oc	Pearson Correlation	1	-.987(**)
	Sig. (2-tailed)	.	.000
	N	9	9
p-Menth-3-en-8-ol	Pearson Correlation	-.987(**)	1
	Sig. (2-tailed)	.000	.
	N	9	9

** Correlation is significant at the 0.01 level (2-tailed).

Table 17. The correlation between soil organic carbon density and amount of Menthone in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		oc	Menthone
oc	Pearson Correlation	1	-.055
	Sig. (2-tailed)	.	.888
	N	9	9
Menthone	Pearson Correlation	-.055	1
	Sig. (2-tailed)	.888	.
	N	9	9

Table 18. The correlation between soil phosphor density and the percent of essential oil in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		p	percent of essential
p	Pearson Correlation	1	.316
	Sig. (2-tailed)	.	.408
	N	9	9
percent of essential	Pearson Correlation	.316	1
	Sig. (2-tailed)	.408	.
	N	9	9

The effect of soil phosphor density on active ingredients(essential oil) of Z. clinopodioides plant

According to the tables (18,19,20 and 21) between soil phosphor density and the percent of essential oil and also between phosphor density and 3 main compounds of the plant, no any significant correlation was seen.

The effect of soil lime amount on active ingredients (essential oil) of Z. clinopodioides plant

According to the table (22, 23,24 and 25) a positive correlation is between the soil lime amount and the percent of essential oil; it means by increasing the soil lime amount, the percent of essential oil increased. Among the main compounds, a correlation was seen between lime and the amount of Menthone that was negative, it means by increasing of soil lime amount, the amount of Menthone decreased.

Table 19. The correlation between soil phosphor density and the amount of PULEGONE in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		P	Pulegone
P	Pearson Correlation	1	.295
	Sig. (2-tailed)	.	.442
	N	9	9
Pulegone	Pearson Correlation	.295	1
	Sig. (2-tailed)	.442	.
	N	9	9

Table 20. The correlation between soil phosphor density and the amount of p-Menth-3-en-8-ol in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		P	p-Menth-3-en-8-ol
P	Pearson Correlation	1	.024
	Sig. (2-tailed)	.	.951
	N	9	9
p-Menth-3-en-8-ol	Pearson Correlation	.024	1
	Sig. (2-tailed)	.951	.
	N	9	9

Table 21. The correlation between soil phosphor density and the amount of Menthone in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		P	Menthone
P	Pearson Correlation	1	-.462
	Sig. (2-tailed)	.	.211
	N	9	9
Menthone	Pearson Correlation	-.462	1
	Sig. (2-tailed)	.211	.
	N	9	9

Table 22. The correlation between soil lime amount and the percent of essential oil in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		Lime	percent of essential
Lime	Pearson Correlation	1	.807(**)
	Sig. (2-tailed)	.	.009
	N	9	9
percent of essential	Pearson Correlation	.807(**)	1
	Sig. (2-tailed)	.009	.
	N	9	9

** Correlation is significant at the 0.01 level (2-tailed).

Table 23. The correlation between soil lime amount and the amount of pulegone in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		Lime	Pulegone
Lime	Pearson Correlation	1	.492
	Sig. (2-tailed)	.	.178
	N	9	9
Pulegone	Pearson Correlation	.492	1
	Sig. (2-tailed)	.178	.
	N	9	9

The effect of soil texture on active ingredient (essential oil) of Z. clinopodioides plant

According to the tables (26 and 27) between the component compounds of soil texture (the percent of sand, clay and silt) and the percent of essential oil, no any correlation was observe. Between the sand amount, clay and silt and density of pulegone and p-Menth-3-en-8-ol a significant correlation was seen. As between sand and PULEGONE amount a negative correlation was seen; it means by increasing of the sand amount, the amount of PULEGONE decreased. Also between sand and amount of p-Menth-3-en-8-ol, a positive correlation was seen; it means by increasing of sand, the amount of p-Menth-3-en-8-ol increased as well. Then between the percent of clay and silt with the amount of pulegone a positive correlation was seen; and with the compound of p-Menth-3-en-8-ol a negative correlation was observed.

Table 24. The correlation between soil lime amount and the amount of p-Menth-3-en-8-ol in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		Lime	p-Menth-3-en-8-ol
Lime	Pearson Correlation	1	.006
	Sig. (2-tailed)	.	.988
	N	9	9
p-Menth-3-en-8-ol	Pearson Correlation	.006	1
	Sig. (2-tailed)	.988	.
	N	9	9

Table 25. The correlation between soil lime amount and the amount of Menthone in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		Lime	Menthone
Lime	Pearson Correlation	1	-.707(*)
	Sig. (2-tailed)	.	.033
	N	9	9
Menthone	Pearson Correlation	-.707(*)	1
	Sig. (2-tailed)	.033	.
	N	9	9

* Correlation is significant at the 0.05 level (2-tailed).

Table 26. The correlation between soil texture components and the percent of essential oil in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

			percent of essential	sand
percent of essential		Pearson Correlation	1	-.106
		Sig. (2-tailed)	.	.785
		N	9	9
sand		Pearson Correlation	-.106	1
		Sig. (2-tailed)	.785	.
		N	9	9
			percent of essential	clay
percent of essential		Pearson Correlation	1	.019
		Sig. (2-tailed)	.	.962
		N	9	9
clay		Pearson Correlation	.019	1
		Sig. (2-tailed)	.962	.
		N	9	9
			percent of essential	silt
percent of essential		Pearson Correlation	1	.019
		Sig. (2-tailed)	.	.962
		N	9	9
silt		Pearson Correlation	.019	1
		Sig. (2-tailed)	.962	.
		N	9	9

The effect of height from sea level on the active ingredients (essential oil) of Z. clinopodioides plant

By calculating Pierson correlation coefficient it was determined that among the considered parameters of physiographic, a significant relation is between the height from sea level and the percent of essential oil efficiency. It means by increasing the height, the percent of essential oil increased. The most percent of

essential oil is related to the height of 2500 m of Boul Mountain site. Among the compounds of essential oil, a significant correlation is between the amount of p-Menth-3-en-8-ol and the height. As by increasing height, the amount of mentioned compound increase as well. Tables (28,29,30 and 31).

Table 27. The correlation between soil texture components and the amount of PULEGONE in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		Pulegone	Menthone	p-Menth-3-en-8-ol
sand	Pearson Correlation	-.930(**)	.278	.964(**)
	Sig. (2-tailed)	.000	.469	.000
	N	9	9	9
clay	Pearson Correlation	.893(**)	-.198	-.980(**)
	Sig. (2-tailed)	.001	.609	.000
	N	9	9	9
silt	Pearson Correlation	.893(**)	-.198	-.980(**)
	Sig. (2-tailed)	.001	.609	.000
	N	9	9	9

** Correlation is significant at the 0.01 level (2-tailed).

Table 28. The correlation between height and percent of essential oil in 3 regions of Abadeh county , Boul Mountain and Dashte Arzhan.

		percent of essential	height
percent of essential	Pearson Correlation	1	.725(*)
	Sig. (2-tailed)	.	.027
	N	9	9
height	Pearson Correlation	.725(*)	1
	Sig. (2-tailed)	.027	.
	N	9	9

* Correlation is significant at the 0.05 level (2-tailed).

Table 29. The correlation between height and amount of pulegone in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		height	Pulegone
height	Pearson Correlation	1	-.207
	Sig. (2-tailed)	.	.593
	N	9	9
Pulegone	Pearson Correlation	-.207	1
	Sig. (2-tailed)	.593	.
	N	9	9

Discussion

Based on the study on this plant in 3 mentioned regions, it was determined that the studied specious spread in a height between 1900 to 2500 m and its most distribution is in the range with the height more than 2200 m. Also by calculating Pierson correlation coefficient, it was determined that between the height and the percent of essential oil of *Z. clinopodioides* Lam. specious, there is a positive and significant correlation and the most percent of essential oil allocated to the height of 2500 m, It means since the height increases, the percent of essential oil in this specious will increase as well. The results of this research regarding the effect of height on plant active ingredients is comply with the obtained results of the study done by Mahmood Zadeh *et al*. (2014) on the plant of *Marrubium vulgare,* Mir Azadi and Pileh Var (2013) on the plant of M*yrthus communis* L., Azimi

(2009) *and* Akhondi (2006) regarding *Z. clinopodioides* plant; Habibi *et al.* (2006) on wild thyme plant; Karimi *et al.* (2010) regarding *Thymus daenesis* plant, Aiseh (2011) about the plant of *Thymus praecox* and Fatima Evada *et al.* (2012) on *Origanum syrixcum* plant as well. Among the compounds of this plant in each of 3 regions, it was determined that the compounds of pulegone،p-Menth-3-en-8-ol and Menthone are as the major compounds of this plant. But its main and most important compound is pulegone.

Table 30. The correlation between height and amount of p-Menth-3-en-8-ol in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		height	p-Menth-3-en-8-ol
height	Pearson Correlation	1	.719(*)
	Sig. (2-tailed)	.	.029
	N	9	9
p-Menth-3-en-8-ol	Pearson Correlation	.719(*)	1
	Sig. (2-tailed)	.029	.
	N	9	9

* Correlation is significant at the 0.05 level (2-tailed).

Table 31. The correlation between height and the amount of Menthone in 3 regions of Abadeh County , Boul Mountain and Dashte Arzhan.

		height	Menthone
height	Pearson Correlation	1	-.565
	Sig. (2-tailed)	.	.113
	N	9	9
Menthone	Pearson Correlation	-.565	1
	Sig. (2-tailed)	.113	.
	N	9	9

The obtained results of this study are consistent with the findings of previous conducted studies on genus and specious of *Z. clinopodioides*; and according to them, the essential oil has a significant amount of pulegone. For example the most essential oil compounds of the mentioned plant are allocated to pulegone with the amount of 24.7(Baba Khanlo *et al*., 1998), 60.3 (Rezaei *et al*., 2001), 53.2 (Sajadi er al.2003), 45.8 (Salehi *et al*, 2005), 44.5 (Behravan *et al*,2007), 36.45 (Verdiani-rizi,2008), 65.2 (Sonboli *et al*,2006) 44.6 (Amiri,2009), 80.7 (Xing *et al*,2010) and 61.67 (Sardashti *et al*,2012) as well. p-Menth-3-en-8-ol was known as the second most important compound this finding was consistent with the obtained results of the study done by Modiri *et al*.(2013) on the essential oil chemical compounds of different sub specious of *Z. clinopodioides* Lam. in the diverse habitats in Iran. The obtained results of study on soil texture showed that the texture of soil is mean (sandy loam) and in terms of EC, that is lack of any salinity limitation. In terms of pH, the samples of analyzed samples, mainly are categorized in weak to mean alkaline class. This findings are comply with the obtained results of a study done by Celvandi (2003) on *Thymus ericalx* plant, Najafi (2004) regarding *Tanacetum polycephalum* plant, Hosheidari (2005) about *Salvia bracteata* and Dehghan *et al.* (2013) on *Z. clinopodioides* plant. In this paper the effect of edafic factors of EC, PH, organic carbon density, phosphor, the amount of soil lime and component compounds of soil texture on essential oil efficiency and 3 important compounds of plant was reviewed;

and it was determined that between the amount of EC and the density of p-Menth-3-en-8-ol compound, there is a negative correlation. It shows the negative effect of soil EC on the amount of p-Menth-3-en-8-ol compound; and is a good guidance for choosing appropriate fields to culture this specious for producing essential oil. Also there is a correlation between soil pH and the percent of essential oil and the amount of Menthone, that Mahmood Zadeh *et al.* (2014) by study on the effect of ecological features on the essential oil quality of *Marrubium vulgare* medicinal plant got this result. The obtained results of the study on the correlation between soil organic carbon and amount of two compounds of pulegone and p-Menth-3-en-8-ol and the correlation between soil pH and the percent of essential oil are comply with the research results of a study done by Azarnvand *et al.*(2009) about yarrow plant.

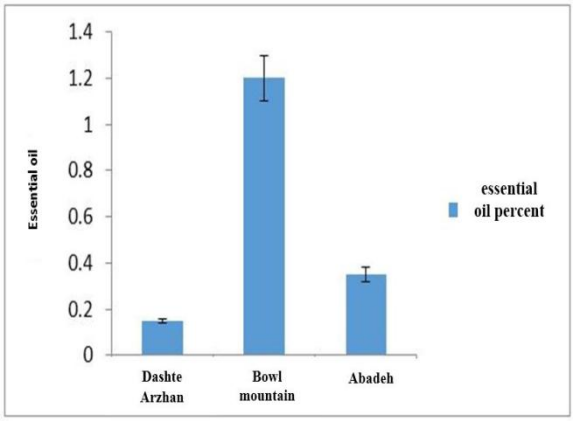

Fig. 1. The comparison of essential oil percent in 3 studied regions (Mean+SE).

Conclusion

As a whole the results of this study confirm this matter that the ecologic parameters of rangeland ecosystems including height and soil can affect their essential oil quality and by reputing the above mentioned study on other habitats of *Z. clinopodioides* Lam. plant, it will be possible to identify the appropriate environmental conditions for obtaining the maximum amount of essential oil.

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