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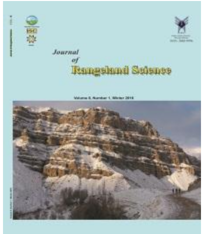

Research and Full Length Article:

Relationship between Some Environmental Factors with Distribution of Medicinal Plants in Ghorkhud Protected Region, Northern Khorasan Province, Iran

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Abstract. Medicinal plant species constitute a considerable part of the flora in Iran and play a major role in the composition of plant communities. Therefore, it is necessary to recognize the factors leading to the establishment and distribution of vegetation. For data sampling (2012), land units were specified. The plot size was determined using minimal area method and number of plots was determined by statistical methods according to the changes in vegetation cover. 120 1 m^2 plots were selected and within each plot, the presence and absence of species and cover percent were estimated. The soil samples were taken in each plot in (0-30 cm) depth. Data were collected and analyzed using Principle Component Analysis (PCA). Results indicated that the first three axes explained the total variation. The variables of altitude, OM, N, pH, and sand had significant correlations with the first axis and explained the 60% variation. For the second component, topographic properties and EC were more important traits and explained the 29% variation. These two components explained the 89% vegetation cover variation in Ghorkhud region as G_1 (*Eryngium bungei-Asperula arvensis*) and G_2 (*Conium maculatum-Acantholimon pterostegium*) types were grown in sandy soils (low OM, N, pH and high EC) coupled with high altitude and slope, G_3 (*Asperula arvensis-Cichorium intybus)* type had a higher adaptability with sandy soils (low OM, N and pH) coupled with lower EC, higher altitude and lower slope and G_4 (*Artemisia sieberi-Convolvulus arvensis*) type tended to be established in clay soils (lower sand% and higher OM, pH and N) and lower altitude.

Key words: Vegetation type, Principal component analysis, Soil properties, Summer rangelands

Introduction

Rangelands have major roles in the supply of livestock forage, production of industrial and medicinal plants, wildlife habitat, soil, and water conservation in the watershed areas. Proper range management is important for the purpose of sustainable use. Therefore, the first step in range management is to determine the habitat of plants and effective the factors affecting their distribution. The presence and distribution of plant communities in rangeland ecosystems are not random, but such factors as climate, soil, topography, human and the others play major roles in their development. Determining the factors that control the presence and distribution of rangelands species is one of the main objectives in the researches of rangeland ecosystems. Environmental factors are effective in the establishment and distribution of plant communities (Heshmati, 2003). Iran has one of the richest floras in the world. Since high percentage of Iran's plant species constitutes medicinal plants, they have great abilities and capabilities from this aspect. Nowadays, with regard to the side effects caused by chemical medicines, the tendency of people to use herbal medicines has increased (Momeni Moghaddam, 2005). Due to the global interest in consumption of medical plants and natural compounds in pharmaceutical, cosmetic and food industries, a there is an urgent need to do basic researches in this field (Sefidkan, 2008). Appropriate, logical, and optimal use of medicinal plants is cheaper in terms of technology and it is simpler than chemical pharmaceutical industry. A realistic understanding of current situation of these resources and the application of scientific and proper methods in all aspects including the identification of habitats, the species composition and their spatial distribution can help us obtain a real and fundamental understanding of role and efficiency of medicinal plants in the communities (Mahmoudi *et al.,* 2012). Therefore, the growing use of medicinal plants in different ways and exploitation of different medicinal species reveal the importance of this category of plants (Nemati Peykani *et al*., 2001).

Taghipoor *et al.* (2008) investigated the effects of environmental factors on the distribution of species in the Hezarjarib region. Their results showed that the most important factors affecting the distribution and establishment of dominant species were moisture and acidity and altitude from sea level. They found that by increasing the altitude, cushion species such as *Onobrychis cornuta* and *Acantholimon pterostegium* had more distribution. Pyrisahragard (2009) investigated the effects of environmental factors on the distribution of plant communities of Taleghan rangelands using PCA. The results showed that the most important factors affecting the separation of vegetation in the study area were altitude, aspect, sand percent, lime percent, soil depth, and soil potassium. Fahimipoor *et al.* (2010) used PCA to determine the most important factors affecting the species diversity. The results showed that among the studied factors, phosphorus, slope, nitrogen, soil texture, and depth had the most effects on the species diversity.

The results of Yibing (2008) achieved using Principal Components Analysis (PCA) and Correspondence Analysis (CA) in China showed that soil physical and chemical properties such as nutrients, moisture, salinity, and pH were effective on the homogeneity of habitat. Similarly, Fu *et al.* (2004) in a study conducted in China (Donglingshan) using PCA and CA found that the amount of organic matter and total nitrogen were important for plant features. According to the potential of Ghorkhud region and proper management of rangelands for better and more rational uses, the necessity of understanding the relationship between environmental factors and vegetation cover is inevitable and efforts towards the stability of this ecosystem are not possible without knowing the interrelationships of its components. The aim of this research was to study the relationships between environmental factors and their effects on the distribution of medicinal plants in order to determine the most important factors.

Materials and Methods

Study area

Ghorkhud area is located between latitudes of 37°20'27" to 37°30'30"N and longitudes of 56°08'48" to 56°17'36"E. Elevation range is between 1000-2700 m. Mean annual precipitation is 400 mm and mean annual temperature is 9°C. Regional climate based on De Martone method (De Martone, 1942) is semi-arid cold. General slope of the district is 0-12% and major vegetation of the area includes perennial herbaceous with dominant grasses and forbs (Keshtkar, 2007). Ghorkhud protected area is diverse in terms of vegetation especially medicinal plants so that nearly 7% of the area under cultivation of Iran`s medicinal plants is in this region (Hoseini, 1995). The map of the study area in the country and in Northern Khorasan Province is shown in Fig. 1.

Sampling method

For sampling (2012), the digital maps including altitude, slope, aspect, vegetation and land use were first prepared. Then, maps were combined using GIS software version 9.3 and land units were identified. Sampling plot size was dependent on the type and distribution of plant species and was determined using minimal area method (Kent and Coker, 1992). The number of plots was determined by statistical methods considering the changes in cover. 120 1m^2 plots were selected and within each plot, the presence and absence of the species and cover percent were estimated by Braun-Blanquet method (Braun-Blanquet, 1972). Then, the plants mentioned in the scientific resources as medicinal species were extracted from the Floristic list. Vegetation types were identified using physiognomy-floristic method. Also, soil samples were taken in each plot from a depth of (0-30 cm) (Northup *et al.*, 1996).The soil properties such as nitrogen (N), organic matter (OM), electrical conductivity (EC), acidity (pH), moisture and texture were measured via laboratory tests (Burt, 2004). Collected data were subjected to Principal Component Analysis (PCA) using PC-ORD software version 5. Prior to analysis, data were standardized by standard deviation (Zare Chahouki, 2006).

Results

A list of medicinal plants in the study area is presented in Table 1 (Asadi, 1988-200; Mirheidar, 1993; Zargari, 199; Akhani, 1998; Rechinger, 1966-1992).

The results of preliminary studies obtained from the separation of vegetation types using physiognomy-floristic method have resulted in the detection of four vegetation types as follows:

G_1: *Eryngium bungei-Asperula arvensis*, G_2: *Conium maculatum-Acantholimon pterostegium*, G_3: *Asperula arvensis-Cichorium intybus*, G_4: *Artemisia sieberi-Convolvulus arvensis*.

According to Table 2, the first three principal components were accounted for the 99.90% variation. In the first component, the variables of altitude, OM, N, pH, sand% were accounted for 59.99% of total variation. Regarding the second component, slope%, aspect and EC were more important traits and explained a 29.45% variation and finally in the third component, the variables of soil saturation, clay and silt with the 10.54% variation were considered as low priority factors (Table 2). The results of biplot for the first and second components of PCA (Fig. 2), showed the distribution of plant communities associated with environmental factors. To interpret the biplot, it is necessary to notice the length of vectors and their angle with respect to each of coordinate axes. Hence, the less angle of vector with the coordinate axes with more length has led to the more correlation coefficient with the coordinate axis. Correlation analysis showed that in the first principal component, altitude and sandy soils had a negative correlation coefficient; therefore, species in the right hand side of the first axis had an inverse relationship with altitude and a direct relationship with OM, N and pH. In the second component, slope%, EC, and aspects showed a same trend and they had significant effects on vegetation separation. Therefore, the species in lower part of biplot had a positive relationship with these factors.

According to the position of *Artemisia sieberi-Convolvulus arvensis* (G_4) on the ordination biplot, this vegetation type is located in right hand side of coordinate axis and according to its high distance from coordinates center, it is more influenced by the first axis (lower altitude and lower sand% coupled with higher OM, N and pH values). Therefore, higher OM, pH and N as well as lower altitude and lower sand percent were favorable environmental conditions for the adaptability of this vegetation type.

Since vegetation type of *Asperula arvensis-Cichorium intybus* (G_3) is located in upper part of biplot, it is negatively correlated with the second axis; therefore, it can be concluded that this vegetation type has a higher adaptability with sandy soils coupled with higher altitude, lower slope and lower EC. Both G_1 (*Eryngium bungei-Asperula arvensis)* and G_2 (*Conium maculatum-Acantholimon pterostegium*) types had strong correlations with the first and second axes. Both types were grown in sandy soils (less OM, N and pH) coupled with high altitude, high slope and high EC.

Table 1. List of medicinal plants in the study area

Plant Species	Plant family	Biological Type	Life Form	Growth Form	Medicinal Useful Parts
Acantholimon pterostegium Bunge.	Plumboginaceae	Ch	Sh	P	Root
Acanthophyllum glandulosum Bge.	Caryophyllaceae	Ch	Sh	P	Root
Ajuga chameecistus Ging.	Lamiaceae	Ch	Sh	P	Leaves and flowers
Allium cristuphii Trautv.	Liliaceae	Ge	F	A	Bulb, Leaves and flowers
Anthemis triumfettii (L.)	Asteraceae	He	F	P	Capitol
Artemisia sieberi Boiss.	Compositeae	Ch	Sh	P	Flowering branches
Asperula arvensis L.	Rubiaceae	He	F	P	All the total
Astragalus gossypinus Fisch.	Papilionaceae	Ch	Sh	P	Root
Berberis integerrima Bge.	Berberidaceae	Ph	Bu	P	Root, skin of root
Conium maculatum L.	Apiaceae	He	F	P	Leaves, fruit
*Cerasus microcarpa (*C.A.Mey.) Boiss	Rosaceae	Ph	F	P	All the total
Cichorium intybus L.	Asteraceae	He	F	P	Root, stem, flower, seed
Convolvulus arvensis L.	Convolvulaceae	Th	F	A	All the total
*Cynodon dactylon (*L.) pers.	Poaceae	Ge	F	P	All the total
Eryngium bungei Boiss.	Apiaceae	He	F	P	leaves
Euphorbia helioscopia L.	Euphorbiaceae	He	F	P	Root, seed, latex
Gallium verum L.	Rubiaceae	He	F	P	Root, Flowering branches, latex
Hyoscyamus niger L.	Solanaceae	Th	F	A	Leaves, seed
Hypericum perforatum L.	Hypericaceae	He	F	P	Flowering branches
Inula vulgaris Trev.	Asteraceae	He	F	P	Capitol
Marrubium vulgare L.	Lamiaceae	He	F	P	Leaves, Flowering branches
Potentilla reptans L.	Rosaceae	Ch	F	P	Root, Rhizome
Perovskia *abrotanoides* Boiss.	Lamiaceae	Ph	F	P	Flowering branches
Salvia aethiopis L.	Lamiaceae	He	F	P	All the total
Stachys lavandulifolia Vahi.	Lamiaceae	He	F	P	Leaves, flower
Taraxacum vulgaris L.	Asteraceae	He	F	P	All the total
Teucrium polium L.	Lamiaceae	He	Sh	P	Flowering branches
Thymus kotschyanus Boiss. Et Hohen.	Lamiaceae	Ch	Sh	P	Flowering branches
Verbascum speciosum Schrad.L.	Scrophulaiaceae	He	F	P	Leaves

He: Hemicryptophyte, Ch: Chamephyte, Th: Therophytes, Ge: Geophyte, Ph: Phanerophyte. F: Forb, Sh: Shrub, Bu: Bush, P: Perennial, A: Annual

Table 2. Results of principal component analysis of soil properties and environmental factors

Variables	Axis1	Axis2	Axis3
Organic matter	**0.387**	-0.005	0.083
Nitrogen	**0.387**	-0.003	0.085
pH	**0.363**	-0.135	0.243
Sand	**-0.362**	0.199	0.064
Altitude	**-0.658**	-0.451	-0.368
Slope	0.231	**-0.445**	-0.040
EC	-0.124	**-0.496**	0.294
Aspect	-0.275	**-0.390**	0.061
Saturation percent	-0.303	-0.262	**0.382**
Clay	0.344	-0.117	**0.384**
Silt	0.229	-0.241	**-0.632**
Eigen values	6.60	3.24	1.16
Percent of variance	59.99	29.45	10.54
Cumulative variance	59.99	89.45	99.90

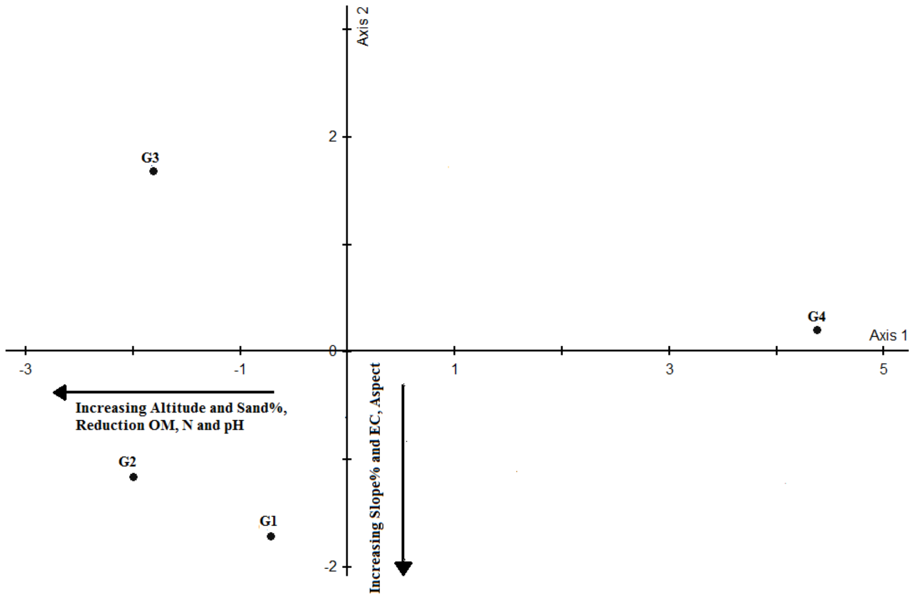

Fig. 2. Ordination of the study sites using PCA method (●) is the representative of vegetation-sampling site, G_1: *Eryngium bungei-Asperula arvensis*, G_2: *Conium maculatum-Acantholimon pterostegium*, G_3: *Asperula arvensis-Cichorium intybus*, G_4: *Artemisia sieberi-Convolvulus arvensis*. OM: Organic matter, N: Nitrogen, pH: Acidity, EC: Electrical conductivity

Discussion and Conclusion

The results of principal component analysis, conducted to determine the most effective environmental factors in vegetation cover indicated that the degree of importance of each factor in separate components was different. In this study, the most important factors, affecting the distribution of vegetation cover were OM, N, pH, sand%, altitude, slope%, EC and aspect.

The vegetation types of G_3 (*Asperula arvensis-Cichorium intybus*), G_1 (*Eryngium bungei-Asperula arvensis*) and G_2 (*Conium maculatum-Acantholimon pterostegium*), were observed in sandy soils (less OM, N and pH) coupled with high altitude; however, soils with heavy texture (lower sand% and the higher OM, pH and N) as well as lower altitude were favorable environmental conditions for the adaptability of G_4 (*Artemisia sieberi-Convolvulus arvensis*) vegetation type.

In this study, a considerable difference in the soil sand percent as one of the determinants of soil texture in different vegetation types indicated that different plant species had different growth needs in terms of bed for the establishment. Soil texture due to the influence of moisture amount and available nutrients in plant, water holding capacity in the soil, food cycle, ventilation, depth of plant rooting, and the amount of runoff flowing after rainfall on the soil surface as well as the distribution of plants plays a role (EL-Sheikh and Youssef, 1981 and EL-Ghani, 2003). According to Kashi pazha (2003), the most important factors in the separation of plant communities were reported to be altitude, slope percent, soil texture, and depth in the Bagh-e-Shad region.

The results of many studies showed that OM was one of the soil characteristics affecting the distribution of vegetation that was in agreement with the results of Ayyad (1976), He *et al*. (2007) and Mahdavi *et al*. (2009). Kooch *et al.* (2007) in the study of ecological distribution of indicator species and effective soil factors in Mazandaran province showed that the distribution of vegetation was correlated with soil properties such as soil texture, P, OM, N and pH. OM is one of the important components of soil whose amount and type are affected by climate and vegetation. OM creates a good soil structure, increases capacity, and makes some changes in the acidity of soil and biological activity (Jafari *et al.,* 2008). Sheikhhosseini and Noorbakhsh (2007) believe that OM of soil plays a major role in supplying soil carbon and energy of heterotrophic microorganisms.

Fisher *et al*. (1987) showed that after available water, soil nitrogen was the most important factor limiting the plant growth. One of the factors affecting the value of nitrogen is soil texture. According to Salardini (1979), clay soils have more N as compared with sandy soils due to the increased nitrogen retention by clay. Fahimipoor *et al*. (2010) reached similar results in their study.

Acidity (pH) has a significant effect on the distribution of plant species. Acidity directly affects plant growth. The role of pH is to control the solubility of nutrients in the soil. Our results are in agreement with those reported by Janisova (2005), Virtanen *et al.* (2006) and Zolfaghari *et al.* (2010).

Altitude from sea level influences other factors such as climate and even factors related to soil. Since the study area is mountainous, it can be concluded that the altitude could directly affect other environmental factors such as rainfall and temperature as well as plant indirectly. In a study, Villers-ruis *et al*. (2003) showed that environmental factors such as altitude, rainfall, and temperature played a role in the distribution of plant. These conclusions were in agreement with the results of Zare Chahouki (2001), Pyrisahragard (2009) and Pink *et al*. (2010). In this study, vegetation density was good in lower altitudes because of the suitability of temperature; however, with the increased altitude, spiny and cushion species such as *Cichorium intybus* and *Acantholimon pterostegium* had more distribution that corresponds with the results of Taghipoor *et al*. (2008).

Both G_1 (*Eryngium bungei-Asperula arvensis)* and G_2 (*Conium maculatum-Acantholimon pterostegium*) types have grown in sandy soils with high EC and high slope. G_3 (*Asperula arvensis-Cichorium intybus*) had a higher adaptability in sandy soils with lower slope and lower EC. In the present study, slope% was the second principal component having a fundamental role in the establishment and distribution of vegetation types. Slope% affected the depth of soil and by the increased slope% and gravity, erosion increased and soil depth decreased and also, the reduced soil depth affected other properties influencing the establishment of plant communities. Mohsennejad Andevari *et al.* (2010) stated that the presence of *Senecio vulgaris* and *Achillea millefolium* was correlated with soil moisture, slope, and altitude which may be similar with the results of present study. The ground slope having a significant effect on the penetration rate and runoff as the indicators of earth performance (Rezai and Arzani, 2007) affects the available moisture of plants. Taghipoor and Rastegar (2009) stated that *Stipa barbata* had a negative correlation with environmental factors (aspect, altitude from sea level, slope percent) and had a positive correlation with slope. *Astragalus gossypinus* had a negative correlation with altitude and showed a positive correlation with slope.

Results of this study also showed that the vegetation of the study area was affected by soil salinity factor. Ghahreman *et al*. (2003) investigated the distribution and species diversity of Mighan desert plant communities. The results showed that two factors of salinity and depth of underground water were the most important edaphic factors. Ahmadi *et al.* (2007) introduced salinity as one of the effective factors in the separation of vegetation types in the Eshtehard rangelands. Abd El-Ghani and Amer (2003) also showed that the salinity was the most important factor in the establishment of plant communities. Salinity and generally concentration of soil solutes or the space around the roots in addition to the reduced plant available water lead to the impaired balance between the ions. Moghaddam (2006) showed that environmental factors including altitude, rainfall, and temperature played an important role in the distribution of vegetation. Another factor contributing to the establishment of plant communities is the geographical factor; water availability, soil temperature and the amount of light received by the plant as well as difference in light intensity in different directions are affected by the changes to the hillside. Iravani (2002) studied the habitat of three species (*Bromus tomentellus, Ferula ovina* and *Cachrys ferulacea*) and showed that aspect was one of the factors affecting the establishment of these species.

Each vegetation type has a different tolerance to environmental factors and soil properties according to the habitat properties and ecological needs. Obtained results in each ecological region can be generalized only to the areas with similar conditions. Generally, the results of this study showed a significant correlation between plant species and environmental factors in the ecological groups so that G_1 (*Eryngium bungei-Asperula arvensis)* and G_2 (*Conium maculatum-Acantholimon pterostegium*) types were grown in sandy soils (less OM, N and pH) coupled with high altitude, high slope and high EC, G_3 (*Asperula arvensis-Cichorium intybus*) vegetation type had a higher adaptability with sandy soils (less OM, N and pH) coupled with higher altitude, lower slope and lower EC and G_4 (*Artemisia sieberi-Convolvulus arvensis*) type was grown in clay soils (lower sand% and higher OM, pH and N) with lower altitude from sea level.

Identification of these relationships can play a major role in preservation of vegetation, soil and water conservation, improvement and restoration of the study area, rangelands, and areas with similar conditions.

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چکیده. گونه‌های گیاهی دارویی بخش قابل توجهی از فلور ایران را تشکیل می‌دهند و نقش عمده‌ای را در ترکیب جوامع گیاهی مختلف ایفا می‌کنند، بنابراین شناخت عواملی که باعث استقرار و پراکنش این گیاهان می‌شوند ضروری است. برای نمونه‌برداری (۲۰۱۲)، واحدهای کاری مشخص شدند. اندازه پلات به روش سطح حداقل نمونه و تعداد پلات با توجه به تغییرات پوشش گیاهی به روش آماری تعیین شد. تعداد ۱۲۰ پلات ۱ مترمربعی انتخاب شد. در داخل هر قطعه نمونه حضور و درصد تاج پوشش گیاهان برآورد گردید. هم چنین نمونه‌برداری از خاک، در هر پلات از عمق ۳۰-۰ سانتی متر انجام شد. سپس به منظور بررسی رابطه بین عوامل محیطی و پراکنش گیاهان دارویی از تجزیه مولفه‌های اصلی (PCA) استفاده شد. نتایج به دست آمده از آنالیز مولفه‌های اصلی نشان داد که از میان عوامل محیطی مورد بررسی به ترتیب ماده آلی، نیتروژن، اسیدیته، درصد شن و ارتفاع از سطح دریا به عنوان مولفه اصلی اول ۶۰ درصد و درصد شیب، هدایت الکتریکی و جهت به عنوان مولفه اصلی دوم ۲۹ درصد، در مجموع از میان عوامل مورد بررسی ۸۹ درصد از تغییرات گیاهان دارویی منطقه قرخود را توجیه نمودند به طوری که تیپ‌های G_1 (***Eryngium bungei-Asperula arvensis***) و G_2 (***Conium maculatum-Acantholimon pterostegium***) در خاک‌های شنی (ماده آلی، نیتروژن، اسیدیته کمتر و شوری زیاد)، ارتفاع بالا و شیب‌های زیاد رشد می‌کنند، تیپ G_3 (***Asperula arvensis-Cichorium intybus***) در خاک‌های شنی (ماده آلی، نیتروژن، اسیدیته و شوری کم)، ارتفاع بالا و شیب‌های کم سازگاری بیشتری داشتند و تیپ G_4 (***Artemisia sieberi-Convolvulus arvensis***) به استقرار در خاک‌های رسی (درصد شن کمتر و ماده آلی، نیتروژن، اسیدیته بیشتر) و ارتفاع پایین گرایش داشت.

کلمات کلیدی: تیپ گیاهی، تجزیه مولفه‌های اصلی، خصوصیات خاک، مراتع ییلاقی