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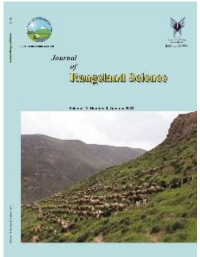

Research and Full Length Article:

Assessing Bioclimatic Characteristics on *Daphne mucronata* as a Medicinal Plant in Fars Province, Iran

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Abstract. Identification and assessment of the relationship between medicinal plant species and climatic factors are important lines of research, which provides insights into reasonable exploitation and sustainable development of these species. In addition, multivariate statistical methods have been proved successful in revealing the relationship between climatic factors and the distribution of plant species. Hence, this study aims to investigate bioclimatic characteristics of *Daphne mucronata* by determining climatic factors in its distribution range in Fars Province, Iran, in the year 2020, where this species has a wide spatial distribution (27% of the total area). Towards this aim, 50 climatic variables related to January, April and July were used. To reduce the number of variables and determine the most important factors, Factor Analysis and Principal Component Analysis (PCA) were used. The results showed that four principal components namely the temperature, precipitation, cloudiness, and wind components account for 38.56, 32.85, 11.03, and 9.09 % (91.54% in total) of data variance, respectively. The results also indicated that temperature and precipitation had the greatest impact on the species distribution. Moreover, the mean temperature within the species distribution range was about 15°C with minimum precipitation of 379 mm. This research identifies the characteristics of vegetative climate to determine the possibility of expansion and development of this plant in natural areas and provides better management.

Key words: *Daphne mucronata* Royle, Climatic variables, Fars province habitats

Introduction

Iranian rangelands with an area of 86 million ha cover the widest area of the country (about 54%), more than 70% of which are located in arid and semi-arid regions (RIFR, 2021). Generally, land-use of these rangelands in the country and overgrazing in these regions have often led to changes in the quantity and quality of vegetation and soil, increasing barren lands, and desertification expansion (Azarnivand *et al.*, 2009). Proper management and exploitation of rangelands require identifying the characteristics of the key species and determining the factors affecting their distribution (Azarnivand *et al.*, 2003).

A large part of Iran covered by mountainous areas due to its specific geographical location on Earth is under the influence of a variety of climates. Such variability along with its high topographical diversity across rangeland, forest, and desert areas has brought about a unique flora. (Fasihi, 1988). Plant species in Iran also have numerous industrial, medicinal, and nutritional values and play a pivotal role in export promotion, bringing many attentions towards forest and rangeland areas (Joneydi *et al.*, 2015).

Daphne mucronata with ~ 2 m height belonging to the family of Thymeleaceae (local names of this plant are Kheshg, Tiro, Torbid, Haftbarg or Tarhineh) is an indigenous native shrub species with significant medicinal properties, which is thought to have a cytotoxic effect against cancer due to producing Alkaloids and Terpenoids, especially betulin and betulinic and the bark of the plant has a medicinal aspect. *D. mucronata* also contributes to soil, water and biodiversity conservation (Hedayati *et al.*, 2003). This species with a Phanerophytes life-form has been frequently recorded in the Iran- Turanian Ecotype (Ahmadi *et al.*, 2013 and Pourmoghadam *et al.*, 2013). It is believed that natural distribution and growth of plant species do not occur by accident and hinge upon and interact with various factors (Heidari *et al.*, 2011). Vegetation significantly takes part in climate zoning. Specifically speaking, vegetation was found to vary between different climatic and topographical areas giving the opportunity to identify bioclimatic zones by simultaneous interpretation of vegetation cover and climate maps. The leaves of this plant are long and 5 to 7 cm wide and lanceolate, without hair, narrow at the end and without petioles, sharp and imperceptibly reticulate. The flowers of this plant are yellowish-white to dense, densely, slightly hairy with ovate edges and have a strong odor that appears integrated along the end of the axis of the flowering branch in late winter or early spring. It has flowers until mid-spring and the fruit is juicy, pitted, fleshy, first green, then red, first covered in flowerpots, then naked, hemispherical, 7 to 10 mm in size, and round (Saligeh *et al.*, 2008).

Fig. 1. View of the *Daphne mucronata* (The photo on the left shows the flowering stage and the photo on the right shows the vegetative stage), (Semirom, 2018)

Climate is a general condition of the prevailing weather conditions of a particular place based on long-term statistics (Bailey Robert, 1991). There are different methods for climate zoning, most of which are based on temperature and rainfall, but sometimes, zoning is based on important non-climatic factors such as plant vegetation. Vegetation plays an important role in climatic zoning. In fact, it can be used as a set of different climatic and topographic patterns; therefore, it is possible to use the adaptation of vegetation and climate maps to identify bioclimatic zones (Chamberlain and Matthews, 1970).

In recent years, a growing invaluable body of research has been carried out on bioclimatic zoning e.g. Khatibi *et al.* (2019), Khatibi *et al.* (2016), Saboohi and Barani (2016), Khodagholi *et al. (*2015), Saboohi and Khodagholi (2013), Pakzad *et al. (*2013), Fatemi *et al.* (2012) and Saligeh *et al. (*2008). A study by Pakzad *et al*.(2013) in Isfahan Province, Iran found that the distribution of *Astragalus brachycalyx* is greatly influenced by three factors: temperature, precipitation, and wind-radiation, which respectively account for 47.4, 30, and 12.8% (90.2% in total) of the primary bioclimatic variables in the province. Khatibi *et al.* (2019) investigate the bioclimatic classification of South east of Iran. Cluster analysis Ward's method divided the study area into 7 bioclimatic zones. The comparison of the obtained results with the results of four common methods of climate classification (Koppen's, Gaussen's, Emberger's, and de Martonne's methods) suggested the high ability of multivariate statistical methods to discriminate between bioclimatic zones. In a study conducted by Saboohi and Barani (2016), the cooling-humidity, temperature, rain-thunder, cloudiness, and wind were reported as the major factors affecting the distribution of *Astragalus gossypinus* in Isfahan province, respectively accounting for 39.05%, 32.77%, 11.44%, and 8.63 % (totally 91.88%) of variation in Isfahan's vegetative climate.

Globally, Pineda-Martinez *et al.* (2007) zoned the bioclimatic regions of central and northeastern Mexico using factor analysis. The calculation of PC1 and PC2 indicates that climate variability is closely related to mean annual precipitation and extraordinary climate events. These atmospheric phenomena influence regional climate patterns due to their seasonal frequency. By applying the classified climates and types of vegetation, 85 bioclimatic zones were defined. Zhou *et al.* (2009) zoned the East Murrumbidgee Irrigation Area (MIA) in Australia using factor analysis and clustering. They used long-term climate data to study climate variability. Their results show two classifications, spatial cluster analysis and climate indices methods. One scheme comes with the two climate zones of the West and the East based on spatial cluster analysis according to selected climatic variables, and the other comes with the three comprehensive hydro-thermal zones and the six hydro-thermal balance zones.

In order to zoning Sistan and Baluchestan Province, Iran, Saligeh *et al.* (2008) utilized factor analysis and climate clustering methods fitted with 20 variables and found that climate of the province is formed by five factors including precipitation, temperature, sunlight, wind, and thunder. Pineda-Martinez *et al.* (2007) used factor analysis for zoning of bioclimatic regions in central, northern, and northeastern Mexico. With the same spirit, Yunus (2011) applied factor analysis and cluster methods for bioclimatic classification in Malaysia. Results of these studies showed the superiority of such methods for bioclimatic classification.

Hence, given the medicinal importance of *D. mucronata* and its wide distribution in Iranian semi-steppe and highland areas, an attempt was made in this study to assess climatic characteristics of this species in the province of Fars, Iran.

Materials and methods

Study area

Fars Province, with an area of about 122,608 km^2, is the fifth-largest province of Iran spanning over 27 N and 21 N longitude and 55 E and 50 E latitude. Precipitation regime of Fars Province is influenced by a low-pressure system coming from the north of Africa (Sudan). This tropical continental air mass originates from deserts of North Africa and after traversing the Saudi Peninsula affects southern and southwestern Iran from the start of fall until early April. On the other hand, given that the province is located in the eastern slopes of the Zagros mountain range and is under the influence of the dry air of the Iranian plateau, this region receives relatively lower amount of precipitation than western foothills of Zagros. In general, annual precipitation decreases from the east, northeast, south, and southwest to the north and northwest (Dehghani, 2011). Mean annual precipitation of the province varies between 100 mm and 650 mm and decreases from the northwest to the northeast. The total weighted mean annual precipitation is about 294 mm. The mean temperature in the north and northwest is about 14°C and 25°C in the south and southwest, respectively.

Climatic data

The climate in each area is determined through considering all climatic factors. Data of 20 climatic factors with the statistical time length of at least 20 years from 23 synoptic and climatological meteorological stations located within and near the province (Fig. 2) were obtained annually and for the months of January (indicative of a cool season), April (indicative of a vegetation growing season), and July (indicative of a warm season) (Table 1). It seems that these climatic factors participate in the formation of the region's climate and growth of *D. mucronata*, both directly and indirectly, in such a way that they reflect the bioclimatic characteristics of this species in its environment.

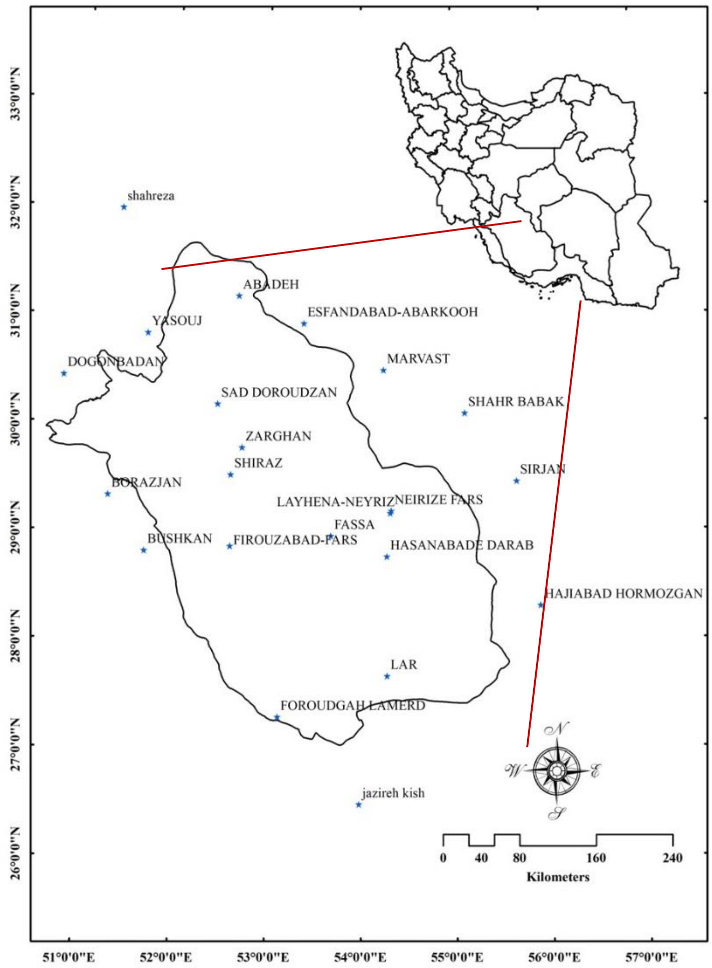

Fig. 2. Location of the study area and stations within and near Fars Province

Table 1. Ecological and climatic factors affecting the *Daphne mucronata* distribution

Climatic variables	Symbol	Climatic variables	Symbol
January mean temperature	V_1	No. of rainy days with rainfall above 1mm per year	V_{26}
April mean temperature	V_2	No. of rainy days with rainfall above 5 mm in January	V_{27}
July mean temperature	V_3	No. of rainy days with annual rainfall above 5 mm	V_{28}
Mean annual temperature	V_4	No. of days with rainfall above 10 mm in January	V_{29}
January mean minimum temperature	V_5	No. of days with rainfall above 10 mm per year	V_{30}
April mean minimum temperature	V_6	No. of cloudy days in January	V_{31}
July mean minimum temperature	V_7	No. of cloudy days per year	V_{32}
Mean annual minimum temperature	V_8	No. of days with a thunderstorm in January	V_{33}
January mean maximum temperature	V_9	No. of days with Thunder per year	V_{34}
April mean maximum temperature	V_{10}	No. of snowy days in January	V_{35}
July mean maximum temperature	V_{11}	No. of snowy days per year	V_{36}
Annual mean maximum temperature	V_{12}	No. of frost days in January	V_{37}
Annual absolute min temperature	V_{13}	No. of frosty days per year	V_{38}
Annual absolute maxtemperature	V_{14}	Mean relative humidity in January	V_{39}
Spring rainfall	V_{15}	Mean annual relative humidity	V_{40}
Summer rainfall	V_{16}	Maximum annual relative humidity	V_{41}
Autumn rainfall	V_{17}	Minimum annual relative humidity	V_{42}
Winter rainfall	V_{18}	January sunshine hours	V_{43}
January rainfall	V_{19}	April sunshine hours	V_{44}
April rainfall	V_{20}	July sunshine hours	V_{45}
July rainfall	V_{21}	Annual sunshine hours	V_{46}
amount of annual rainfall	V_{22}	Mean wind speed in January	V_{47}
No. of rainy days in January	V_{23}	Mean wind speed in April	V_{48}
No. of rainy days	V_{24}	Mean wind speed in July	V_{49}
No. of rainy days with recipitation above 1mm in January	V_{25}	Mean annual wind speed	V_{50}

It should be noted that selecting stations adjacent to the province not only improves the accuracy of factor discrimination, but also reveals the effect of neighboring areas on the province' climate. A 23×50 matrix was formed in which each row represents a station and each column represents a variable. Using Kriging Interpolation method embedded in the Surfer v.13 software, the above matrix was converted to a 958×50 matrix. Thus, using the Kriging Interpolation method, point data were used to produce continuous variable layers covering the entire extent of the province. The maps produced using Kriging significantly comply with the growing extents to which plants have higher thresholds. The maps were then used as inputs to the Principal Component Analysis (PCA).

PCA with the varimax rotation was employed to reduce the number of factors and determine the *D. mucronata*'s bioclimatic characteristics. The matrix of factor loadings derived from PCA determines the effect of each component and component score matrix was utilized to produce component maps. Following that use of the vegetation map of Fars Province (Khodagholi *et al*., 2016), the *D. mucronata* distribution areas were identified and mapped using a GIS software and the boundaries were controlled using reference GPS field collected points (species presence points). GPS points were collected in accordance with the size of pixels (11 km^2). Accordingly, the location of each pixel was first identified on the ground and then, a number of 40 species presence points were collected in dominant or non-dominant occurrence areas. Ultimately, factor maps were overlaid with the produced vegetation map and mean value of the components derived from factor analysis were determined in the species distribution extent.

KMO test was used to determine and determine the suitability of the data for factor analysis. The value of this statistic always fluctuates between 0 and 1. If the KMO value is less than 0.5, the data will not be suitable for factor analysis. If the value is between 0.5 and 0.69, factor analysis can be done with more caution. But if the value is greater than 0.7, the correlations between the data will be suitable for factor analysis (Farshadfar, 2005).

Results

Factor analysis

As mentioned, in order to evaluate the efficiency of factor analysis method, the first step is the accuracy control method using KMO coefficient. The KMO coefficient obtained from the data studied in this study was 0.83 and Farshadfar, according to Kaiser, evaluates the KMO coefficient from 0.8 to 0.9 well (Farshadfar, 2005).

The results of factor analysis using PCA with varimax rotation showed that four components explained 91% of the variance from which the first, second, third and fourth components respectively contributed to 39, 33, 11 and 9% of data variance. The fifth component accounted for less than 1% of the variance, lower than the variance of initial variables, and in turn, it was excluded from the following analysis. The total climate of the study area is influenced by four factors. Table 2 shows the importance of the components.

Since the main objective of factor analysis is to reduce the number of variables and convert them into new components, following the calculation of load factor, it was found that a series of climatic variables constitute the

PCA1) the first component including January and annual mean temperature, January, April, July and annual mean minimum temperature, January, April, July and annual mean maximum temperature, annual absolute maximum temperature, annual absolute minimum temperature, number of frosty days in January and over a year, number of snowy days in January and over a year, number of rainy days over a year and April, July and summer precipitation.

PCA2) The second component related primarily to precipitation because the following variables have the highest weight on this component; annual, winter, and spring precipitation, January and annual precipitation, number of rainy days in January, number of days with precipitation above 1 mm in January and over a year, number of days with precipitation above 5 mm in January and over a year, number of rainy days with precipitation more than 10 mm in January and over a year, number of days with a thunderstorm in January and over a year, number of cloudy days in January and over a year, mean relative humidity in January and over a year, annual maximum and minimum relative humidity and mean temperature in April and July.

PCA3) The third component included sunshine hours in January, April, July, and over a year and was termed the sunshine component.

PCA4) was named the wind component because factor loadings of the total variables related to mean wind in January, April, July, and over a year have the highest weight (Table 3).

Table 2. Eigenvalues and percentages of variance associated with each component

Factors	PCA1	PCA 2	PCA 3	PCA 4
Eigenvalue	20.05	17.08	5.073	4.73
Relative variance%	38.56	32.85	11.03	9.09
Cumulative variance%	38.56	71.41	82.44	91.54

Table 3. Factorial loadings of 50 climatic variables in Fars Province, Iran

Symbol#	PCA1	PCA2	PCA3	PCA4	Symbol	PCA1	PCA2	PCA3	PCA4
V1	0.955				V26		0.909		
V2		-0.772			V27		0.956		
V3	-0.746	-0.746			V28		0.970		
V4	0.897				V29		0.965		
V5	0.948				V30		0.961		
V6	0.945				V31		0.868		
V7	0.964				V32		0.897		
V8	0.951				V33		0.662		
V9	0.934				V34		0.643		
V10	0.948				V35	-0.768			
V11	0.941				V36	-0.758			
V12	0.949				V37	-0.985			
V13	0.949				V38	-0.974			
V14	0.890				V39		0.846		
V15		0.739			V40		0.677		
V16	0.773				V41		0.615		
V17		0.959			V42		0.673		
V18		0.947			V43			-0.903	
V19	0.938				V44			-0.914	
V20	-0.853				V45			-0.899	
V21	0.735				V46			-0.925	
V22		0.959			V47				0.934
V23		0.689			V48				0.784
V24	-0.627				V49				0.776
V25		0.956			V50				0.949

V = climatic variable symbols are defined in Table 2
Limit of desirability: 0.6

Spatial distribution of climatic data (Fig. 3) illustrates the spatial variability of heating temperature. As it is shown, the minimum value of this factor was -2.4 in northern areas and the highest value was recorded in western (near the port of Deilam and Borazjan) and southern areas. Moreover, from the north towards the south and west, temperature increased and in the west, especially around Deilam Port, this component reached its highest value; so, northern elevations faced with decreasing temperature, but western and southern regions, according to Fig. 4, have the lowest elevation and experienced the highest temperature.

Spatial distribution of climatic data (Fig. 5) illustrates the spatial variability of the second component (the precipitation component) in Fars Province. According to this Fig., the maximum value of this component (2.7) was observed in the northwestern part of the province towards the province of Yasouj which has the highest elevation of the region. This value decreased towards the east of the province to its minimum of about -2.1. Climate assessments showed that Fars Province is more influenced by the dry climate of the Iranian plateau in the eastern slopes of the Zagros mountain range than the climate of the western foothills of the Zagros. As the overview on the statistical records of the case study stations showed, precipitation decreased from the north and northwest to the northeast so that the highest amount of precipitation (650 mm) was recorded in the northwest and the minimum amount (100 mm) occurred in the northeast.

The lowest sunshine hour score (1.3) occurred the southeastern part of the province and the highest score (3.9) was observed in Lamerd airport indicating that the southeast of the region has more sunshine hours and the minimum number of sunshine hours was in the southwest because radiation was involved in this group with a negative correlation (Fig. 6). Climatic statistics of Fars Province showed that the number of sunshine hours varied from 3100 hours in the southeast to 2700 hours in the southwest.

Spatial distribution of climatic data (Fig. 7) shows spatial variability of the wind component (the fourth component) in the study area. The lowest score for this factor (1.5) occurred near Lamerd airport and Zarghan and the highest one (3) was observed around Firozabad, suggesting no consistent trend in the province and according to the statistics of weather stations, western and northeastern regions with wind speed of 6 knots and northwestern and southeastern regions with wind speed of 3 knots were recognized as regions with the lowest speed of wind in which the existence of the Zagros mountains and differential pressure between Shiraz and Yasouj could be the reason behind lowering wind speed in northwestern parts

Evaluating bioclimatic characteristics of *D. mucronata*

The distribution of *D. mucronata* was identified using vegetation maps and field investigations (Fig. 8). The vegetation map was then gridded and the effect of climatic variables on the species distribution was assessed using the factor score matrix. By overlapping the vegetation map (Fig. 8).

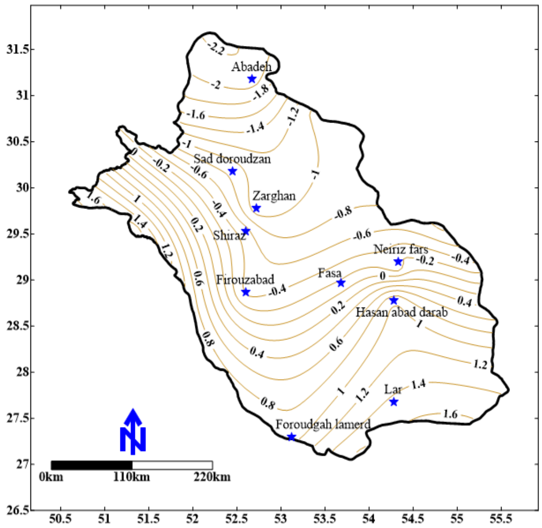

Fig. 3. Spatial distribution scores of heating temperature

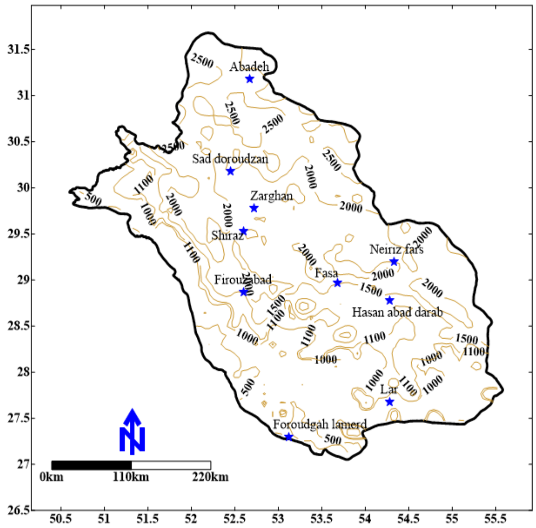

Fig. 4. Contour line map of Fars Province

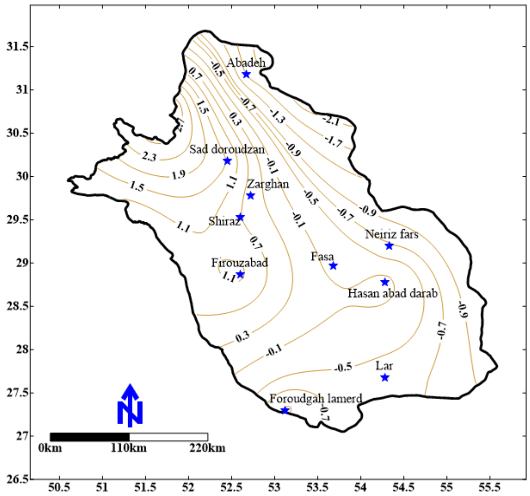

Fig. 5. Spatial distribution scores of the precipitation component in Fars Province

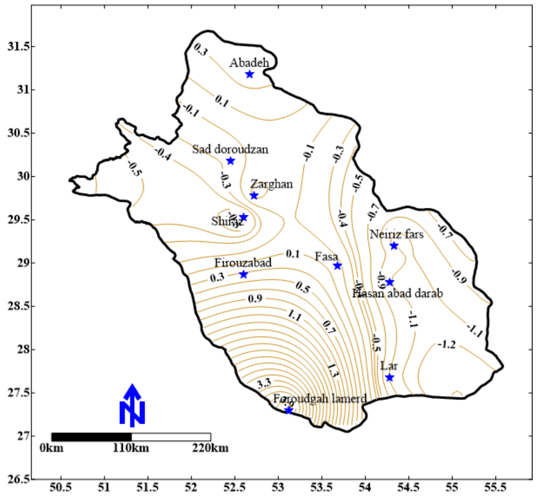

Fig. 6. Spatial distribution score of the sunshine **PC**

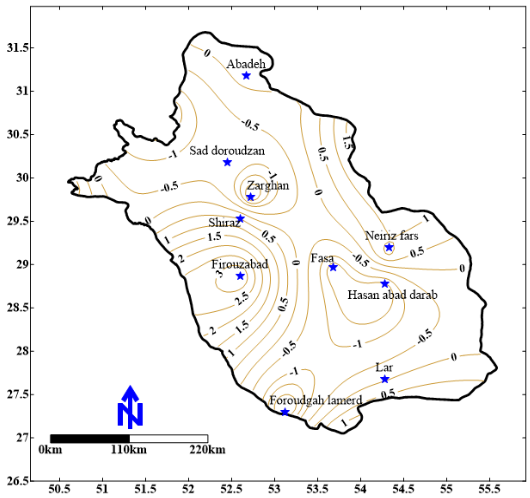

Fig. 7. Distribution of wind scores in Fars province

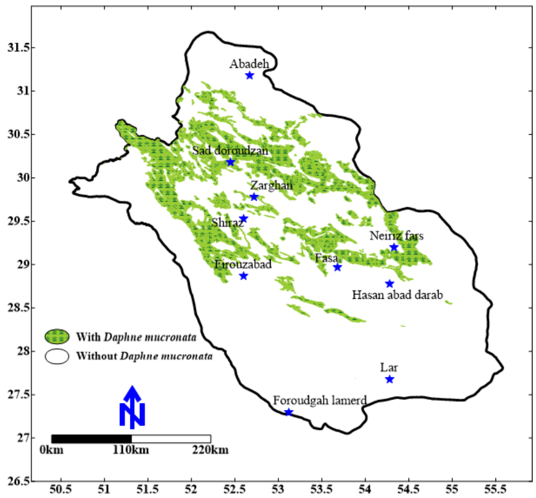

Fig. 8. Distribution of D.mucronata in Fars Province

Using the gridded variable map and factor scores, the score of each cell was determined. Table 4 shows the mean scores of pixels in the species presence and absence areas.

Approximately 33075 km^2 (26.97% of the total area) of the province, especially in central and northern highlands, is occupied with this species. Table 4 gives factorial scores of the four main components in the area. Note that this Table shows the difference in scores between areas with and without *D. mucronata* so that temperature, precipitation, sunshine, and wind components in the species presence areas were -0.53,-0.51,-0.23 and -0.13, respectively while they were equal to 0.20, -0.19.-0.9, and 0.05 in the species absence areas. Some climatic characteristics of these areas were: mean annual precipitation of 379 mm, mean annual temperature of 15.5 °C, 36.26 days with frost events, and the mean wind speed of 4.01 knots (Table 5). The mean elevation of areas containing this species was about 2003 meters above sea level. Areas without *D. mucronata* in Fars Province were 89532.9 km^2 (73.02% of the total area). According to Table 4, this species avoids areas with low temperature, sunshine, wind, and precipitation so that the precipitation component was negative in absence areas even if the other components were positive. The main climatic characteristics in absence areas were: mean annual precipitation of 289.70 mm, annual mean temperature of 19.2 °C, 24.39 days with frost and mean wind speed of 4.26 knots (Table 5). The mean elevation of this areas was about 1355 m.

Table 4. Mean factorial scores in different areas of *Daphne mucronata* Royle habitat

class	Temperature (°C)	Precipitation (mm)	Sunny hours (hr)	Wind (knot)	Elevation(m)
Area with *Daphne mucronata*	-0.53	0.51	-0.23	-0.13	2003.8
Area without *Daphne mucronata*	0.20	-0.19	0.09	0.05	1355.6

Table 5. Mean climatic variables in the *Daphne mucronata* presence and absence areas

Climatic variable	*D.mucronata*		Climatic variable	*D.mucronata*	
	Presence	Absence		Presence	Absence
January mean temperature	6.37	8.90	No. of rainy days	43.28	37.20
April mean temperature	23.50	25.12	No. days with rainfall above 1mm in January	6.46	5.51
July mean temperature	30.38	31.59	No. days with rainfall above 1mm per year	31.06	25.80
Mean annual temperature	15.48	19.24	No. days with rainfall above 5 mm in January	4.34	3.63
Mean min temperature in January	0.51	2.74	No. days with rainfall above 5 mm per year	18.53	14.80
Mean min temperature in April	14.31	16.65	No. days with rainfall above 10 mm in January	2.92	2.34
Mean min temperature in July	21.39	23.49	No. days with rainfall above 10 mm per year	11.59	8.82
Mean annual min temperature	7.13	11.40	No. of days with a thunderstorm in January	0.69	0.80
Mean max temperature in January	12.21	15.07	No. of days with thunder per year	8.53	9.65
mean max temperature in April	31.09	34.20	No. of frost days in January	14.30	9.03
mean max temperature in July	38.14	40.16	No. of frost days per year	36.27	24.39
annual mean max temperature	23.49	26.86	Mean relative humidity in January	62.92	61.85
Annual mean temperature	-10.42	-7.11	Mean annual relative humidity	40.84	40.75
Annual absolute max temperature	43.62	45.70	max annual relative humidity	59.18	59.82
Spring rainfall	31.70	20.02	Min annual relative humidity	26.63	27.50
Summer rainfall	3.14	8.50	Sunshine in January	202.02	187.82
Autumn rainfall	114.98	83.50	April sunshine hours	319.55	288.28
Winter rainfall	226.67	176.75	July sunshine hours	328.82	289.15
January rainfall	97.19	77.81	Annual sunshine hours	3227.3	2920.4
April rainfall	5.17	2.86	Mean wind speed in January	3.38	3.37
July rainfall	1.59	3.81	Mean wind speed in April	0.0	0.0
Annual rainfall	379.02	289.70	Mean wind speed in July	4.71	5.32
No. days with rainfall in January	8.08	7.08	Mean annual wind speed	4.01	4.26

Discussion and conclusion

The plant species characteristics are greatly dependent upon environmental conditions such as climatic, soil and physiographic factors. *D. mucronata* is a native widespread Iranian species which has not been well researched. Therefore, the present research aimed to identify suitable climatic conditions for growth and expansion of this medicinally invaluable species. In this study, 50 important variables were used to study this species. The results showed that four components including

a) temperature (January and annual mean temperature, January, April, July and annual mean minimum temperature, January, April, July and annual mean maximum temperature, annual absolute maximum temperature, annual absolute minimum temperature, number of frosty days in January and over a year, number of snowy days in January and over a year, number of rainy days over a year and April, July and summer

b) precipitation (annual, winter, and spring precipitation, January and annual precipitation, number of rainy days in January, number of days with precipitation above 1 mm in January and over a year, number of days with precipitation above 5 mm in January and over a year, number of rainy days with precipitation more than 10 mm in January and over a year, number of days with a thunderstorm in January and over a year, number of cloudy days in January and over a year, mean relative humidity in January and over a year, annual maximum and minimum relative humidity and mean temperature in April and July),
c) Cloudiness (sunshine hours in January, April, July, and over a year and was termed the sunshine component) and
d) Wind (mean wind in January, April, July) accounts for 38.56, 32.85, 11.03, and 9.09% (91.54% in total) of data variance, respectively.

Evaluation of bioclimatic features affecting the species distribution indicated that temperature and precipitation have the greatest impact on the presence of this species so that it occurs in areas where the temperature and precipitation components are negative. A large amount of literature published in this field including Khodagholi *et al.* (2016), Saboohi and Khodagholi (2013), Lashani *et al.* (2011), Amir Ahmadi and Abbasnia (2010), Yunes (2011), Pineda Martinez *et al*. (2007), Hossel *et al*. (2003) reported temperature, precipitation and wind as the most important climatic factors. Khodagholi *et al.* (2016) found that precipitation, temperature, and wind account for about 96 % of the primary variables in the distribution of Iranian oak species in the province of Chahar Mahal and Bakhtiari. Hossel *et al.* (2003) also indicated that precipitation, temperature, wind speed, and sunshine explain 97 % of the primary variables and accordingly distinguish different parts of Ireland and Great Britain. Except for temperature and precipitation, differences between other variables can be due to several reasons such as the number and type of input data as well as time intervals that can affect the variance. According to results of the present research, this species is exclusively distributed in highlands with low temperature and in turn showed a highly significant negative relationship with temperature. Moreover, this species was absent where the temperature component values were positive and a considerable difference in the values of this component was detected between areas with and without the species.

The precipitation component, with a small difference from the temperature component, ranked second and was positive in the species presence areas and negative in absence locations. One of the notable findings of this research was 70% difference in the precipitation scores between presence and absence areas so that low temperature and high precipitation increased the odds of the species presence. Annual precipitation in regions growing this species varied from 100 m to 650 m. In agreement with our results, Hamblin (1985) showed that precipitation has a significant impact on the distribution and density of vegetation while Joneydi *et al.* (2015) outlined that despite differences in the distribution of annual precipitation occurring in Kurdistan Province, Iran, there was no clear relationship between precipitation and the species density. They concluded that the limited number of precipitation gauging stations and access to reliable and accurate data are among the most important factors leading to an insignificant relationship between precipitation and the density of this species. Both the sunshine and wind components negatively affected the species presence because this species has been adapted to highlands where due to higher cloudiness, the amount of sunshine hours is low. Although Aragon (2007) and Goldin (2001) found that the diversity and evolution of vegetation in northern slopes are higher than those of in southern slopes, Joneydi *et al. (*2015) concluded that *D.mucronata* requires high humidity and low sunshine; however, it seems that the species presence in northern regions is attributed not to low sunshine, but to high amount of moisture resulted from the presence of snow. According to the results, *D.mucronata was* found in areas elevated from 1044 to 3091 m (mean elevation of 2003 m above sea level) indicating that this has adapted to live in highlands. Other studies also found that this species occupy highlands with elevation ranging from 1700 to 2550 m above sea level in Kurdistan Province,Iran (Joneydi *et al.*, 2015), from 2300 to 3050 m above sea level in Isfahan Province (Yusefinejad, 2011), and from 1850 to 2350 m above sea level in Hamedan Province, Iran (with mean precipitation and temperature of about 379 mm and 15 ° C, respectively) (Babaei, 2017).

Hence, regarding the species role in soil protection, its invaluable industrial and medicinal implications, its relatively high production and vast geographical distribution, it would be incumbent to protect this species, especially in regions prone to landslide and solifluction. As a shrub species, *D. mucronata* can provide shelter for wildlife species and help the sustainability of highland habitats. In total, given the diversity of climatic conditions and vegetation forms, Iran has long been considered as one of the main producers and exporters of medicinal plant products and, by appropriate planning and assessment of environmental characteristics of medicinal plants, great steps can be taken towards their protection, disease treatment, providing various industries with raw materials, and profitable export growth.

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بررسی ویژگی‌های اقلیم رویشی گونه دارویی خوشک (*Daphne mucronata* Royle) در استان فارس

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چکیده. شناسایی و مطالعه ارتباط بین گونه‌های دارویی و عوامل اقلیمی از مسایل ضروری و بنیادی در عرصه‌های منابع طبیعی و محیط زیست است تا با امکان شناخت صحیح ضمن بهره‌برداری معقولانه، شرایط برای توسعه پایدار گونه‌های دارویی فراهم گردد. همچنین استفاده از روش‌های آماری چنـد متغیره می‌تواند در آشکارسازی ارتباط بین عوامل اقلیمی و پراکنش گونه‌های گیاهی مؤثر باشد. در این مطالعه به‌منظـور بررسـی عوامـل اقلیمـی تأثیرگذار بر پراکنش گونه گیاهی خوشک *Daphne mucronata* Royleکه گسترش و توسعه زیادی در استان فارس (در حدود ۲۷ درصد مساحت استان) دارد، ویژگی‌های اقلیمی این گونه در سال ۱۳۹۹ مورد بررسی قرار گرفت. بدین منظور در این مطالعه ۵۰ متغیر اقلیمی مربوط به ماه‌های ژانویه، آوریل و ژوئیه و بازه سالانه اسـتفاده گردیـد و بـرای کـاهش تعداد متغیرها و تعیین مهمترین عوامل مؤثر، تحلیل عاملی از روش تجزیه مؤلفه‌های اصلی استفاده شد. نتایج نشان داد چهار عامل دمـای گرمایشی، بارش، ابرناکی و باد به ترتیب ۳۸/۵۶، ۳۲/۸۵، ۱۱/۰۳ و ۹/۰۹ درصد و در مجموع ۹۱/۵۴ درصد از واریانس داده‌ها را تبیین کردند. بررسی اقلیم رویشی این گونه حاکی از آن است که دمای گرمایشی و بارندگی بیشترین تاثیر را بر حضور این گونه داشته اند، به طوری که در مناطقی که این گونه مشاهده می‌شود تاثیر عامل دمای گرمایشی، منفی و بارش مثبت بوده است. همچنین مقدار میانگین دما در مناطق رویشی خوشک در حدود ۱۵ درجه سانتی‌گراد و مقدار بارش بیش از ۳۷۹ میلی‌متر می‌باشد. این تحقیق با شناسایی ویژگی‌های اقلیم رویشی امکان گسترش و توسعه این گیاه در عرصه‌های طبیعی را مشخص کرده و امکان مدیریت بهتر را فراهم می‌سازد.

واژه‌های کلیدی: *Daphne mucronata* Royale، متغیرهای اقلیمی، تحلیل عاملی، رویشگاه‌های استان فارس