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PHYTOSOCIOLOGICAL AND HEAVY METAL PROFILE OF *IPHIONA GRANTIOIDES* AND *PLUCHEA ARGUTA* (BOISS.) ANDERB. SUBSP. *GLABRA* QAISER

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Abstract

The aim of this study was to investigate the phytosociological, ethnobotanical and heavy metal profile of *Iphiona grantioides* (Boiss.) Anderb. and *Pluchea arguta* (Boiss.) subsp. *glabra* Qaiser of family Asteraceae, from saline localities of District Karak, Khyber Pukhtunkhwah, Pakistan. The resluts showed that the two plants are haloxerophytes in nature found widely growing in close association with other 80 plant species, in areas with highest salinity values, at an elevation, ranging from 450 m to 900 m. *Iphiona grantioides* was found dominant with maximum importance value (IV) of 49.9 and maximum importance value index (IVI) 16.6. *Pluchea arguta* subsp. *glabra* mostly growing in close association with *Iphiona grantioides*, having the maximum IV of 28.3 and IVI of 9.4. Soil analysis revealed that soil samples of the studied sites were alkaline in reaction and strongly calcareous in nature and deficient in organic matter, N and P. Results obtained for heavy and toxic metals revealed that various parts of *Iphiona grantioides* and *Pluchea arguta* subsp. *glabra* contain heavy metals within safer and permissible limits.

Key words: *Iphiona grantioides, Pluchea arguta* subsp. g*labra,* Heavy metals.

Introduction

Phytosociology is the quantitative study of vegetation with aim to describe its structure, composition and to classify it in a meaningful way (Ilorkar & Khatri, 2003). The term Phytosociology, first used by Józef Paczoski in 1896 (Rabotnov, 1970), is the study of the distinctiveness, classification, association and distribution of plant communities. The survival and organization of a community reflects the plant type and habitat conditions under which they grow (Rabotnov, 1970). Phytosociological data is very helpful for understanding the population dynamics of individual species and their relationship with other species in the same community (Marielos, 2003). Microclimate, edaphic factors, biotic factors and exposure are the basis of differences among various communities and plant association (El-Ghani & Amer, 2003). Vegetation is an ecological expression of an area showing complex inter-relationships among the various components including plant-plant, plant-animal and plant-physical environment interaction. In Pakistan, various plant communities of different habitats have been studied phytosociologically, but very little information is available on various attributes of a single species. In this respect, some of the reported previous work is on *Picea smithiana* (Wahab *et al*., 2008), and *Quercus baloot* (Khan *et al*., 2010).

Ethnobotany is the customary knowledge about local plant resources and establish an interaction of man and plants for sustainable development (Ahmad *et al*., 2006), and recently these studies are gaining popularity in the development of health care system in various parts of the world (Sardar & Khan, 2009). Medicinal plants are easily available and have fewer side effects, so 80% of the world population relies on medicinal plants for primary health care. The ethnobotanical information is also very helpful for ecologists, taxonomists, pharmacologists, watershed and wild life managers in their efforts for improving the financial condition of the local people in the remote areas (Ibrar *et al*., 2007) and for the conservation of medicinal plants as well as their habitat.

Although herbal medicines have less side effects as compared to allopathic medicine but the presence of heavy metals in plants, which may be toxic when present in higher amounts, can cause health issues (Hussain *et al*., 2006). According to the recommendation of Anon., (1998) medicinal plants must be checked for the presence of heavy metals and other contaminations. Recent work done on the heavy metal analysis of different medicinal plants includes Khan *et al*., (2012), and Ibrar *et al*., (2013). Begum *et al*., (2017) reported the heavy metal profile of frequently consumable medicinal plants of Khyber Paktunkhwa. Similarly Idrees *et al*., (2017) analyzed the vegetable and soil samples for heavy metal concentrations. *Iphiona grantioides* and *Pluchea arguta* subsp. *glabra* Qaiser, are two very important wild haloxerophytes, dominating the saline areas of District Karak. Both these plants have been investigated for their various medicinal potentials and anatomical features (Naveed *et al*., 2016; Naveed *et al*., 2017). But no information is yet available on the phytosociology and heavy metal profile of *Iphiona grantioides* and *Pluchea arguta* subsp. *glabra* Qaiser, therefore, this study was designed to investigate the phytosociological distribution, ethnobotany and heavy metals contents of *Iphiona grantioides* and *Pluchea arguta* subsp. *glabra*.

Material and Methods

Phytosocilogical and heavy metal profile of *Iphiona grantioides* and *Pluchea arguta*: *Iphiona grantioides* (Boiss.) Anderb. and *Pluchea arguta* subsp. *glabra* Qaiser) were studied from phytosociological point of view following Raunkiaer (1934) and Hussain (1989). Seven study sites were selected in Karak district for the this study including Malgeen (Salts deposits), Nari Panoos, Bahader Khel, Chushmai, Karat Ghar, Noshpa Salt Range and Sour Daag, during June, 2013. Soil samples were collected from the seven sites and analyzed in the laboratory for various physical and chemical parameters. Plant community structure was studied by Quadrat sampling method (Hussain ,1989). and Importance Value Index (IVI) of species was calculated following Curtis (1956).Plant species were classified into several constancy classes following Raunkiaer (1934). Plant specimens were collected and preserved according to the standard procedure. The specimens were identified with help of flora of Pakistan (Qaiser & Abid, 2003) and Mr. Ghulam Jelani, Curator, Herbarium, department of Botany, University of Peshawar, Pakistan, where voucher specimens number were assigned to the sheets and kept in the same herbarium for reference. Plants identification was confirmed from Herbarium, Department of Botany, University of KarachiSoil samples were collected from the depth of 0-15cm, air dried and passed through mesh sieve of 2 mm, to remove large sized particles and large root fragments. The sieved soil was used for detailed soil analysis. Soil texture was determined by Bouyoucos hydrometer method (Brady, 1990), Soil pH by following Jackson (1962), Soil organic matter by rapid dichromate oxidation technique (Rayan *et al*., 1997) and Soil nitrogen was determined by Kjeldahl method of Bremner and Mulvaney (1982). Phosphorus was determined by following the method of Oslen & Sommers (1982). Potassium of soil was determined by using flame emission spectrophotometery (Rhoades, 1982). Heavy metals analysis of powder drug of different parts of the two plants was carried out with atomic absorption spectrophotometer (Jackson, 1962) and samples were prepared by wet digestion method Perkin (1991) and arithmetic mean and standard deviation were used to analyze the data statistically.

Results and Discussion

In the present study *Iphiona grantioides* and *Pluchea arguta* subsp. *glabra*, the two research plants, were found present in close association of each other along with 80 other plants, in the seven localities (Fig. 1). Qureshi (2012) and Atta-ur-Rehman *et al*., (2006) also reported these plants from Sind and Ziarat (Balochistan) respectively, thus confirming a wide range of distribution of these plants in arid and saline regions of Pakistan.

A total of nine trees species i.e., *Acacia jacquemontii* Benth., *Tamarix aphylla* (L.) Karst, *Zizyphus mauritiana* Lam., *Monotheca buxifolia*, *Acacia nilotica* subsp. *nilotica* (L.) Delile, (*Vachellia nilotica*) *Phoenix dactylifera* L., *Tecomella undulate* (Sm.) Seem, *Salvadora percica* and *Acacia modesta* Wall, were found in all 7 localities in association with *Iphiona grantioides* and *Pluchea arguta* subsp. *glabra*, in which *Acacia jacquemontii* Benth. was the only constant tree species occurring in all seven stands. *Tamarix aphylla* (L.), was the second constant tree species present in all the sites except one stand. 37 shrubs were found in co- dominance with *Iphiona grantioides* and *Pluchea arguta* subsp. glabra with variable importance values .Moreover herbs and grasses i.e., *Asphodelus tenuifolius, Tribulus terristris* L. *Pulicaria glutinosa, Peganum harmala* L., *Cymbopogon jwarancusa* (Jones) Schultes, *Justicia adhatoda, Cenchrus ciliaris* L. and *Amaranthus viridis* were present with variable importance values that fell in "mostly present" class of Raunkiaer's classes of constancy. Most of the herbs were classified as seldom and rare species having narrow range of distribution with *Iphiona grantioides* and *Pluchea arguta* subsp. *glabra*.

Fig. 1. *Iphiona grantioides* and *Pluchea arguta* subsp. *glabra*. growing in a locality in District Karak.

Dominance of plants was determined on the basis of importance value index (Barkatullah 2012). *Iphiona grantioides* was found dominant at two sites, second dominant at Karat area and third dominant at Nari Panous site, with maximum IV of 49.9, at Chashmai area of Andai, and minimum IV was 7.1 at Malgeen area. Average Important value index (IVI) of *Iphiona grantioides* was 9.45 with maximum IVI of 16.6 and minimum IVI 2.3. *Pluchea arguta* subsp. *glabra* was regularly found in all the seven sites, mostly growing in close association with *Iphiona grantioides*. It was 1st dominant at Bahader Khail site near the old tunnel, second dominant at Chasmai and third dominant at three sites i.e., Malgeen, Karat and Noshpa area, having the maximum IV of 28. 3 and minimum IV of 7.1. Average Important value index (IVI) of *Pluchea arguta* subsp. glabra was 5.9, maximum IVI 9.4 and minimum IVI 2.4.

Similar phytosociological studies have also been conducted for the local flora of Tehsil Takht-e- Nasrati of District Karak by Khan (2012); Barkatullah (2012) for the phytosociological studies of *Skimmia laureola* and *Zanthoxylum armatum* and Ilyas *et al*., 2015 with more or less similar phytosociological results.

Results of soil analysis: Soil pH of the surface soil ranged from 7.40 to 8.95 with a mean value of 7.98 being higher in Bahader Khel salt range, while its lower value was found in soil from Sour Daag area. Variation in pH was low in the area. Almost all of the soil samples were alkaline in reaction. Electrical conductivity of the soil ranged from 4.30 to 17.65 dS m-1 with a mean value of 10.98 dS m-1. The higher and lower values were found in Karat Ghar and Chushmai area, respectively. All of the samples collected from different locations were found saline. Organic matter content of the soil ranged from 0.72 to 1.66% with a mean value of 1.14%, being higher in Sour Daag area. All of the samples collected from different sites were deficient in total N. Available phosphorus (P) in soil ranged from 1 to 4%. The higher P value was found in Noushpa while all other samples were deficient in available phosphorus. Phosphorous content showed very high variation. Available Potassium (K) in the surface soil ranged from 100 to 210 mg kg-^{1}. The higher value was found in Karat Ghar and its lower value was noted in Bahader Khel area. Regarding categorization of available K, only 29 % samples were marginal and rest of the samples were adequate in Potassium. All the soil samples analysed from different areas of district Karak were alkaline in reaction and strongly calcareous in nature. Organic matter, soil N and P were found deficient in most of area sampled. The sampled area soil had permanent salt with semi-arid climate. Therefore, the soil can be reclaimed by management practices and by growing salt tolerant plants. In general soil of the studied sites was loamy in nature. Three places had sandy-clay loam while four sites had sandy-loam, silt-loam, sandy-silt loam and silt-clay loam respectively. The present results are also in lineage with Khan *et al*., (2012), who characterized soils from various spots of the surroundings of tehsil Takhti Nasrati, District Karak.

Ethnobotany of *Iphiona grantioides:* Locally this plant is called Zair gul in Pashto (Khan *et al*., 2011), Naro in Balochi (Qureshi, 2012) and Khol Meer in Sindhi (Attur-ur-Rehman, 2006). Leaves and entire plant are used as the folks medicine. The leaves are stepped in water and used as a remedy for the treatment of Asthma (Wazir *et al.*, 2007). The paste of the plant is applied on wounds for rapid healing (Qureshi, 2012). Leaves are used as a remedy for itching, scabies, haepatitis and against snake bite (Attur-ur-Rehman, 2006).

Ethnobotany of *Pluchea arguta* subsp. *glabra:* *Pluchea arguta* subsp. *glabra* is locally known as Kasteera (Pashtoo). Decoction of the whole plant is used as a diuretic and as a camel fodder (Qureshi, 2012). Similar ethnobotanical studies have been carried out by various other workers in Pakistan, particularly in Khyber Pakhtunkhwa, e.g., Ahmad *et al*., (2011); Khan *et al*., (2013) and Sher *et al*., (2014). The present ethnobotanical studies will open new avenues for researchers to investigate these plants for further medicinal properties.

Heavy metal analysis: Plants have the ability to accumulate essential elements in their different parts, which are of highest importance in human nutrition (Clemens *et al*., 2002). There are also some toxic heavy metals like Co, Cd etc., which are not directly required by the plants, but still they are accumulated in some plants due to environmental pollutions (Ajasa *et al.*, 2004) which create serious health hazards, when the plants are consumed by humans and animals (En *et al*., 2003). In human body, trace elements play a vital role both in prevention and treatment of different human diseases (Saeed *et al*., 2010a). In the present study leaf, shoot, root and flower of *Iphiona grantioides* and *Pluchea arguta* subsp. *glabra* were analyzed to determine the concentration of various heavy and toxic metals in these plants. The results obtained for these and some other metals are given in Table 1.

Nickel (Ni): Nickel plays an important role as an active site of some enzymes (Sydor & Zambie, 2013). In the present Phytosocilogical and heavy metal profile of *Iphiona grantioides* and *Pluchea arguta* study, Ni was present in the range of 0.102±0.0232 ppm - 0.287±0.0211 ppm *Iphiona grantioides* and 0.398±0.0066 ppm in *Pluchea arguta* which are within the standard permissible limits (1.5 ppm) (Table 1). More or less similar results for Nickel concentration were reported by Ibrar *et al*., 2013 and Saeed *et al*., 2011. Similarly Ozcan (2005) detected Ni presence in young shoots, flower buds, berries (fruit), and seeds of *Capparis ovata* but were found to be very low in all these parts of the plant. So these plants can be used safely without any fear of accumulation of Ni beyond the allowable limit.

Zinc (Zn): Zinc concentration in *Iphiona grantioides* was in the range of 2.234±0.0151ppm and 3.117 ±0.0095 ppm in branch (stem) and leaves and 4.730±.0010 ppm-0.572±.3881ppms in branches and leaves of *Pluchea arguta* subsp. *glabra*, respectively. The permissible limit of Zn in medicinal plants is 50 µg /g (Markert, 1994) and the dietary limit of Zn is 100 ppm (Jones, 1987). Saeed *et al*., (2010a) and Sultan *et al*., (2010) reported the presence of Zn in some medicinal plants and suggested to have a key role in plant as well as animal metabolism. Our findings showed that Zn amount was below the permissible limit so this plant could be useful Zn in deficiency conditions.

Table 1. Heavy metal profile of various parts of *Iphiona grantioides* and *Pluchea arguta* subsp. *glabra*.

Metal	IF (ppm)	IL (ppm)	IS (ppm)	IR (ppm)	PL (ppm)	PS (ppm)	PR (ppm)
Mn	1.083±0.04	1.842±0.039	1.141±0.01	2.012±0.05	7.273±0.03	4.912±0.012	2.317±0.03
Fe	10.50±0.086	11.72±0.026	13.09±0.09	20.47±0.09	16.35±0.05	7.492±11.62	23.60±0.17
Cu	0.147±0.00	0.226±0.00	0.185±0.00	0.581±0.00	0.412±0.00	0.2744±0.00	0.327±0.00
Zn	2.412±0.01	3.117±0.00	2.234±0.01	3.544±0.01	0.572±.388	4.730±.00	3.050±0.02
Cr	0.041±0.00	0.021±0.00	0.030±0.00	0.061±0.00	0.045±0.00	0.061±0.00	0.044±0.02
Pb	0.122±0.02	0.0113±0.02	0.051±0.03	0.066±0.03	0.176±0.03	0.245±0.018	0.127±0.00
Co	0.029±0.00	0.034±0.00	0.054±0.01	0.067±0.00	0.103±0.00	0.104±0.004	0.094±0.00
Ni	0.111±0.04	0.102±0.02	0.149±0.00	0.287±0.02	0.304±0.03	0.398±0.006	0.325±0.01
Cd	ND	ND	ND	ND	ND	ND	ND

Key = I = *Iphiona grantioides*, P= *Pluchea arguta* subsp. *glabra* , L = leaf, F = flower, S = stem, R =root, ND = Non detectable

Manganese (Mn): According to our findings, concentration of Mn in *Iphiona grantioides* in was leaves) 1.842±0.0396 ppm and in stem was 1.141±0.0199 ppm.Similarly in *Pluchea arguta* subsp. *glabra*s root, Mn was 2.317±0.0316 ppm –and in leaf was 7.273±0.0343 ppm, within the permissible limits. Mn intoxication is responsible for Parkinsonism condition (shaking or tremors) Wang *et al*., 2008). Similar results are also reported by Ibrar *et al*., (2003) for Mn contents in *Hedera helix*. The results clearly showed that both the plants are safe to be used with reference to Mn.

Chromium (Cr): The results obtained in the present study showed a concentration range of 0.021± 0.00 – 0.061±0.00 in *Iphiona grantioides* and 0.044±0.02-0.06±0.00ppm in various samples of in *Pluchea arguta* subsp. *glabra* in *Pluchea arguta* subsp. *glabra* as shown in Table 1. The daily intake of Cr 50-200 µg has been recommended for adults by US National Academy of Sciences (Watson, 1993).Thus the concentrations are within the permissible limit for Cr in plants (1.5 ppm) (Saeed *et al*., 2010 b). Chromium is one of the abundant elements on the earth, and plays an important role in body metabolism (Emsley & John, 2001). Inhaling high level of chromium (Cr) may lead to irritation of the nose, asthma, shortness of breath and wheezing.

Copper (Cu): The range of Cu in present study was 0.581±0.00 ppm (*Iphiona grantioides*root), 0.412±0.00 (*P. arguta* leaf), 0.327±0.00 (*P. arguta* root), 0.2744±0.00 (*P. arguta* stem), 0.226±0.00 ppm (*I. grantioides* leaves), 0.185±0.00 (*I. grantioides* stem) and 0.147±0.00 (*I. grantioides* flower) (Table 1. The permissible limit of Cu is 10 µg/g in plants (Markert, 1994) and 340–900 µg /day of Cu is the recommended dietary allowance (RDA) (Saeed *et al*., 2010b) for normal enzymatic function (Huang & Failla, 2000). The results suggest that both the plants are safe to use as far as concentration of Cu is concerned.

Iron (Fe): In the present study, iron concentration was 10.50±0.086 ppm in flower, 11.72±0.026 ppm in leaf, 13.090.09± ppm in stem and 20.47±0.09 ppm in root while in *Pluchea arguta* subsp. *glabra* the concentrations were 23.60± 0.17 ppm in root, 16.35±0.057 ppm in leaf and 7.492 ±11.62 ppm in stem, which is within the permissible limit (36-241 ppm). The present data indicated that Iron is in sufficient amount in our tested samples and this might be the reason for hepatoprotective effect of *Iphiona grantioides* and *Pluchea arguta* subsp. *glabra.*

Cobalt (Co): The concentration of Co in the present study was 0.034±0.00 ppm (leaf), 0.067±0.00 pm (root), 0.054±0.01 ppm (stem) and 0.029±0.00 ppm (flower) in *Iphiona grantioides*, while it was 0.103±0.00 ppm (leaf), 0.104±0.004 ppm (stem) and 0.094±0.0048 ppm (root) in *Pluchea arguta* subsp. *glabra* (Table1). In plants permissible limit of Co is 0.2 ppm (Markert, 1994). It means that all the samples of crude drugs contain Co within the standard limits (0.2ppm). Cobalt is a useful trace metals, however, high concentrations of cobalt may damage human health.

Lead (Pb): In our present study Pb concentration was (0.0113±0.0271- 0.122±0.0239 ppm in leaves and flower of *Iphiona grantioides* while it was 0.127±0.0037 - 0.245±0.0187 ppm in roots and stem of *Pluchea arguta* subsp. *glabra,* respectively. Lead is present within the range of permissible limits (10 µg/g) designed by Word Health Organization (Issac & Jonson, 1975). Lead is a toxic element and its presence in plants may be due to environmental pollution. According to our present findings, both the crude drugs are safe for human use.

Cadmium (Cd): Like Lead, cadmium is a non-essential trace element having functions neither in human body nor in plants. They induce various toxic effects in humans at low doses. The lowest level of Cd which can cause yield reduction is 5-30 ppm, while the maximum acceptable concentration for food stuff is around 1 ppm (Neil, 1993). Surprisingly no Cd was detected in plant samples (Below detection limit).

According to the recommendations of World Health Organization, medicinal plants, must be checked for the presence of toxic heavy metals and it also regulates the maximum allowable limits of toxic metals (Anon., 1998). Medicinal plants may very easily be contaminated during growth, development, collection, processing and after conversion into dosage form the heavy metals present in plants may finally enter into the human body and disturb the normal functions. As it is clear from the results (Table 1), that both the plants, in the present study, have all the elements within safer and permissible limits.

The present study revealed that the two research plants are xerophytic in nature, and occur along with other xeric plants in dry and saline soil conditions of District Karak. IVI values of these plants showed that population is not rich in their natural habitate. It is therefore suggested that proper curative measures should be taken by the relevant departments for the improvement of the soil of the area, which in turn will improve their growth and conservation of local flora. It, in turn, will improve the economy of the local people, and will increase the biodiversity of the area.

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