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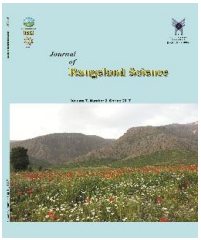

Research and Full Length Article:

Identification of Some Ecological Factors Affecting Essential Oil of *Verbascum songaricum* Schrenk Shoots (Case Study: Rangelands of Isfahan and Kohgiluyeh and Buyerahmad Provinces, Iran)

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Abstract. The effect of environmental factors on plant vegetation is different. Therefore, it is necessary to evaluate role of these factors in medicinal plants growth, development and essential oil. This study was performed to investigate the effect of factors on qualitative and quantitative variations of the essential oil of *Verbascum songaricum* in its habitats in central Zagros Mountains, Iran in 2012. *V. songaricum* aerial biomass was collected in flowering stages from four rangeland sites in Isfahan (Dareh Hose, Ghahiz, Ghaleghadam, Semirom) and one site in Kohgiluyeh, and Buyerahmad (Dena) provinces, Iran. The samples were dried in open air and their essential oils were extracted through digestion method. Gas Chromatography Mass Spectroscopy (GC-MS) was used to identify essential oil composition as Alcohol, Hydrocarbon, Amin, Acid, Ester and Ketone of species in five sites. The most important environmental factors such as climate, and physiographic, soil physical and chemical properties were determined. In order to investigate the relationship between environmental factors and plant essential oil, Ordination analysis was performed using Redundancy Analysis (RDA). The results of correlation analysis indicated that the most important environmental factors affecting the essential oil were annual rainfall (r=0.86), frozen days (r=0.86), Aridity index (r=0.86), Altitude (r=0.86), gravel (r=0.74), nitrogen (r=0.78), organic matter (r=0.62) and soil texture (r=0.68). Results showed that there was an increase in essential oil production in *V. songaricum* under semi-arid cold climate, uplands, higher precipitation, relatively light texture and fertile soil. According to RDA analysis, two habitats were identified. The first habitat was more appropriate for essential oil production of *V. songaricum* (Dareh Hose, Semirom and Dena) in comparison with the second one (Ghahiz and Ghaleghadam). As a result, the first habitat was considered as a suitable natural place for the cultivation and domestication of *V. songaricum.*

Key words: *Verbascum songaricum*, Ecological factors, Ordination analysis, Zagros

Introduction

In recent years, drugs made from medicinal plants have increased due to their lower side effects, cost and patient compliance (Yavari *et al.,* 2011). Iran with a high position for its phylogenetical reserves (7500 plant species), climate (11 of 13 types of world climate) and political geography conditions has important habitats in the field of medicinal plants (Jahantab *et al.,* 2011). Due to the global interest in the consumption of medical plants and natural compounds in pharmaceutical, cosmetic and food industries, there is priority to do basic researches in this field (Akbarlou and Nodehi, 2016). Although the rate of secondary metabolites is controlled by genes, the rates of concentration and their accumulation are considerably influenced by environmental conditions (Yanive and Palevitch, 1982). Essential oil quality and quantity are extremely dependent on the climate conditions. In *Ferula assa-foetida*, its physicochemical characteristics are determinant factors in secondary metabolites composition especially for the quality of volatiles (Moghadam and Farshid, 2015). As the effects of environmental factors on plant growth are different, it is necessary to evaluate the role of these factors in medicinal plants growth, development and essential oil. The environmental factors as light, temperature, rainfall, length of day, latitude, soil properties, altitude and nutrition have a major impact on the quality and medicinal essential oil (Alirezalu *et al.,* 2014). Generally, environmental factors including climatic characteristics, topography and soil fertility have a great impact on plant growth and quantity and quality of essential oil of medicinal plants (Saharkhiz, 2002).

In several species of medicinal plants, the occurrence of geographic variations of volatiles quantity and quality and the existence of distinct chemotypes were reported. The variations in the essential oils of *Lychnophora ericoides* (Curado *et al.,* 2006), *Thymus carnosus* (Miguel *et al.,* 2005), *Crithmum maritimum* (Ozcan *et al.,* 2006), and *Cryptomeria fortunei* (Xie *et al.,* 2012) of different origins can be given. The different essential oil compositions of a species found in different origins could reflect various environmental conditions of each particular location and growth condition. Also, numerous studies showed that environmental parameters such as temperature, moisture and soil can affect the essential oil production as well as their quality (Falzari *et al.,* 2006; Gotsiou *et al.,* 2002; Loziene and Venskutonis, 2005). In a study in Isfahan, Iran, Ghomeshi Bozorg (2008) indicates that quality of gum *Astragalus spp.* differs according to environmental conditions of habitat. She also found that its carbohydrates production varies with climatic factors such as temperature, evaporation, and evapotranspiration. Moreover, the dry and rainfall periods had positive and negative correlations with respect to carbohydrates concentration, respectively. Afifian (2011) found that the increasing of alkaloids production of *Fritillaria imperialis* species in cold and humid climates and calcareous soils (slightly alkaline) with medium texture and relatively fertile. In a sustainable agronomy system, we not only should focus on increasing performance but also we should focus on the preservation, survival and sustainability of this system in the use of proper management in the nutrient cycle and the judicious use of organic and biological resources.

Iran's natural habitats are regarded as valuable resources for medicinal plants production plants in nature. However, the direct and incorrect use of these plants in nature leads to the eradication and extinction of some important plants. So, it is recommended to use these plants in their natural habitat as a pattern of

localization. Regarding the recognition of native medicinal plants or plants good adapted to some ecological areas of Iran, it is possible to make domestication and cultivation in large scale to take production on commercial scale (Emadian and Mirnia, 1999). The environmental factors improve the growth of medicinal plants and the quality and quantity of their essential oil; so, it produces more when its metabolites are desirable. Therefore, by choosing the environmental factors and suitable plant varieties, the maximum production can be achieved (Habibi *et al.*, 2007).

Verbascum spp. is the largest genus of family of Scrophulariaceae (Emam, 2010). This genus of plants is called Mullen in English (Mirhaidar, 2005). *V. songaricum* is herbaceous perennial with the height of to 1.5 m. The genus *Verbascum* contains 42 species and 14 endemic species have been found in Iran (Kheiri, 2010).

This study aims to identify the environmental factors affecting the quality and quantity of essential oil of different organs (flowers, leaves and stems) of *V. songaricum* in the central Zagros through identifying the ecological factors affecting the plant essential oil composition and to provide information for researchers and administrators when there is a need to cultivate and localize this plant.

Materials and Methods

Plant material

Plant samples were taken from 4 rangeland sites (Dareh hoz, Ghahiz, Semirom, Ghaleh ghadam) in Isfahan province and one site (Dena) in Kohgiluyeh and Buyerahmad province, Iran (Fig. 1). In all habitats, samples were taken by a random-systematic method along with the located transects (3 transects). Plant materials consists of leaves, flowers and stems of *V. songaricum* taken in the flowering stage. Three plants were collected from each transect and cut from the collar located in the special packages and the plants were identified using a scientific source.

Habitat characteristics

Sites characteristics such as altitude, aspect, longitude, and latitude were detrained using GPS. Moreover, climatic characteristics including average annual precipitation, the number of annual freezing days, average annual temperature, maximum and minimum temperature, annual evaporation, and annual evapotranspiration were determined using the nearest meteorological stations. During the dry period, Ambrgeh Moisture coefficient and Demarton Aridity coefficient were determined through empirical relationships.

At the same time, soil samples were taken in the root depth of plants (rhizosphere) in the studied sites and the most important physicochemical properties of soil including soil gravel with volumetric percent method (Page and Keeny, 1992), soil texture with hydrometer method (Bouyoucos, 1962), Soil acidity (pH) and Electrical Conductivity (EC) were estimated from the saturated soil paste extract (Kalra and Maynard, 1991). Soil organic matter with titration method (Nelson, 1982), Cation Exchange Capacity (CEC) with Bower method (Bower *et al*., 1952), Soil Nitrogen by Kjeldahl method (Bremmer and Mulvaney, 1982) and $Caco_3$% by titration method (Jafari Haghighi, 2003) were measured.

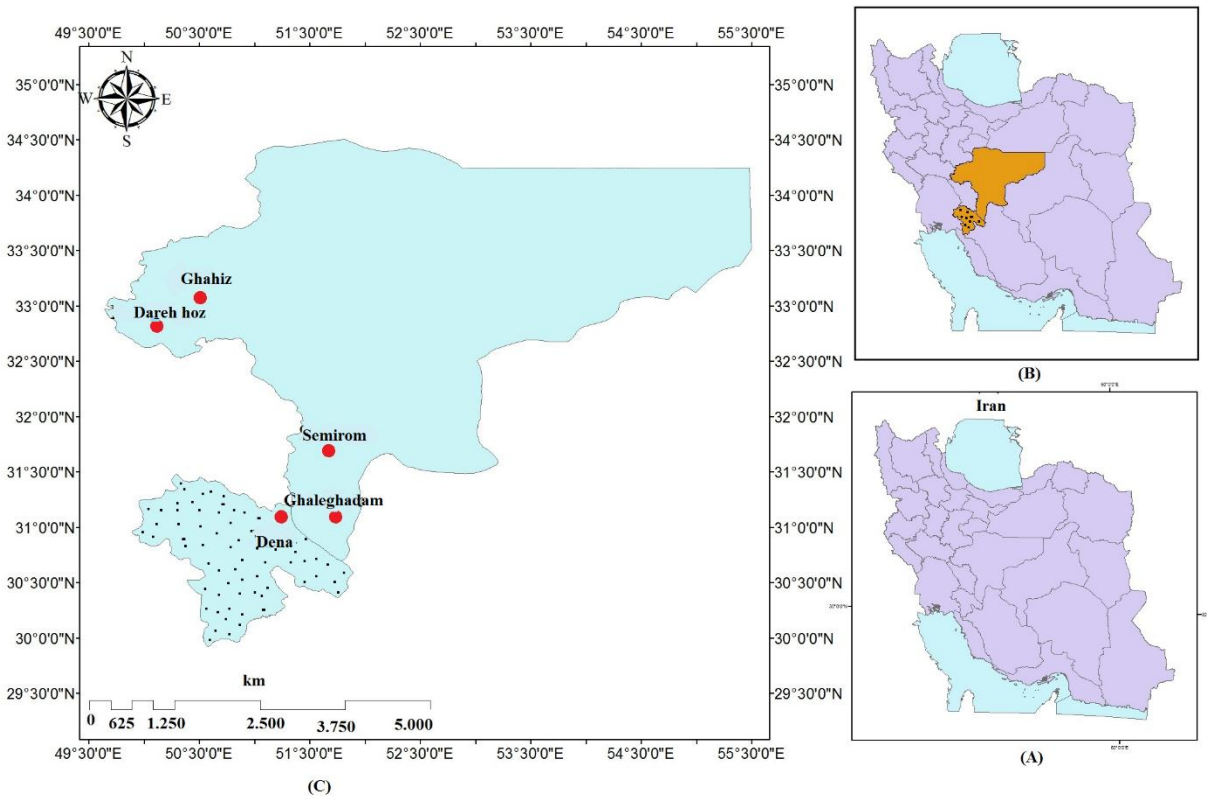

Fig. 1. The location of the study areas (C) in Isfahan and Kohgiluyeh and Buyerahmad Province (B), and Iran (A)

Table 1. Habitat characteristics of 5 rangeland sites in Isfahan (Dareh Hose, Ghahiz, Ghaleghadam, Semirom) and Kohgiluyeh and Buyerahmad (Dena) provinces

Rangeland Site	Altitude (m)	Latitude (N)	Longitude E)	Av. annual temperature.(◦C)	Annual precipitation(mm)	pH	Ec (ds/m)
Dareh hoz	2519	33°30′12″	49°58′55″	9.8	406.3	7.6	0.7
Ghahiz	2400	33°40′16″	52°37′09″	10.7	372.1	7.9	0.7
Semirom	2600	31°57′25″	51°27′34″	9.2	429.5	7.8	0.9
Ghaleghadam	2457	31°48′28″	51°42′25″	10.2	388.5	7.9	0.5
Dena	2900	30°34′52″	51°30′40″	6.9	515.5	7.8	0.9

Extracts preparation

Aboveground organs of *V. songaricum* were collected at flowering stage. The plants were transferred into herbarium of Isfahan University of Technology to be identified by botanists using valid scientific literatures. Then, samples were shadow dried. The extraction process was followed according to the digestion approach. Amount of 20 g dry powder from each organ of plants in each site was mixed separately in 208 cc of 96% alcohol ethanol with 184 cc distilled water and stirred for three hours. Then, vessels contents were filtered by filter paper. To be better filtered, the specimens were centrifuged in 3000 cycles per second. Then, the solution was poured into the beaker and placed in the evaporator device under vacuum in 45°C in moderate cycle to bring it into 6 cc (Armatu *et al.*, 2011).

Essence extraction and GC-MS analysis

The extracts were mixed with 12 cc ethanol, and passed through Decanto in which two phases were appeared. This operation was repeated four times until metabolites entered into bothanolic phase; after that, it was poured into the separator vessel and collected. Finally, it was stored in darkness under 4°C (Armatu *et al.*, 2011).

In this study to identify the composition of extracts (Alcohol,

Hydrocarbon, Amin, Acid, Ester and Ketone) in organs of the flower, leaf and stem, GC-MS (Gas Chromatography Mass Spectroscopy) was used at central laboratory (Isfahan University of Technology, Iran; GC/MS model Agilent Technologies).

Statistical analysis

To investigate the relationships between ecological factors and essential oil, multivariate statistical methods were used. In this study, to determine the type of the ordination method, Detrended Correspondence Analysis (DCA) was performed and the length of the gradient was measured (data of DCA is not shown). According to the length of the gradient (<4), Redundancy Analysis (RDA) was done by the software CANOCO version 4.5.

Results

Results of some important chemical compounds in the extracts of flowers, leaves and stems of *V. songaricum* species in five sites are presented in Table 2.

Higher and lower alcohol% in the flower extract with average values of 4.5% and 21.36% were obtained in Ghaleghadam and Dareh hoz sites, respectively. For Hydrocarbon, higher and lower values of 23.62%, and 51.39% were obtained in Dena and Semirom sites, respectively. For Amines compounds, higher value of 15.6% was obtained in Ghahiz rangeland. This compound was not available in Dena and Semirom rangelands extract. For Acid, higher and lower values of 15.77% and 25.79% were obtained in Ghahiz and Ghaleghadam sites, respectively. For Ester, higher and lower values of 11.03% and 36.05% were obtained in Semirom and Dena sites, respectively and For Ketone compounds, higher value of 6.88% was obtained in Ghahiz rangeland. This compound was not available in Ghaleghadam rangelands extract (Table 2).

For alcohol% in the leaves extract, higher and lower values of 24.13 and 7.24% were obtained in Ghahiz and Dareh hoz sites, respectively. For Hydrocarbon, higher and lower values of 25.89% and 50.43% were obtained in Semirom and Ghaleghadam sites, respectively. For Amines compounds, higher value of 6.27% was obtained in Dareh hoz rangeland. This compound was not available in Semirom and Dena rangelands extract. For Acid, higher and lower values of 12.5% and 25.5% were obtained in Ghahiz and Semirom sites, respectively. For Ester, higher and lower values of 30% and 11.51% were obtained in Semirom and Ghahiz sites, respectively. For Ketone, higher and lower values of 15.6% and 3.5% were obtained in Ghahiz and sites Dareh hoz, respectively (Table 2).

Results of extracts of stems are presented in Table 2. Higher and lower alcohol% of stems extract with values of 17 and 7 were obtained in Ghaleghadam and Dena sites, respectively. For Hydrocarbon, higher and lower values of 34.6% and 3.56% were obtained in Dena and Ghahiz sites, respectively. For Amin, higher and lower values of 9% and 2.59% were obtained in Dena and Dareh hoz sites, respectively. For Acid, higher and lower values of 29% and 21.17% were obtained in Semirom and Ghahiz sites, respectively. For Ester, higher and lower values of 27.34% and 13.85% were obtained in Dena and Ghaleghadam sites, respectively and For Ketone compounds, higher value of 17.89% was obtained in Ghaleghadam rangeland. This compound was not available in Dena rangelands extract.

In comparison between the sites average for different organs, results showed that the highest alcohol in the leaves, the highest hydrocarbons in the leaves and the flowers, the highest Amin in flower and the highest acids, ester and ketone were obtained in the stem (Table 2).

Table 2. The most important chemical compounds existing in the extracts of flowers, leaves and stems of *V. songaricum* species in the studied sites

Plants organ	sits	Alcohol%	Hydrocarbon%	Amin%	Acid%	Ester%	Ketone%
Flowers	Dareh hoz	21.36	25.96	3.50	22.55	20.45	6.15
	Ghahiz	8.00	37.56	15.6	15.77	16.00	6.88
	Semirom	17.07	51.39	-	17.58	11.03	2.80
	Ghaleghadam	4.50	47.62	5.5	25.79	16.40	-
	Dena	14.07	23.62	-	23.02	36.05	3.22
	Means±SE	11.4±1.95	35.1±3.87	6.7±1.55	20.9±1.59	18.5±2.58	5.1±0.69
Leaves	Dareh hoz	7.24	47.87	6.27	19.00	16.1	3.5.0
	Ghahiz	24.13	33.49	2.60	12.50	11.51	15.60
	Semirom	12.58	25.89	-	25.50	30.00	6.00
	Ghaleghadam	17.20	50.43	2.00	13.22	12.00	5.14
	Dena	16.19	31.05	-	23.01	17.98	11.63
	Means±SE	15.0±2.09	34.1±3.12	4.1±0.82	18.6±2.22	17.5±2.88	8.3±1.95
Stems	Dareh hoz	9.69	26.00	2.59	24.87	22. 20	14.81
	Ghahiz	15.70	3.56	7.00	21.17	18.00	7.40
	Semirom	7.49	29.50	4.35	29.00	24.90	4.61
	Ghaleghadam	17.00	25.79	3.00	22.47	13.85	17.89
	Dena	7.00	34.60	9.00	21.87	27.34	-
	Means±SE	11.3±1.80	27.9±1.64	5.1±1.05	23.8±1.22	20.8±2.07	10.1±2.20

Relationship of essential oil and environmental factors

Plant extract data analysis and environmental factors (climate, soil and topography) using RDA showed that the first and second principal components account for 39.6% and 31.5% of variations (Table 3). According to the data in Table 4, environmental factors such as minimum temperature, maximum temperature, annual precipitation, soil organic matter, gravel soil, nitrogen, demarton aridity coefficient, number of freezing days, altitude and ambrgeh moisture coefficient are positively correlated with the first axis with correlation coefficient values ranged from 0.62 to 0.87. In contrast, annual potential evapotranspiration, annual evaporation, average annual temperature and dry period are negatively correlated with the first axis with correlation coefficient values ranged from -0.84 to -0.86 (Table 4). The sandy loam and sandy clay loam had a negative and positive correlation (r=-0.68 and r=0.68) with the second axis, respectively. Soil pH and the eastern and southern aspects showed (r=0.75, r=-0.76, r=0.76) a correlation with the third axis, respectively. Caco3% and Cation exchange capacity showed a positive (r=0.60 and r=0.78) correlation with the fourth axis (Table 4).

Table 3. The eigenvalues of the four axes in the ordination of qualitative indicators of chemical compounds environmental factors of rangeland sites using RDA

Axis	Axis1	Axis2	Axis3	Axis4
Eigen values	0.396	0.315	0.215	0.074
Correlation coefficient	98.20	95.02	90.32	88.23
Percent of variance	39.60	31.50	21.50	7.4.00
Percent of cumulative variance	39.60	71.10	92.60	100.0

Table 4. Correlation coefficient axes with environmental factors

Environmental Factors	Abbreviation	Axis1	Axis2	Axis3	Axis4
Average Minimum Temperature	AMT2	**0.865**	0.094	0.059	-0.482
Average Maximum Temperature	AMT1	**0.866**	0.111	0.052	-0.484
Average Annual Precipitation	AAP	**0.869**	-0.107	-0.058	0.479
Soil Organic Matter	SOM	**0.624**	-0.192	-0.656	0.375
Gravel Soil	GS	**0.749**	-0.587	0.158	-0.284
Nitrogen	N	**0.787**	-0.215	-0.252	0.517
Demarton Aridity Coefficient	DAC	**0.863**	-0.133	-0.014	0.486
Number of Freezing Days	FD	**0.869**	-0.107	-0.059	0.477
Altitude	A	**0.869**	-0.107	-0.057	0.479
Ambrgeh Moisture Coefficient	AMC	**0.871**	-0.111	-0.051	0.474
Annual Potential Evapotranspiration	APE	**-0.869**	0.117	0.057	-0.479
Annual Evaporation	AE	**-0.868**	0.112	0.050	-0.480
Average Annual Temperature	AAT	**0.858**	0.115	0.057	-0.496
Dry Period	DDP	**-0.845**	**-0.657**	0.151	-0.508
Clay%	C	**-0.546**	**0.543**	-0.36	0.522
Sandy Loam	SL	0.453	**-0.686**	0.292	-0.488
Sandy Clay Loam	SCL	-0.453	**0.686**	-0.292	0.448
East Aspect	EA	0.181	0.384	**-0.762**	-0.487
South Aspect	SA	-0.181	-0.384	**0.762**	0.487
Soil pH	PH	-0.374	0.300	**0.755**	0.445
Caco3%	Ca	-0.474	0.231	**0.599**	**0.601**
Cation Exchange Capacity	CEC	0.443	0.303	-0.317	**0.781**

The bold and underlined values had significant correlation with the relevant axes

Biplot of the first two axes ordination of RDA

Biplot of the first two axes ordination for environment and plant organ essential oil composition is scatted in Fig. 2. It is clear that the studied sites were spitted into two major habitats showing Semirom, Dena and Dareh hoz on the right side of the chart, and Ghahiz and Ghaleghadam on the left side of the chart. Environmental factors such as eastern aspect, cation exchange capacity, annual precipitation, Ambrgeh moisture coefficient, the number of freezing days, altitude, Demarton aridity coefficient, nitrogen, soil organic matter, gravel, and sandy loam soil had separated two habitats.

According to Fig. 2, the combination of Stem Acid (SA), Leaf Esther (LE), Flower Alcohol (FAL), Leaf Acid (LA), Stem Esters (SE), Stem Hydrocarbons (SH), Stem Amin (SA), Leaf Ketone (LK), Flower Ketone (FK) and Flower Ester (FE) was positively correlated with the environmental factors on the right side of the chart such as Cation Exchange Capacity (CEC), East Aspect (EA), Annual Precipitation (AAP), Ambrgeh Moisture Cof. (AMC), Altitude (A), Demarton Aridity Cof. (DAC), Freezing Days (FD), Nitrogen (N), Soil Organic Matter (SOM), Gravel Soil (GS) and Sandy Loam (SL). flowers Hydrocarbons (FH), Leaf Alcohol (LAL), Flower Amin (FAM), Flower Acid (FA), Stem Alcohol (SAL), Stem Ketones (SK), Leaf Hydrocarbons (LH) and Leaf Amin (LAM) had s positive correlation with the environmental factors on the left side of the chart including Sandy Clay Loam (SCL), Clay (C), pH (SAC), caco3 (Ca), annual temperature (AAT), maximum temperature (AMT1), annual evaporation (AE), annual potential evapotranspiration (APE), minimum temperature (AMT2), during dry period (ddp) and south aspect (sa).

Therefore, environmental factors and essential oil indicators on the right side of the chart, and the environmental factors and essential oil indicators on the left side of the chart had a negative correlation in an inverse manner.

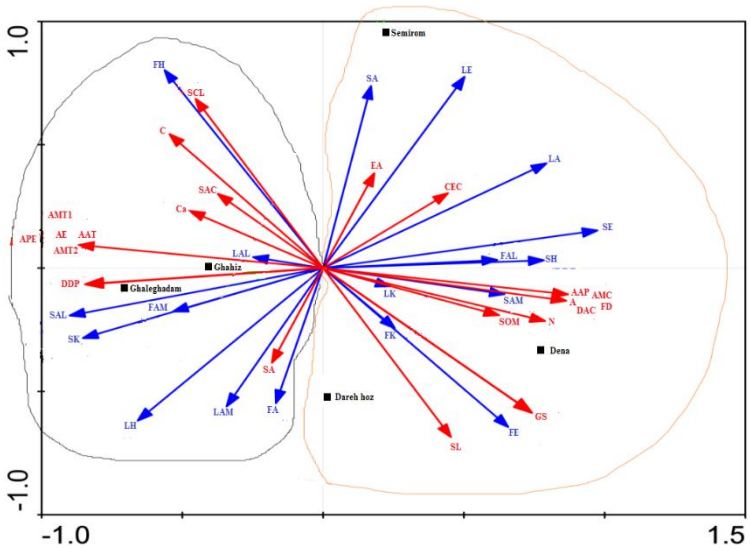

Fig. 2. Biplot of the first two axes ordination for environment and plant organ essential oil composition of *Verbascum songaricum*). The red arrows = environmental factors and blue arrows= essential oil composition:

A	Altitude	EA	East Aspect	LH	Leaf Hydrocarbon
AAP	Annual Precipitation	FA	Flower Acid	LK	Leaf Ketone
AAT	Annual Temperature	FAl	Flower Alcohol	N	Nitrogen
AE	Annual Evaporation	FAm	Flower Amin	SA	South Aspect
AMC	Ambrgeh Moisture Cof.	FD	Freezing Days	SA	Stem Acid
AMT1	Maximum Temperature	FE	Flower Ester	SAc	pH
AMT2	Minimum Temperature	FH	Flower Hydrocarbon	SAl	Stem Alcohol
APE	Evapotranspiration	FK	Flower Ketone	SAm	Stem Amin
C	Clay%	GS	Gravel Soil	SCL	Sandy Clay Loam
Ca	Caco3%	LA	Leaf Acid	SE	Stem Ester
CEC	Cation	LAl	Leaf Alcohol	SH	Stem Hydrocarbon
DAC	Demarton Aridity Cof	LAm	Leaf Amin	SK	Stem Ketone
DDP	Dry Period	LE	Leaf Ester	SL	Sandy Loam
				SOM	Soil Organic Matter

Discussion

Currently, different countries conducted the studies and extensive researches on the extraction of the secondary essential oil in different species of medicinal plants. This research aimed to identify plants with important compounds which are useful in the disease treatment or can be used in different industries such as a natural material utilized in the production of low risk and effective drugs. Although many studies had dealt with aromatic and medicinal species, there is limit research on *V. songaricum*. Under the agricultural conditions and natural ecosystems, factors such as moisture, nutrients, light, altitude, etc. are major and determining factors in the essential oil production. Therefore, identifying the effective factors in the amount of composition of essential and the effectiveness of these compounds is of great importance (Mohamadian *et al.*, 2014).

In this study, results showed that essence compounds such as acids, esters, hydrocarbons and amines exist in the extracts of the stem, esters, acids and ketones in the extracts of leaves, ester, alcohol and ketone in the extract of flowers in the first habitat (Dareh hoz, Semirom and Dena) were higher than the second one (Ghahiz, Ghaleghadam). Diversity of these compounds in the second habitat was less, so that in the second habitat ester and acid composition of leaves and stems were not found. It seemed that there was an increase in the production of mentioned compounds in the organs of flowers, leaf and stem in the first habitat (Dareh hoz and Semirom and Dena) resulted from high pH conditions (7.6 to 8.7), high precipitation and long glacial period, sandy loam soils, medium texture of gravel, fertile soils under climate semi-arid and cold condition and

eastern slopes. As the result, it can be said as acid production was increased, ester compounds in different organs were increased accordingly. In total, according to the output ordination, it has been showed that environmental factors had not a similar effect on plant essential oil that is consistent with the results of Soleimani Meimand (2012) and Afifian (2011). Increasing the amount of nitrogen in the first habitat can be attributed to high organic matter because the main supply source of nitrogen is in organic matter (Azarnivand and Zare chahouki, 2008). In the habitats of Dareh hoz, Semirom and Dena, there was a better growth of the plant due to high organic matter that was the supply source of nitrogen. In the second habitats, alcohols, hydrocarbons and ketones found in the leaf extract, hydrocarbons, amines and acid in the flower extract, stem, alcohol and ketone were more than the first one. According to the environmental conditions, it seems that the production compounds listed in the organs of flowers, leaves and stem in the second habitats (Ghahiz and Ghaleghadam), in the habitat conditions with high lime percent, during long drought, high evapotranspiration, maximum temperature, sandy clay soil, limestone with medium texture, and high acidity increase. Soleimani Meimand (2012) in a phytochemical study (*Stachys lavandulifolia*) showed that there was an increase in alcoholic compounds of this plant in habitat conditions with high altitude, higher precipitation and longer glacial period which is inconsistent with the results of the present study. What is consistent with Soleimani Meimand's research is only the alcohol in the flower organs.

In habitats with cool, moist climate conditions, *V. songaricum* is able to produce higher essential oil which represents the cold-like plant. Moreover, the plant can produce mainly substances of acid and ester compounds under cold and wet climate conditions in effect of photosynthesis. Furthermore, it can protect the production of hydrocarbon compounds and amines under hot and somehow dry conditions and the lower part due to changes in metabolism and biochemical synthesis (Fazilati, 2010).

It seems that in the mountainous areas that the day and night variable temperature is higher than lower altitude areas with more moderate climate, thermal stress caused that *V. songaricum* plant could stimulate the synthesis of biochemical processes of some materials and consequently increased the production of compounds in such conditions (Omidbeygi, 1995). Environmental factors lead to some changes in the growth of medicinal plants, quantity and quality of their essential oil (Saharkhiz, 2002). It should be noted that due to location of Dena rangeland in the first habitat, the greatest amount of potassium is found. On the other hand, the coldest place in rangeland has been studied in terms of the production essential oil compounds' significant percentage of this place species.

Generally, the results of this study showed that the essential oil of *V. songaricum* in different ecological conditions varied considerably in line with Soleimani Meimand's results (2012) and Sepahvand (2009). Also, the result of this study is consistent with the results of Mohamadian *et al.* (2014) regarding the increasing impact of altitude and the relationship between soil physicochemical factors and *Thymus vulgaris* essential oil. In order to identify an important habitat for this plant in the Zagros, essential oil of this plant in different sites under different ecological conditions was studied. Therefore, the results suggested that the essential oil in the extract of this plant in the first habitat (Dareh hoz and Semirom and Dena) was higher than the second one (Ghahiz and Ghaleghadam).

So, the natural resource authorities and other responsible people can take necessary actions through making copy of the findings of this study with the policy of both preventing from the destruction of *V. songaricum* and helping the country's pharmaceutical industry.

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شناسایی برخی عوامل بوم‌شناختی تاثیر گذار بر مواد موثره اندام‌های هوایی گیاه دارویی ***Verbascum songaricum* schrenk** (مطالعه موردی: مراتع استان‌های اصفهان و کهگیلویه و بویراحمد)

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چکیده. تأثیر عوامل محیطی بر گیاهان مختلف متفاوت است و همواره باید با تحقیقات مناسب به بررسی نقش عوامل محیطی بر رشد، نمو و مواد موثره گیاهان دارویی پرداخت. این مطالعه با هدف بررسی تاثیر عوامل بوم‌شناختی بر تغییرات کمی و کیفی مواد موثره گل‌ماهور *Verbascum songaricum* در رویشگاه‌های طبیعی در سال۱۳۹۱ انجام شد. اندام‌های برگ و گل و ساقه گیاه در مرحله گلدهی از ۵ مکان مرتعی واقع در استان‌های اصفهان (دره حوض، قهیز، قلعه قدم و سمیرم) و کهگیلویه و بویراحمد (دنا) به عنوان نماینده زاگرس جمع‌آوری، در سایه خشک و عصاره آنها به روش هضم استخراج گردید. جهت شناسایی مواد موثره (الکل، هیدروکربن، آمین، اسید، استر و کتون) از دستگاه گاز کروماتوگرافی متصل به طیف‌سنج جرمی استفاده شد. در همه مکان‌های برخی خصوصیات محیطی شامل اقلیم، فیزیوگرافی و خصوصیات فیزیکوشیمیایی خاک اندازه گیری شد. به منظور بررسی رابطه بین عوامل محیطی و مواد موثره گیاه آنالیز رج بندی، به روش RDA انجام گرفت. نتایج همبستگی نشان داد مهمترین عوامل محیطی موثر بر مواد موثره شامل متوسط بارندگی سالانه (r=۰/۸۶)، روزهای یخبندان(r=۰/۸۶)، ضریب خشکی(r=۰/۸۶)، ارتفاع از سطح دریا (r=۰/۸۶)، سنگریزه (r=۰/۷۴)، نیتروژن(r=۰/۷۸)، ماده آلی(r=۰/۶۲) و بافت خاک(شنی رسی لومی) (r=۰/۶۸) بودند. به طورکلی با توجه به شرایط اقلیمی، خاک و فیزیوگرافیکی به نظر می‌رسد تولید عصاره در گیاه گل ماهور در شرایط اقلیمی نیمه‌خشک و سرد، مناطق مرتفع و متوسط بارندگی سالانه بالا، خاک نسبتا سبک و حاصلخیز، افزایش - یابد. نتایج تجزیه RDA پنج مکان مرتعی را به دو رویشگاه تجزیه نمود. با توجه شرایط اقلیمی مناسب در رویشگاه اول مواد موثره گل ماهور در این رویشگاه (مکان‌های مرتعی‌دره حوض، سمیرم و دنا) نسبت به رویشگاه دوم (مکان‌های مرتعی قهیز و قلعه قدم) بیشتر بود و رویشگاه اول را بعنوان مکان‌های طبیعی مناسب گل ماهور قلمداد شد تا از شرایط محیطی این رویشگاه به عنوان الگو جهت کشت و اهلی سازی گیاه دارویی گل ماهور استفاده شود.

کلمات کلیدی: گل ماهور، عوامل بوم‌شناختی، آنالیز رج‌بندی، زاگرس