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ORIGINAL ARTICLE

STUDY OF THE IMPACT OF ENVIRONMENTAL HABITATS ON THE SEASONAL DISTRIBUTION OF MINERAL ELEMENTS IN ROOTS OF SOME MEDICINAL PLANTS IN ARAFAT AREA, KINGDOM OF SAUDI ARABIA

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ABSTRACT: This study aimed to assess the impact of habitat on the distribution of the elements of commonly used medicinal plants that grow in the area of Arafat, Saudi Arabia. The study areas represented by ten sites to include five habitats (two sites per habitat). The habitats were selected based on the type of soil, type of vegetation and topography of the soil. The soil in the area of Arafat includes: sand dunes (habitat 1), easy rock (habitat 2), Valley (habitat 3), a transition zone between sand stones and easy rock (habitat 4) and the plains of rock covered with loose sand (habitat5). Samples were taken from the soil of the sites from two different places inside the habitat to a depth of 30 cm. The most famous medicinal plants were selected to conduct the study; these are Rhazya stricta, Rhanterium epapposum, Cassia italca, Cassia senna, Citrullus colocynthis and Abutilon pannosum. Measurements in soil included, pH, Electrical conductivity (EC) and the amount of some heavy elements (zinc, copper and manganese), In addition, sodium, calcium, potassium and magnesium have been determined in roots of the medicinal plants, during two periods, named as: the first winter and second winter, except for soil texture where results were taken three times a year including summer. The results revealed that, potassium was high in expense of sodium element in Arafat area plants, especially in Rhazya stricta all over the year. It was observed that the soil texture is characterized by high sand contents which increase in winter compared to summer. We concluded that the soil texture and mineral elements are the limiting factors for distribution of medicinal plants in Arafat area.

KEYWORDS: environmental Habitat, medicinal plant, Arafat area, mineral elements, heavy elements, mineral element, soil texture

INTRODUCTION

Saudi Arabia Characterized by wide areas reflects clear contrast in topography and climate prevailing in all its parts, and therefore shows plant diversity in all areas. Medicinal plants represent a large place in the Kingdom (Mossa *et al.,* 1987). These plants are very famous and representing an important medical facets through folk medicine in Saudi Arabia. It is well known that the environment is determined by plant species and natural land cover patterns on the surface of the Earth (Loziene and Vaciuniene, 2000; Keely and Fotheringham, 2003). The vegetable community is a plant grouping specific across the region occupied by the same physical appearance, that determine the interrelationships between environmental conditions and plants (Givinish, 1978; Frei *et al.,* 2000; Graziella and Giovanni, 2005; Kathryn, 2005; Xia and Jian, 2005). This relationship is one of the fundamentals that determine the distribution of plants in general (Suboh *et al.,* 2004). Many authors in Saudi Arabia have conducted several studies on plants in general and medical plants in particular, the most important studies were those conducted by Shalaby *et al.,* (1985); Hosni and Hegazy (1996); Hajar and Alzahrani (1997); Hajar *et al.,* (1998); Beha *et al.,* 2004; Kawther (2007).

The site of Arafat is the most complex geological formations in the Kingdom. Mecca is rising up more than 300 meters from the sea level. It is Located within the formations of Arabian Shield, consisting of old rocks that constitute most of the mountains that surround the city of the Holy Mecca and occupied most of the space of the city. On the other hand, the valleys constitute the remainder of the area of Mecca, and follow most of these valleys movements' cracks and fractures that seized Arabian Shield during ancient geologic time (Abrahams and Parsons, 1994).

In the present study the focus was on certain medicinal plants because many researchers have clarified the importance of medical and therapeutic values for these plants, either within the Kingdom of Saudi Arabia (Zahran *et al.,* 1983; Migahid *et al.,* 1978) or in other different parts of the world (Tran *et al.,* 2001; Rag *et al.,* 2001; Watanabe *et al.,* 2001; Mohammed *et al.,* 2008).

MATERIAL AND METHODS

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Ten sites were selected in the area of Arafat. The studied habitats occupied the area from the North Valley of Noman until the beginning of Muzdalifah (Map 1), taken into account that these selected sites represent five different habitats (each habitat was represented by two sites) on the basis of differences in vegetation, topography and soil characteristics. At the end the geography of the 5 habitats include sand dunes (habitat 1), easy rock (habitat 2), Valley (habitat 3), a transition zone between the sandstone rock and easy (habitat 4) and rocky plains covered with loose sand (habitat5).The prone areas that are directly exposed to human activity was avoided, since the study period lasted for three seasons (whole year round). These seasons were named as First Winter (from December 2005 to February 2006), summer (from June-August 2006) and Second Winter (from December 2006 to February 2007).

2.1. Sample Collection:

Soil samples were collected from different areas of Arafat for three consecutive seasons, the first winter, summer and the second winter. Samples were then placed in airtight plastic bags until they arrive to the laboratory for analysis. Roots of the medicinal plants were collected during the First and Second winter only because many plants disappear or poorly grown during the hot summer of the Kingdom. The samples were air dried in the laboratory, grind with a blender and kept in bottles for elements determination.

2.2. Estimation of Mineral Elements in Plants

2.2.1. Plant Sample Digestion

0.2 grams of the each plant powdered root sample were digested in digestion tubes following the method of Stewart (1983). The digested samples were used in element determinations. The estimated elements are sodium (Na^+), potassium (K^+), calcium (Ca^{+2}), and magnesium (Mg^{+2}), zinc (Zn), copper (Cu), manganese (Mn), using Atomic Absorption Flame Emission Spectrometer Perkin Elemer Model 5000.

2.3. Soil Analysis

2.3.1. pH and EC Estimation

EC and pH were measured in the soil extracts using EC, Meter, Matter Toledo- AG and pH-Meter, WTW. Model 512, for EC and pH, respectively.

2.4. Determination of Soil Texture

The mechanical method of sieves was used for this determination. 100 g of soil was taken for volumetric analysis of the soil particles. Using sieves with specific holes to identify the percentage of sand, silt and clay particles.

2.5. Statistical Analysis

The experiments were designed in a complete randomized design with 3 replications for each treatment. The data were statistically analyzed using ANOVA by the software program SPSS 20.

RESULTS

Figure 1, illustrated the seasonal variations in soil texture of various habitats in Arafat over three seasons (the first winter, summer and the second winter). It has been observed that the soil of Arafat ranged from sandy and sandy alluvial. The sand occupied large proportion in every habitat. Habitat 1, showed the highest percentage of sand (91.86%) in the first winter compared to other habitats at the same season. Nonetheless, this ratio has declined in summer to reach (63.10%) and then returned to rise again to (72.88%) in the second winter.

On the other hand, habitat 5 in Arafat area recorded the highest percentage of silt during the First Winter (20.99%). The highest percentage of silt was recorded in habitat 1 during the second winter (22.10%). Results of clay percent, clarified that it occupied the least percentage in all habitats.

It is worth mentioning, during summer, sand percent's were lower in the five habitats than during the other two seasons.

Figure 2 Clarified that habitat 1 has high Mn, while habitat 2 has the highest Cu. Habitat 3, 4 and 5recorded reasonable values of these heavy elements. High Mn in habitat 1 may affect plant production through its adverse effect on photosynthesis as was mentioned by Macfie and Taylor (1992).

The results of pH recorded in the Table (1) to the lack of significant differences among the different habitats of Arafat However, there were significant differences between winter I and II. In the first winter, pH value ranged between weak acid to slightly basic, whereas in the second winter, pH values tend to be slightly basic in all habitats.

Habitat 5 recorded the highest in the values of electrical conductivity (EC) in the first winter (627 mmos/cm). In the second winter, it has been observed that there is a slight decrease in the values of electrical conductivity in Arafat habitats except for habitat 4 and 5. EC values decreased in the second winter. The decrease between winter I and II was (19.4%) in habitat 4 and (319%) in habitat 5.

With regard to elements results (Table 2) demonstrated that, sodium, potassium, calcium and magnesium, indicated a saline soil in habitat 5. The amount of sodium in habitat 5 was 46.40 mg/L and 12.30 mg/l in the first and second winter respectively.

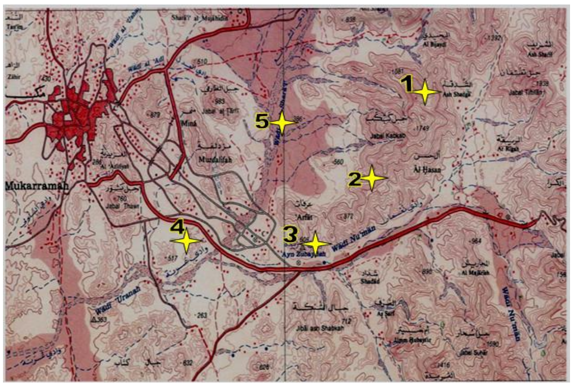
It was noticeable that habitat 5 recorded the highest amount of potassium and calcium, as well. Moreover, the amount of potassium and calcium in the winter I and II, showed clear fluctuation. Habitat 2 contains large amount of these two elements all over the year (10.00 mg/l and 17.20) mg/l for potassium and (21.50 and 17.20) mg/l of calcium, in the first and second winter, respectively.

Concerning magnesium values, it has been observed that magnesium showed high increase in the second winter compared to the first winter in all habitats.

Moreover,, habitat 5 recorded the highest value of zinc (Zn) (2.10 mg/l). Habitat 2 on the other hand, recorded high Copper (Cu) values (5.32 mg/l) and the highest amount of Mn was recorded Habitat 1 (7.62 mg/l).

Roots of the selected medicinal plants in these habitats (Table, 3), clarified that sodium element is low in all plants habitat 5, all over the year. The amount of this element ranged in the first winter, between (0.20 mg/l) in Cassia senna in habitat 4 and 5 and (2.70 mg/l) Citrullus colocynthis in habitat 3. The results of potassium, on the other hand, in the First Winter, showed the high amount in roots of Rhyzya stricta in habitat 1 (16.30 mg/L) and the less amount was recorded in habitat 3 (4.10 mg/l) in the same plant during the first Winter. Moreover, the highest amount of potassium was recorded in C. italica roots in habitat 2 (23.10 mg/l). While, the least amount was recorded in roots of R. stricta in habitat 3 (4.10 mg/l).

Calcium results in table (3) showed that the amount of this element has been ranged in the first winter between (1.70 mg/L) in Cassia senna in habitat 3 as a lesser value and (31.80 mg/l) in R. epaposum plant in habitat 2 as the highest value. In the second winter, the amount ranged between (3.30 mg/l) in C.italica in habitat 5 and (44.20 mg/l) in R. epaposum in habitat 4. Results of roots accumulation of magnesium, Table (3), showed no significant difference among plants in all habitats during the first winter. In the second winter however, R. stricta in habitat 4 accumulated the highest amount of this element (6.30 mg/l), while R stricta in habitat 2 recorded the least amount of this element (1.70 mg/l).



Map (1): Arafat Region showing the 5 Habitats

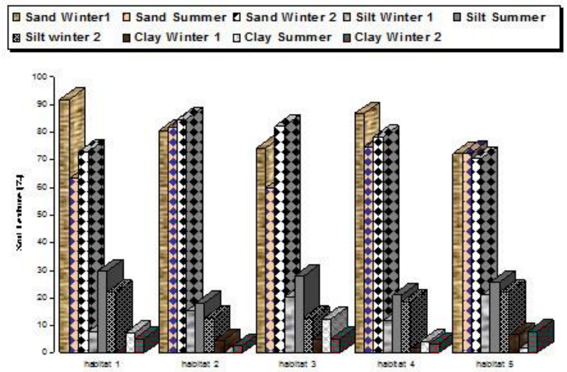


Figure 1: Soil Particle % in different habitats during three seasons

Table 1: Means ± SE of pH and EC (μmos/cm) in Arafat Area during three successive seasons. Data are expressed in mean ± SE. n=3 in each group.

	Second Winter		First Winter	
Habitat	EC	pH	EC	pH
1	114.0	7.14±0.04	116.60	6.95±0.03
2	188.4	7.63±0.18	189.80	6-38±0.02
3	132.4	7.53±0.33	118.70	6.77±0.04
4	98.7	7.04±0.01	122,50	6.85±0.02
5	149.0	7.31±0.03	627.0	7.08±0.15

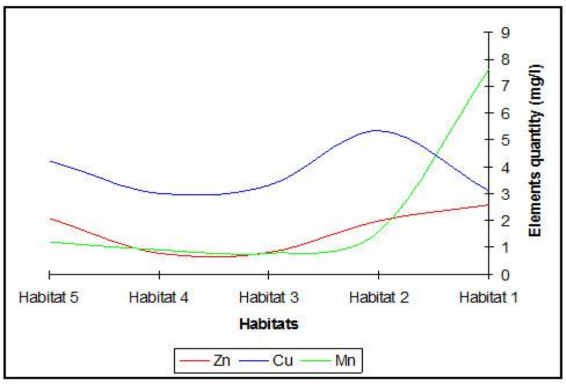


Figure 2: Some heavy elements (mg/l) of different habitats in Arafat Area

Table 2: Seasonal Variations in the Amount of Soil Elements (mg/l) in Different Habitats of Arafat

Habitat	Winter 2				Winter 1			
	Mg	Ca	Na	K	Mg	Ca	Na	K
1	2.60±.06a	7.20±0.77a	11.0±0.56a	3.40±0.03a	0.70±0.04	14.2±0.32a	2.10±0.04a	4.20 ±o.08 a
2	2.80±0.08a	17.2±0.02b	5.70±0.03b	17.2±0.46b	1.30±0.08b	21.5±0.05b	1.70±0.05a	10.00 ±o.18b
3	2.70±0.08a	12.1±0.07c	6.0±0.73b	3.60±0.25a	0.90±0.07b	15.1±0.32a	2.30±0.35a	2.80 ±o.o3c
4	2.50±0.10a	8.60±0.06a	6.50±0.19b	2.80±0.03a	1.10±0.08b	14.9±0.22a	2.80±0.29a	3.10±o.25a
5	1.40±0.16b	16.2±0.16b	12.30±0.56a	2.40±0.05a	2.80±0.16c	7.10±0.77c	46.4±0.49b	4.90 ±o.07a

The data are expressed in mean ± SE. n=3 in each group.
Means marked with different letters in the same column significantly differ at P < 0.05 of probability

Table 3: Seasonal Variations in the Amount of Elements in Plants (mg/l)

Plants	Winter 1				Winter 2				Habitats
	K	Na	Ca	Mg	K	Na	Ca	Mg	
R. Stricta	16.3±2.6 a	0.70±0.27 a	4.0±0.03 a	1.2±0.05	22.4±0.37 a	0.80±0.01 a	4.30±0.07 a	1.9±0.05a	1
R.epeposum	6.8±0.75 b	0.50±0.03 a	30.0±2.31 b	1.5±0.07	11.6±0.16 b	0.80±0.05	24.6±1.22 b	1.9±0.22	
R. Stricta	11.0±1.7 c	0.40±0.22a	5.0±0.99 a	1.2±0.31	14.8±0.14 b	0.9±0.22	4.0±0.12 a	1.7±0.69	2
R.epeposum	6.10±0.7 b	0.70±0.03 a	31.8±1.66 b	2.7±0.04	9.20±0.99 c	1.4±0.34 b	26.1±1.33 b	2.7±0.88	
C.italica	23.1±2.8 d	1.9±0.99 b	16.9±1.8 c	4.31±0.81	19.5±1.2 b	1.3±0.37 b	10.3±0.99 c	4.8±0.91 b	
R. Stricta	4.1±0.04 b	0.60±0.06 a	5.20±1.45 a	1.50±0.07	16.0±1.2 b	1.0±0.01	4.8±0.08 a	2.3±0.08	3
R.epeposum	8.7±1.1 e	0.90±0.04a	13.6±1.7 c	2.60±0.81	14.2±0.97 b	1.10±0.02	23.6±1.15 b	4.7±0.32	
C.italica	*	*	*	*	16.5±1.4 b	0.70±0.05	13.8±1.05d	4.2±0.21	
C.senna	5.3±0.3 b	0.40±0.12a	1.7±0.99d	1.10±0.66	14.8±2.3 b	0.80±0.04	24.6±1.02b	3.0±0.15	
C.colocynthis	19.0±2.4 a	2.70±0.14 c	6.0±0.81 a	4.60±0.23	13.3±0.15 b	4.80±0.99 c	9.6±0.99 c	5.10±0.37	
A.pannosum	*	*	*	*	14.6±0.77 b	2.1±0.71	36.5±1.43 e	6.10±0.42 c	
R.epeposum	8.7±2.5 b	0.90±0.44a	13.6±1.3 c	2.60±0.15	16.7±1.48 b	1.10±0.05	44.2±2.10 f	2.6±0.27	4
C.italica	*	*	*	*	32.1±1.2 d	1.90±0.08	10.5±1.35 c	6.30±0.22	
C.italica	10.10±2.1 b	0.20±0.01a	4.7±0.99 a	1.10±0.09	21.1±1.40 d	0.80±0.10	25.8±1.40 b	3.50±0.17	
C.colocynthis	19.5±0.12 a	2.0±0.99 c	4.4±0.71 a	2.90±0.07	37.3±2.4 d	1.1±0.99	11.6±1.30 d	6.0±0.99	
R.epeposum	13.4±0.41 c	0.30±0.12a	27.5±1.12 b	2.10±0.12	9.7±0.99 c	2.0±0.05	29.5±1.20b	2.10±0.33	
C.italica	*	*	*	*	10.3±1.4 c	0.60±0.03	3.30±0.71 a	2.5±0.12	
C.italica	10.6±0.12 b	0.20±0.01 a	13.2±1.32 c	1.60±0.14	16.8±1.8 b	0.60±0.22	9.7±0.98 c	2.50±0.15	5
C.colocynthis	19.5±0.11 a	2.0±0.08 c	4.4±0.90 a	2.90±0.89	34.4±1.7 d	0.90±0.41	7.80±0.38 c	4.90±0.45	

Means marked with different letters in the same column are significantly differ at P < 0.05 of probability
*= Plants absent in this season.

DISCUSSION

From this study it was observed that the soils with high proportions in the sand grains less water capacity, pH, electrical conductivity and because the sand grains with weak capacity to hold water. In addition, the porous sandy soil causing high cliff of silt particles that can hold water and thus less water capacity of the soil. Similar results recorded by Abrahams and Parsons (1994) in the lack of water capacity in sandy soils. The selected medicinal plants Viz, R. stricta, R. epapposum, C. italca, C. senna, and C. colocynthis for this study, are commonly used in folk medicine Saudi (Migahid *et al.*, 1978; Rizwana *et al.*, 1997; Samresh *et al.*, 2002; Tran *et al.*, 2001). The lower value of the electrical conductivity (EC) in sandy soils caused the elements to be free in this type of soil, and so it is easy to dislodge deeper to the root zones. Similar results have reported by Lambers *et al.*, (1998). It has been observed that the high percentage of sand particles and low clay particles leading to high pH value, which in turn leads to lower a amount of magnesium.

An increase of the element potassium instead of sodium was noticeable in medicinal plants of Arafat area all year round. It has been observed that calcium and potassium recorded a rise in some plants and especially in R.epaposum which considered as good factor as was shown by some previous studies that calcium and potassium have an important role in stomatal oppening (Inoue and Katoh, 1987). Qary (1999) reported that there is contradiction between the amount of sodium and potassium; he attributed this to what is known as feature contrast between these elements. Many researchers have confirmed that the absorption of sodium contradicts with potassium absorption (Inoue and Katoh, 1987; Macfie and Taylor, 1992).

CONCLUSION

In conclusion, habitat 3 is the most stable habitat Arafat area. All the studied species were found in this habitat throughout the year. The reason may be the high water content since this habitat represents the Valley and thus the soil to plants is able to absorb rain water. In addition, the more deteriorated habitat is 1 and so a few species were found in this habitat. Soil texture and mineral elements are the limiting factors in not only distribution but also stabilization of these medicinal in Arafat area.

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