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MINERAL COMPOSITION OF PLANTS OF FAMILY ZYGOPHYLLACEAE AND EUPHORBIACEAE

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Abstract

In the present study with few exceptions, most of the minerals concentrations were higher in winter than in summer in all the investigated plants of family Zygophyllaceae and Euphorbiaceae. Calcium content in *Fagonia cretica*, *Peganum harmala* and *Chrozophora tinctoria* was significantly higher in winter than summer while in *Tribulus terrestris* and *Ricinus communis* it was significantly lower in winter. Potassium significantly increased in winter compared to summer in all the tested plants. Sodium in winter significantly differed in all the tested plants. Copper increased insignificantly in winter than summer in all plants. Mn also increased in winter as compared to summer in all the plants. The Mo was less in winter in *F. cretica* and *T. terrestris* while it increased in *P. harmala*, *C. tinctoria* and *R. communis* during winter and all plants means showed that they were significantly different from each other. Zinc was poor in winter than summer in *F. cretica, P. harmala* and *T. terrestris,* and it increased in *C. tinctoria* and *R. communis*. Aluminum was less in winter in *F. cretica, P. harmala* and *R. communis* which increased in *T. terrestris* and *C. tinctoria* winter.

Introduction

Therapeutic plants have always been valued as a mode of treatment of variety of ailments in folk cultures and have played a very important role in discovering the modern day medicines (Devi *et al*., 2008). Several workers reported the importance of minerals which enhanced the awareness of minerals in these plants (Koe & Sari, 2009; Basgel & Erdemoglu, 2006). The elements like Mg, Fe, Cu, Ca, and K are important medicinally. Mg lowers the cholesterol. Fe deficiency is associated with myocardial infarction. Cu plays an important role in controlling blood lipid level (Zafar *et al*., 2010). Iron is a component of enzymes, hemoglobin and myoglobin and maintains a healthy immune system and digestive action (Ahmed & Chaudhary, 2009). Chromium is provisionally considered to be a nutrient because of its metabolic role and is one of the abundant elements on the earth. It plays important role in the synthesis of cholesterols, metabolism of carbohydrates, proteins, lipids and it facilitates the action of insulin. Therefore, chromium based supplements are used for weight loss (Saeed *et al*., 2010). The synthetic drugs approved as safe and efficacious a decade ago had to be recalled and relabeled because of unanticipated side effects. The mineral composition of the plants is influenced by geographic factors, climatic, soil minerals, seasonal changes, and phenological changes (Hussain & Durrani, 2008). Studies have shown that the deficiencies of minerals cause many problems in human bodies (Djama *et al.*, 2011). Several workers have worked on mineral composition of medicinal plants e.g., (*Oxalis corniculata*, Jain *et al*., 2010; *Amaranthus viridis*, *Chenopodium murale*, *Nosturcium officinale*, Imran *et al*., 2007). Hussain *et al*., (2011) detected Na, K, Mg and Cl in *Tribulus terrestris*. Different studies showed that the selected plants in the present study have been investigated for their antimicrobial activities (Al-Bayati & Al-Mola, 2008; Jain & Nafis, 2011) but no elemental composition of the selected species of family Zygophyllaceae and Euphorbiaceae has been done. The detection of minerals of the widely used medicinal plants is highly desirable. In our country medicinal plants are used either in the form of decoction or infusion or extracts by the local communities in different regions of KPK. It is then useful to find out their nutritional value that might assist to understand the potential of wild important medicinal plants.

Materials and Methods

Collection of plant samples: The different plant parts of *Fagonia cretica* L., *Peganum harmala* L., *Tribulus terrestris* L.,(Zygophyllaceae), *Chrozophora tinctoria* (L.) Raf. and *Ricinus communis* L.,(Euphorbiaceae) were collected from Peshawar and Attock Hills during two seasons (summer and winter in 2009). The plant parts were oven dried at 65 ºC for 72 h. The dried powdered samples were stored in plastic bags for mineral analysis.

A small amount i.e., 0.5 g of the powdered plant material of each plant was taken in a 50 ml conical flask and 10 ml nitric acid (HNO^3) was added in it. Next day, 4 ml perchloric acid (HClO4) was added in it and it was boiled on a hot plate in a fume hood. After few minutes the yellowish color of plant material changed into white fumes and it indicated that digestion was completed. The flasks were removed, cooled down and 100 ml distilled water was added. It was filtered with filter paper (Whatmann No. 42) and filterates were collected in labeled plastic bottles. These solutions were analysed for the elements utilizing Atomic Absorption Spectrometer. The standard working solutions of test elements were prepared to make the standard calibration curve. Atomic flame emission spectrophotometer (FES) (Model no. JEOL Japan) was used for the determination of (Na) and flame atomic absorption spectrometer (AAS) (Model no. JEOL Japan) was used for (Ca), (Mg), (Fe), (Zn), (Mn), (Cu) and (Cr). In AAS, cathode lamp was used as radiation source which provides both sensitivity and selectivity. Other elements in the sample generally not absorb the selected wavelength and thus, not interfere with the measurement. Concentrations of test elements were calculated from calibration curves obtained from standards (Zafar *et al*., 2010).

Statistical analysis: The results of the two seasons of elemental analysis were subjected to two way analysis of variance (ANOVA) and differences between samples were determined by F-test using the Statistical Analysis System (SAS, 1999) program. LSD was also given. Probability values < 0.05 were regarded as significant level (Khan *et al*., 2008).

Results and Discussion

Macronutrients

i. Calcium: The macro and micro- nutrients of plant parts (roots, stems, leaves and fruit) during summer and winter are summarised in (Tables 1-6).

The mean values varied from 116.38mg/L (*Fagonia cretica*) to 196.25mg/L in (*Tribulus terrestris*) (Table 8) which disagrees with Zafar *et al*., (2010) who reported low Ca content in *Fagonia indica*. The Ca content was significantly higher in winter than summer in *Fagonia cretica*, *Peganum harmala* and *Chrozophora tinctoria* while it was significantly lower in winter in *Tribulus terrestris* and *Ricinus communis* (Tables 1, 4). AI-Rumaih *et al*., (2002) observed the higher minerals levels in each part of *Rumex vesicarius* during spring compared to winter and summer. ANOVA showed highly significant differences between two seasons in all studied plants and interaction between seasons and seasons and plant was also significant. Plants and season means were significant (Table 7). These seasonal differences in the concentration of element within the different plants was could be due to mineral composition of the soil and its surrounding climatological conditions (Rajurkar & Damame, 1998). Due to high Ca contents, herbal preparations from these medicinal plants can be used to neutralize the excess of stomach acidity. The intake of aqueous extracts could provide about 200 mg of Ca from 100 g of the studied plants. This will certainly mitigate the deficiency of Ca content in the needy individuals.

Table 1. Macro-nutrients status of plants of family Zygophyllaceae and Euphorbiaceae during summer.

Plants	Parts	Ca (mg/L)		K (mg/L)		Mg (mg/L)		Na (mg/L)	
		M	**SD**	**M**	**S**	**M**	**SD**	**M**	**SD**
Zygophyllaceae									
Fagonia cretica L.	Root	24.46	0.334	27.02	0.001	9.263	0.0882	1.969	0.0048
	Stem	25.50	0.298	26.96	0.000	8.777	0.0590	1.787	0.0041
	Leaf	29.99	0.245	27.03	0.002	9.243	0.0316	1.618	0.0124
	Fruit	29.25	0.150	26.99	0.000	9.527	0.0524	1.445	0.0019
	Mean	**27.4**		**27.0**		**9.20**		**1.70**	
Peganum harmala L.	Root	31.14	0.219	26.89	0.003	9.181	0.0709	2.156	0.0211
	Stem	29.85	0.054	26.86	0.000	9.450	0.1687	2.293	0.0220
	Leaf	35.24	0.123	27.00	0.001	9.251	0.0554	1.827	0.0150
	Fruit	23.50	0.055	26.92	0.001	8.665	0.1213	1.969	0.0034
	Mean	**29.9**		**27.0**		**9.13**		**2.06**	
Tribulus terrestris L.	Root	202.0	12.81	26.90	0.001	12.48	0.100	4.463	0.0165
	Stem	252.7	3.95	26.90	0.001	13.08	0.113	6.444	1.6670
	Leaf	240.3	7.22	26.89	0.005	12.62	0.195	5.716	0.0309
	Fruit	252.4	6.41	26.91	0.001	11.16	0.074	2.254	0.0501
	Mean	**236.9**		**27.0**		**12.33**		**4.71**	
Euphorbiaceae									
Chrozophora tinctoria (L.) Raf.	Root	251.5	9.41	26.97	0.001	10.91	0.052	1.994	0.0165
	Stem	250.7	10.99	26.96	0.001	11.29	0.166	1.952	0.0065
	Leaf	91.88	0.700	27.07	0.002	9.083	0.0636	1.555	0.0108
	Fruit	82.06	0.588	27.10	0.002	8.243	0.0446	1.568	0.0063
	Mean	**169.0**		**27.0**		**9.9**		**1.76**	
Ricinus communis L.	Root	144.2	0.99	27.01	0.003	10.42	0.086	3.713	2.6333
	Stem	147.6	23.39	27.08	0.001	10.00	0.088	2.235	0.0100
	Leaf	236.9	6.70	27.10	0.000	9.992	0.2226	2.235	0.0100
	Fruit	51.50	0.218	27.11	0.001	10.26	0.035	2.837	0.0087
	Mean	**145.0**		**27.0**		**10.16**		**2.75**	

Table 2. Cr, Cu, Fe and Mn concentration of some plants of family Zygophyllaceae and Euphorbiaceae during summer.

Plants	Parts	Cr (mg/L)		Cu (mg/L)		Fe (mg/L)		Mn (mg/L)	
		M	SD	M	SD	M	SD	M	SD
Zygophyllaceae									
Fagonia cretica L.	Root	0.0	0.0301	0.064	0.0009	2.197	0.0236	0.192	0.0029
	Stem	0.0	0.0137	0.030	0.0009	1.965	0.0072	0.100	0.0014
	Leaf	0.269	0.0079	0.039	0.0009	11.30	0.133	0.184	0.0045
	Fruit	0.101	0.0179	0.033	0.0012	2.165	0.0051	0.102	0.0033
	Mean	**0.185**		**0.04**		**4.40**		**0.14**	
Peganum harmala L.	Root	0.0	0.0081	0.038	0.0012	2.156	0.0211	0.098	0.0069
	Stem	0.0	0.0188	0.047	0.0014	2.293	0.0220	0.249	0.0020
	Leaf	0.0	0.0127	0.034	0.0012	1.827	0.0150	0.098	0.0019
	Fruit	0.0	0.0088	0.037	0.0020	1.969	0.0034	0.094	0.0020
	Mean	**0.0**		**0.04**		**2.06**		**0.13**	
Tribulus terrestris L.	Root	0.0	0.0213	0.067	0.0039	2.503	0.0020	0.099	0.0012
	Stem	0.0	0.0021	0.079	0.0035	1.893	0.0428	0.141	0.0018
	Leaf	0.0	0.0296	0.069	0.0007	5.408	0.0094	0.148	0.0048
	Fruit	0.0	0.0031	0.058	0.0016	5.444	0.0199	0.361	0.0020
	Mean	**0.0**		**0.06**		**3.81**		**0.18**	
Euphorbiaceae									
Chrozophora tinctoria (L.) Raf.	Root	0.0	0.0039	0.059	0.0022	3.549	0.0106	0.265	0.0037
	Stem	0.0	0.0047	0.073	0.0036	3.852	0.0094	0.432	0.0038
	Leaf	0.0	0.0241	0.060	0.0023	2.989	0.0258	0.130	0.0017
	Fruit	0.0	0.0058	0.031	0.0023	1.819	0.0096	0.122	0.0014
	Mean	**0.0**		**0.05**		**3.05**		**0.24**	
Ricinus communis L.	Root	0.135	0.0195	0.074	0.0013	6.339	0.214	0.247	0.0039
	Stem	0.135	0.0106	0.055	0.0017	2.148	0.0113	0.170	0.0031
	Leaf	0.0	0.0257	0.050	0.0059	2.735	0.0113	0.216	0.0066
	Fruit	0.006	0.0235	0.076	0.0012	10.41	0.044	0.233	0.0029
	Mean	**0.092**		**0.063**		**5.4**		**0.22**	

ii. Potassium: The mean value varied from 27.1mg/L (*Ricinus communis*) to 27.07mg/L (*Tribulus terrestris* and 27.07mg/L (*Chrozophora tinctoria*) (Table 8). Jabeen *et al*., (2010) reported less K content in *Ricinus communis*, *Convolvulus arvensis* and *Hordeum vulgare.* K contents significantly increased in winter compared to summer in all the analysed plants (Tables 4, 1). It agrees with Roca-Perez *et al*., (2006) who also reported that K content was lower in summer in *Digitalis obscura* leaves. ANOVA showed highly significant differences of K in all the analysed plants between two seasons and showed significant differences in seasons and plant interaction (Tables 7, 8). Zafar *et al*., (2010) also reported that K was high in *Fagonia indica*.

iii. Magnesium: The mean value varied from 9.67mg/L (*Peganum harmala*) to 11.15mg/L (*Tribulus terrestris*) (Table 8). Mg contents were significantly high in winter than in summer in *Fagonia cretica* and *Peganum harmala* while it significantly decreased in winter in *Tribulus terrestris* and *Ricinus communis* while same values in *Chrozophora tinctoria* (Tables 4, 1). Zafar *et al*., (2010) reported low Mg contents in *Fagonia indica* which differed from the present findings. ANOVA showed highly significant differences of Mg contents in all analysed plants and it also showed highly significant differences of seasons and plant interaction (Table 7).

iv. Sodium: The mean value varied from 3.55mg/L (*Fagonia cretica*) to 5.63mg/L (*Tribulus terrestris*) (Table 8) which differed from the findings of other workers as (Zafar *et al.*, 2010; Hussain *et al.*, 2011) who reported low Na (0.015mg/L) in the aerial parts of medicinal plants. Jabeen *et al*., (2010) also recorded similar level of Na in *Ricinus communis*.AI- Rumaih *et al*., (2002) reported that growth stage of species significantly affects mineral composition of range grasses and also found that Na contents of *Panicum turgidum* decreased with advance in stage of growth.

Na contents significantly increased in winter than summer in all the analysed plants in the present study (Tables 4, 1). During summer Na contents differences were significant in *Fagonia cretica*, *Peganum harmala*, *Chrozophora tinctoria* and *Ricinus communis*; Na contents in winter significantly differed in all the tested plants. The plant and season means were significant. There was high significant differences between seasons and plant interaction (Table 7). Similar to our present study. YinPing *et al*., (2009) also reported seasonal variation of Na content in the leaves of *Sabina przewalskii* and *S. chinensis* Differences in Na contents observed in the present study could be due to the genotypic differences, stage of maturity, levels of available Na in the soil and soil pH (Khan *et al.*, 2006).

Table 3. Mo, Zn and Al status of plants of family Zygophyllaceae and Euphorbiaceae during summer.

Plants	Parts	Mo (mg/L)		Zn (mg/L)		Al (mg/L)	
		M	SD	M	SD	M	SD
Zygophyllaceae							
Fagonia cretica L.	Root	0.014	0.0051	9.590	0.0815	0.634	0.0713
	Stem	0.004	0.0237	0.0	0.0021	0.361	0.1195
	Leaf	0.002	0.0141	0.385	0.0008	0.802	0.1162
	Fruit	0.011	0.0302	0.297	0.0015	0.0	0.0880
	Mean	**0.007**		**3.4**		**0.6**	
Peganum harmala L.	Root	0.012	0.0336	0.221	0.0018	0.0	0.0349
	Stem	0.032	0.0115	0.231	0.0030	0.097	0.0538
	Leaf	0.063	0.0166	0.255	0.0041	0.034	0.1229
	Fruit	0.111	0.0011	0.192	0.0010	0.080	0.1981
	Mean	**0.05**		**0.22**		**0.07**	
Tribulus terrestris L.	Root	0.165	0.0293	0.313	0.0022	0.0	0.0718
	Stem	0.0	0.0286	0.316	0.0044	0.826	0.1236
	Leaf	0.0	0.0172	0.371	0.0007	0.527	0.1041
	Fruit	0.0	0.0170	0.240	0.0027	0.384	0.0252
	Mean	**0.165**		**0.31**		**0.6**	
Euphorbiaceae							
Chrozophora tinctoria (L.) Raf	Root	0.00	0.0118	0.211	0.0022	0.0	0.1198
	Stem	0.00	0.0149	0.232	0.0016	0.0	0.0867
	Leaf	0.01	0.0048	0.232	0.0021	0.0	0.0679
	Fruit	0.00	0.0161	0.231	0.0019	0.9	0.0580
	Mean	**0.01**		**0.22**		**0.9**	
Ricinus Communis L.	Root	0.00	0.0101	0.225	0.0009	10.10	2.117
	Stem	0.00	0.0030	0.159	0.0020	0.0	0.2818
	Leaf	0.01	0.0155	0.170	0.0025	0.0	0.0782
	Fruit	0.00	0.0164	0.180	0.0028	2.847	0.2391
	Mean	**0.01**		**0.18**		**6.5**	

Key: M = Mean; SD = Standard Deviation

Micronutrients

i. Chromium: Chromium contents varied from 0.004mg/L in (*Peganum harmala*) to 0.185mg/L in (*Fagonia cretica*) in summer (Table 2). *Ricinus communis* had 0.114 mg/L in winter (Table 5). Many workers (Hussain *et al*., 2011; Adnan *et al*., 2010). Hussain *et al*., (2011) reported high Cr in *Nepeta suavis, Calotropis procera, Aerva javanica*, as compared to the present study. It has been reported in the literature that Cr at 5mg/L proved to be toxic. In the present study low Cr contents were detected both in summer and winter seasons. The permissible limit set by FAO/WHO in edible plants was 0.02 mg/L.

ii. Copper: The mean value varied from 0.105mg/L (*Fagonia cretica*) to 0.09mg/L (*Chrozophora tinctoria*) (Table 8) which are higher than reported by Zafar *et al*., (2010) which was 0.00018mg/L in *Fagonia indica*. Similar results were also reported by Ashraf *et al*., (2010) in *Artemesia japonica* and *A. persica*. Cu contents increased insignificantly in winter than summer in all the tested plants (Tables 2, 5). Chinnasamy *et al*., (2003) reported that Cu showed significant variation among nodule tissues of *Lathyrus maritimus* in summer and winter. The plants and seasons means were significant (Table 7). ANOVA showed highly significant differences between plants and between seasons but plant interactions were insignificant (Table 7). The present results disagree with Shad *et al*., (2002) who reported low Cu contents in *Fagonia arabica*. Hashem & Alfarhan (1993) reported similar findings in *Peganum harmala* collected from different localities of Saudi Arabia.

iii. Iron: The mean value varied from 2.7mg/L (*Peganum harmala*) to 4.7mg/L (*Ricinus communis*) (Table 8). Iron decreased in winter in *Fagonia cretica* and *Ricinus communis* and Fe contents were same in *Tribulus terrestris* in both the seasons (Tables 2, 5). Fe contents increased in winter in *Peganum harmala* and *Chrozophora tinctoria* (Table 5). The results were statistically insignificant. Hussain & Khan (2010) also reported insignificant variations in Fe in *Eclipta alba*. ANOVA showed no significant differences between seasons, plants and plants and seasons interactions (Table 7). Zafar *et al*., (2010) reported low Fe in *Fagonia indica* which differed from the present investigation. These results agree with the findings of AI- Rumaih *et al*., (2002).

Table 4. Macro-nutrients of some plants of family Zygophyllaceae and Euphorbiaceae during winter.

Plants	Parts	Ca (mg/L)		K (mg/L)		Mg (mg/L)		Na (mg/L)	
		M	SD	M	SD	M	SD	M	SD
Zygophyllaceae									
Fagonia cretica L.	Root	100.8	0.33	27.08	0.001	10.37	0.127	6.764	0.0599
	Stem	234.2	7.31	27.12	0.001	11.04	0.205	4.423	0.0083
	Leaf	230.6	4.90	27.07	0.003	10.62	0.059	5.254	0.0137
	Fruit	255.9	1.88	27.06	0.003	11.12	0.031	5.210	0.0290
	Mean	**205.4**		**27.08**		**10.8**		**5.41**	
Peganum harmala L.	Root	261.0	5.01	27.12	0.001	9.677	0.0951	6.132	0.2378
	Stem	254.6	5.94	27.07	0.000	10.19	0.104	6.229	0.0361
	Leaf	163.7	12.85	27.09	0.001	10.44	0.068	6.671	1.3255
	Fruit	164.4	32.02	27.16	0.000	10.57	0.086	6.163	0.0354
	Mean	**210.9**		**27.11**		**10.21**		**6.3**	
Tribulus terrestris L.	Root	251.1	8.18	27.21	0.000	9.973	0.1370	7.422	2.1833
	Stem	68.15	0.584	27.09	0.000	10.18	0.013	6.621	0.050
	Leaf	105.3	1.36	27.11	0.000	9.895	0.1042	5.394	0.0255
	Fruit	197.8	5.55	27.17	0.000	9.800	0.1147	6.792	1.2553
	Mean	**155.6**		**27.15**		**9.96**		**6.55**	
Euphorbiaceae									
Chrozophora tinctoria (L.) Raf	Root	91.27	0.617	27.15	0.001	9.780	0.0987	8.740	0.1823
	Stem	201.7	15.08	27.17	0.001	9.463	0.1177	8.375	0.1560
	Leaf	221.8	3.23	27.14	0.001	9.101	0.0410	9.255	0.9327
	Fruit	251.6	8.42	27.09	0.000	10.90	0.248	8.148	0.0282
	Mean	**191.6**		**27.14**		**9.81**		**8.63**	
Ricinus communis L.	Root	65.85	0.309	27.25	0.000	8.395	0.0887	7.913	1.9739
	Stem	48.48	0.259	27.11	0.001	9.315	0.1393	7.163	0.0709
	Leaf	88.72	0.617	27.15	0.001	9.790	0.0934	9.061	1.5972
	Fruit	151.5	9.05	27.21	0.000	9.903	0.1021	6.287	0.0136
	Mean	**88.6**		**27.2**		**9.35**		**7.6**	

iv. Manganese: The mean values varied from 0.2mg/L for (*Fagonia cretica*, *Peganum harmala* and *Chrozophora tinctoria*) to 0.3mg/L (*Ricinus communis*) (Table 8). Unlike the present study Zafar *et al*., (2010) reported high Mn contents (32.2) mg/L in the *Fagonia indica*. In the present study *Peganum harmala* had 0.2 mg/L Mn content that differed from Hashem & Alfarhan (1993) who reported low Mn contents in *Peganum harmala*. Mn content increased in winter than summer in all the plants without any statistical significance (Table 5). The differences between plant means were insignificant while those between the seasons means were significant. ANOVA showed that seasons were significant while plants and seasons and plant interaction were not significant (Table 7).

v. Molybdenum: The mean value varied from 0.0075mg/L (*Fagonia cretica*) to 0.09mg/L (*Peganum harmala* and *Tribulus terrestris*) (Table 8). The Mo contents were less in winter in *Fagonia cretica*, *Tribulus terrestris* while it increased in *Peganum harmala*, *Chrozophora tinctoria* and *Ricinus communis* during winter (Table 6). All plants means showed that they were significantly different from each other. ANOVA showed that plants were significant while seasons and plants seasons interaction were insignificant (Table 7). Reddy *et al*., (1981) reported seasonal changes in Mo contents in *Trifolium subterraneum, Vulpia* sp*., Lolium rigidum* and *Arctotheca calendula*. The Mo content remained constant throughout the season, *T. subterraneum* had lower Mo than *Vulpia* sp while *A. calendula* had more Mo.

vi. Zinc: This study shows that the mean value varied from 0.02 mg/L (*Ricinus communis*) to 1.77mg/L (*Fagonia cretica*) (Table 8). Jabeen *et al*., (2010) recorded poor Zn contents in *Ricinus communis*, *Convolvulus arvensis*, *Hordeum vulgare* and *Fagonia indica*.

In the present study Zn contents were poor in winter than summer in *Fagonia cretica* and *Tribulus terrestris* while Zn contents were same in both the seasons in *Peganum harmala, Chrozophora tinctoria* and *Ricinus communis* (Tables 3, 6). ANOVA showed that results were statistically insignificant for plants and seasons (Table 7). The present findings agree with Roca-Perez (2006) who reported that Zn contents in the leaves of *Digitalis obscura* did not show a clear seasonal trend. The considerable amount of Zn was present in all the studied plants and it was highest in *Fagonia cretica* which may be directly or indirectly helpful in the management of diseases.

Table 5. Cr, Cu, Fe and Mn contents of some plants of family Zygophyllaceae and Euphorbiaceae during winter.

Plants	Parts used	Cr (mg/L)		Cu (mg/L)		Fe (mg/L)		Mn (mg/L)	
		M	SD	M	SD	M	SD	M	SD
Zygophyllaceae									
Fagonia cretica L.	Root	0.0	0.0171	0.060	0.0040	4.634	0.0083	0.247	0.0015
	Stem	0.0	0.0097	0.045	0.0017	2.520	0.0115	0.367	0.0014
	Leaf	0.0	0.0186	0.050	0.0030	2.824	0.0252	0.297	0.0039
	Fruit	0.0	0.0083	0.087	0.0005	3.845	0.0181	0.264	0.0052
	Mean	**0.0**		**0.06**		**3.45**		**0.29**	
Peganum harmala L.	Root	0.0	0.0095	0.086	0.0030	4.799	0.0233	0.198	0.0033
	Stem	0.0	0.0212	0.064	0.0030	2.384	0.0042	0.247	0.0022
	Leaf	0.0	0.0210	0.082	0.0027	3.497	0.0011	0.231	0.0010
	Fruit	**0.0**	0.0056	0.070	0.0013	2.813	0.0183	0.179	0.0044
	Mean	**0.0**		**0.07**		**3.37**		**0.21**	
Tribulus terrestris L.	Root	0.0	0.0128	0.065	0.0006	6.848	0.0218	0.232	0.0030
	Stem	0.0	0.0170	0.097	0.0026	3.308	0.0119	0.213	0.0017
	Leaf	0.0	0.0072	0.067	0.0008	1.859	0.0249	0.163	0.0027
	Fruit	0.0	0.0036	0.068	0.0019	3.108	0.0101	0.222	0.0058
	Mean	**0.0**		**0.07**		**3.78**		**0.2**	
Euphorbiaceae									
Chrozophora tinctoria (L.) Raf	Root	0.0	0.0091	0.100	0.0019	4.866	0.0243	0.226	0.0088
	Stem	0.0	0.0004	0.085	0.0038	2.643	0.0124	0.177	0.0023
	Leaf	0.0	0.0158	0.082	0.0024	4.167	0.0100	0.196	0.0054
	Fruit	0.0	0.0125	0.109	0.0025	6.027	0.0215	0.411	0.0004
	Mean	**0.0**		**0.09**		**4.425**		**0.25**	
Ricinus communis L.	Root	0.114	0.0386	0.061	0.0037	2.716	0.0109	0.762	0.0089
	Stem	0.0	0.0404	0.085	0.0053	6.789	0.0073	0.248	0.0033
	Leaf	0.0	0.0163	0.076	0.0022	2.652	0.0094	0.280	0.0059
	Fruit	0.0	0.0187	0.067	0.0044	3.894	0.0108	0.283	0.0050
	Mean	**0.114**		**0.07**		**4.01**		**0.39**	

vii. Aluminum: The mean value (Table 8) varied from 0.25mg/L (*Peganum harmala*) to 3.74 (*Chrozophora tinctoria*). Higher Al contents in *Viola odorata* compared to the present study were recorded by Bibi *et al*., (2006).

Al contents were less in winter in *Fagonia cretica*, and *Ricinus communis* which increased in *Peganum harmala, Tribulus terrestris* and *Chrozophora tinctoria* in winter (Table 6). The summer data for *Ricinus communis* showed that Al contents were significantly different than other four plants, (Table 3) while the other plants among themselves were insignificant. In winter, *Tribulus terrestris, Chrozophora tinctoria* and *Ricinus communis* (Table 3) showed that the Al contents were significantly varied among themselves and these plants were significantly different than *Fagonia cretica* and *Peganum harmala*. Chinnasamy *et al*., (2003) reported that Al showed significant variation among nodule tissues of *Lathyrus maritimus* in summer and winter seasons. The plants and seasons means were significantly different from each other. ANOVA showed significant differences of Al content in all plants in both the seasons, and it also showed highly significant seasons and plant interaction (Table 7).

Trend of accumulation of macro and micronutrients: Trend of accumulation of macro nutrients in plants of family Zygophyllaceae and Euphorbiaceae remained same and showed that Ca > K > Mg > Na while the trend of accumulation of micro nutrients in the same plants of family Zygophyllaceae and Euphorbiaceae showed variation as given below:

Fe > Zn > Mn > Al > Cu > Mo > Cr in *Fagonia cretica* , Fe > Zn and Mn > Mo > Cu > Al > Cr in *Peganum harmala*, Fe > Al > Zn > Mn > Cu > Mo > Cr in *Tribulus terrestris,* Al > Fe > Mn > Zn > Cu > Mo > Cr in *Chrozophora tinctoria*, Fe > Al > Mn > Zn > Cu > Mo > Cr in *Ricinus communis*. Mean values obtained from summer and winter seasons were considered in the trend of accumulation of nutrients (Table 8).

Table 6. Mo, Zn and Al contents of some plants of family Zygophyllaceae and Euphorbiaceae during winter.

Plants	Parts	Mo (mg/L)		Zn (mg/L)		Al (mg/L)	
		M	SD	M	SD	M	SD
Zygophyllaceae							
Fagonia cretica L.	Root	0.0	0.0112	0.123	0.0018	0.0	0.0201
	Stem	0.0	0.0059	0.117	0.0015	0.0	0.0728
	Leaf	0.0	0.0438	0.132	0.0030	0.0	0.1055
	Fruit	0.001	0.0163	0.189	0.0008	0.0	0.0932
	Mean	**0.001**		**0.14**		**0.0**	
Peganum harmala L.	Root	0.067	0.0134	0.150	0.0011	0.023	0.0373
	Stem	0.149	0.0220	0.123	0.0002	0.0	0.1987
	Leaf	0.208	0.0063	0.215	0.0021	0.0	0.1095
	Fruit	0.0	0.0081	0.132	0.0009	0.832	0.0348
	Mean	**0.14**		**0.16**		**0.42**	
Tribulus terrestris L.	Root	0.0	0.0169	0.186	0.0012	2.228	0.1921
	Stem	0.0	0.0087	0.216	0.0060	2.856	0.1916
	Leaf	0.0	0.0162	0.142	0.0012	4.307	0.1224
	Fruit	0.029	0.0041	0.180	0.0009	5.958	0.3545
	Mean	**0.029**		**0.18**		**3.83**	
Euphorbiaceae							
Chrozophora tinctoria (L.) Raf	Root	0.038	0.0026	0.160	0.0045	7.674	0.4596
	Stem	0.063	0.0076	0.120	0.0012	8.968	0.4311
	Leaf	0.022	0.0019	0.188	0.0037	11.83	0.375
	Fruit	0.022	0.0060	0.485	0.0065	0.812	0.5840
	Mean	**0.04**		**0.3**		**7.321**	
Ricinus Communis L.	Root	0.060	0.0129	0.189	0.0021	0.765	0.0708
	Stem	0.049	0.0162	0.256	0.0020	0.953	0.0216
	Leaf	0.027	0.0045	0.159	0.0022	0.330	0.0558
	Fruit	0.055	0.0072	0.275	0.0014	0.407	0.1752
	Mean	**0.04**		**0.23**		**0.6**	

Key: M = Mean; SD = Standard Deviation

Table 7. Statistical analysis of seasonal variation of macro and micronutrients in some plants of family Zygophyllaceae and Euphorbiaceae.

Plants	**Ca (mg/L)**			**K (mg/L)**			**Mg (mg/L)**		
	Summer	**Winter**	**Mean**	**Summer**	**Winter**	**Mean**	**Summer**	**Winter**	**Mean**
				Zygophyllaceae					
Fagonia cretica L.	27.36 d	205.4ab	116.37c	27.0e	27.08bcd	27.04bc	9.20d	10.8b	10.0b
Peganum harmala L.	29.9 d	210.0ab	119.9bc	27.0f	27.11bc	27.05c	9.13d	10.21bc	9.678b
Tribulus terrestris L.	236.9 a	155.6abc	196.2a	27.0 f	27.15ab	27.07c	12.3a	9.96bcd	10.5a
				Euphorbiaceae					
Chrozophora tinctoria (L.) Raf	169.0abc	191.6ab	180.3ab	27.0de	27.14abc	27.07b	9.9bcd	9.81cd	9.85b
Ricinus communis L.	145.0 bc	88.6cd	116.8c	27.0cd	27.28a	27.14a	10.16bc	9.35cd	9.75b
Mean	**121.63b**	**170.26a**		**27.0b**	**27.13a**		**10.138**	**10.026**	
LSD value at 5%	39.39 (Seasons), 62.27 (plants), 88.07 (seasons and plants interaction)			0.028 (Seasons), 0.045 (plants), 0.064 (seasons and plants interaction)			0.68 (Seasons), 0.96 (plants)		
				Zygophyllaceae					
	Na (mg/L)			**Cr (mg/L)**			**Cu (mg/L)**		
Fagonia cretica L.	1.70e	5.413cd	3.55b	0.85	0.0	0.85	0.04	0.7	0.37c
Peganum harmala L.	1.81e	6.3c	4.05b	0.0	0.0	0.0	0.4	0.07	0.23bc
Tribulus terrestris L.	4.719d	6.55bc	5.63a	0 .92	0 .0	0 .92	0.06	0.07	0.06a
				Euphorbiaceae					
Chrozophora tinctoria L.) Raf.	1.767e	8.629a	5.198a	0.0	0.0	0.0	0.05	0.094	0.075a
Ricinus communis L.	2.755e	7.606ab	5.181a	0.0	0 .0	0.0	0.076	0.072	0.068ab
Mean	**2.55b**	**6.89a**		**0.88**	**0.0**	**0 .0**	**0.12b**	**0.20a**	
LSD value at 5%	0.55 (Seasons), 0.87 (plants), 1.239 (seasons and plants interaction)			Nil			0.0081 (seasons), 0.012 (plants)		
				Zygophyllaceae					
	Fe (mg/L)			**Mn (mg/L)**			**Mo (mg/L)**		
Fagonia cretica L.	4.40	3.45	3.9	0.15	0.29	0.22	0.0075	0.01	0.008b
Peganum harmala L.	2.06	3.37	2.7	0.14	0.21	0.17	0.05	0.14	0.09a
Tribulus terrestris L.	3.81	3.78	3.7	0.4	0.20	0.3	0.165	0.029	0.09b
				Euphorbiaceae					
Chrozophora tinctoria L.) Raf	3.05	4.42	3.735	0.24	0.25	0.245	0.00	0.022	0.01b
Ricinus communis L.	5.40	4.01	4.7	0.22	0.39	0.305	0.00	0.04	0.02b
Mean	3.6	**3.8**		**0.23b**	**0.26a**		**0.07**	**0.04**	
LSD value at 5%	Nil			0.07 (Seasons), 0.035 (plants), .055 (seasons and plants interaction)			0.05 (plants)		

			Zygophyllaceae			
	Zn (mg/L)			**Al (mg/L)**		
Fagonia cretica L.	3.4	0.14	1.77	0.6cd	0.00d	0.6b
Peganum harmala L.	0.22	0.16	0.19	0.07d	0.42cd	0.24b
Tribulus terrestris L.	0.31	0.18	0.24	0.6cd	3.83b	2.13ab
			Euphorbiaceae			
Chrozophora tinctoria L.) Raf	0.22	0.64	0.43	0.9cd	7.21a	4.05a
Ricinus communis L.	0.18	0.23	0.2	6.5bc	0.407cd	1.16ab
Mean	**0.86**	**0.27**		**1.73b**	**2.96a**	
LSD value at 5%	Nil			1.416 (Seasons), 2.238 (plants); 3.165 (seasons and plants interaction		

Means followed by the same letter are not significantly different at 0.05%

Table 8. Variation in macro and micronutrients in two seasons in some plants of family Zygophyllaceae and Euphorbiaceae.

Plants	Season	Macronutrient (mg/L)				Micronutrient (mg/L)						
		Ca	K	Mg	Na	Al	Cr	Cu	Fe	Mn	Mo	Zn
Zygophyllaceae												
Fagonia cretica L.	Summer	27.36	27	9.20	1.70	0.37	0.0	0.04	4.4	0.14	0.014	2.55
	Winter	205.4	27.08	10.78	5.41	0.0	0.0	0.17	3.45	0.29	0.001	0.14
	Mean	**116.38**	**27.04**	**9.99**	**3.55**	**0.37**	**0.0**	**0.105**	**3.9**	**0.2**	**0.023**	**1.35**
Peganum harmala L.	Summer	29.9	27.0	9.13	1.81	0.07	0.0	0.04	2.06	0.14	0.05	0.22
	Winter	210.9	27.11	10.21	6.3	0.42	0.0	0.07	3.37	0.21	0.14	0.162
	Mean	**120.4**	**27.05**	**9.67**	**4.05**	**0.25**	**0.0**	**0.05**	**2.7**	**0.2**	**0.09**	**0.2**
Tribulus terrestris L.	Summer	236.9	27.0	12.33	4.71	0.38	0.0	0.06	3.81	0.18	0.165	0.31
	Winter	155.6	27.15	9.96	6.55	3.83	0.0	0.07	3.78	0.20	0.029	0.18
	Mean	**196.25**	**27.07**	**11.15**	**5.63**	**2.1**	**0.0**	**0.06**	**3.8**	**0.2**	**0.09**	**0.25**
Euphorbiaceae												
Chrozophora tinctoria L.) Raf	Summer	169.0	27.0	9.88	1.76	0.16	0.0	0.05	3.05	0.24	0.0	0.22
	Winter	191.6	27.14	9.81	8.63	7.321	0.0	0.09	4.425	0.25	0.02	0.264
	Mean	**180.3**	**27.07**	**9.85**	**5.2**	**3.74**	**0.0**	**0.07**	**3.7**	**0.25**	**0.02**	**0.24**
Ricinus communis L.	Summer	145.0	27.0	10.16	2.75	2.93	**0.0**	0.06	5.4	0.21	0.0	0.18
	Winter	88.6	27.2	9.35	7.6	0.407	0.0	0.07	4.01	0.39	0.04	0.23
	Mean	**116.8**	**27.1**	**9.8**	**5.2**	**1.67**	0.0	**0.06**	**4.7**	**0.3**	0.04	**0.20**

Conclusion

It is concluded that the present study of nutrients regarding the indigenous medicinal plants showed the presence of zinc in the plants could mean that the studied plants can play an important role to manage diabetes. The presence of Ca, Mg, Fe and Zn indicate the ability of these plants to keep the body in healthy immune system. This study could be helpful to determine the dosage to be given to patients considering elemental contents and concentrations and it showed the safe level of the minerals determined in five plants. The investigated plants need to be cultivated on large scale as they are being used traditionally for the treatment of different diseases as little attention has been given so far to these plants.

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