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Research Article

Assessment of Metal Accumulation in Medicinal Plants and Their Soil in District Kamber-Shahdadkot, Sindh, Pakistan

Abdul Hameed Lanjwani[1], Muhammad Farooque Lanjwani[2*], Taj Muhammad Jahangir Khuhawar[3], Ghulam Serwar Sheikh[1], Qararo Shah[4], Vinay Kumar[1]

[1]Department of Biochemistry, Shaheed Mohtrma Banzir Bhutto Medical University Larkana, Sindh, Pakistan
[2]Dr M. A. Kazi Institute of Chemistry, University of Sindh, Jamshoro, Sindh, Pakistan
[3]Institute of Advanced Research Studies in Chemical Sciences, University of Sindh, Jamshoro, Sindh, Pakistan
[4]Department of Community Medicine, Shaheed Mohtrma Banzir Bhutto Medical University Larkana, Sindh, Pakistan
E-mail: mfarooquechemist@yahoo.com

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Abstract: The current study was carried out to investigate the physicochemical properties, major elements such as Na, K, Ca, and Mg, and heavy metals like Zn, Fe, Cu, Cd, Pb, Ni, Co, and Mn in medicinal plants and their soil from the district of Kamber-Shahdadkot, Sindh, Pakistan. Five plant samples were collected from the study area and divided into five different parts: root, stem, leaf, seed, and flower. Five soil samples were collected from the same location from a 90 cm-deep ditch. Samples were prepared using acid digestion and analyzed using a flame atomic absorption spectrophotometer (FAAS). Multivariate statistical analyses, including correlation coefficient analysis, principal component analysis, cluster diagrams, and Piper diagrams, were conducted for better interpretation of the data. The concentrations of Na, K, Mg, and Ca in plants varied from 368 to 2,480 mg/kg, 866 to 1,349 mg/kg, 455 to 1,530 mg/kg, and 1,840 to 17,360 mg/kg, respectively, while heavy metals varied as follows: Fe (10.96 to 1,115.2 mg/kg), Mn (0-59.04 mg/kg), Cu (0-68.4 mg/kg), Cr (0-7.68 mg/kg), Pb (0.32-25.28 mg/kg), Zn (0-56.28 mg/kg), and Ni (0.88-8.40 mg/kg). The trace element values varied from plant to plant and also among different plant parts. The correlation and principal component analyses indicated that the major parameters showed strong positive loadings with each other, and the Piper diagram indicated that calcium is the predominant cation. The present study compares the major and trace metals in medicinal plants and their associated soils. The physicochemical results of the soil samples indicated variations from place to place due to differences in soil quality across locations.

***Keywords*:** metals, medicinal plants, principal component analysis, soil

1. Introduction

Medicinal plants are mostly used in medicine for long time due to they are low cost, nontoxic in nature, have ease of access and are freely available.[1] Most of the population in emerging countries depends on alternative medicine for primary health care.[2] The chemical constituent in the medicinal plants exhibited the most important nutritional and medicinal properties.[3] Plants can transport metals from soils and nowadays this deposition is the most important environmental concern. It is not harmful to crops themselves as well as to human health and animals.[4] The effectiveness of medicinal plants in handling various therapeutic/ailments actions is directly depend on the concentration of trace

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metals and their complexation with many chemotherapeutic agents.[5] Trace metasl play a main role in medicinal plants' quality which leads to the creation of the active chemical ore and components.[6] Many metals are necessary for nutrients including sodium, calcium, potassium, magnesium, iron, zinc, manganese, cobalt and copper but higher concentrations can cause serious concern for human health.[7] The determination of major and trace metals is necessary to decide the amount of the herbal medications prepared by these plants. Thus great attention to establishing the number of metals in medicinal plants due to the higher levels, they might show toxic effects.[8] Soil contamination is produced by adding metals to the soils through human usage including agriculture chemicals such as insecticides, herbicides, fungicides, fertilizers, wind and unclean water.

It is also contaminated by industrial, urban and biological waste.[9] The grasslands possess deep soils that are nutrient rich due to the large amount of the plant's tissues (biomass) which die off and put into the soil by breakdown every year.[10-11] Nutrient control occurs in soils which is the most essential affecting factor in the arrangement of the plants.[12] The soil is mainly composed of minerals and organic tissues having different textures, structures, color consistency, biological, chemical, and other features that cover the earth's surface.[13] There are many studies that have reported the analysis of heavy metals from medicinal plants and soil. Parveen et al.[14] examined the different minerals (Cd, Co, Ca, Zn, Cr, Fe, Cu, Mg, Pb, Mn and Sr) from the 8 selected medicinal plants. Sajad et al.[15] analyzed chromium in the different parts of plants and soil of different sites and plant parts. Hosseini et al.[16] examined the soils and two main herbaceous species *Cardaria draba* and *Achillea wilhelmsii*. Massadeh et al.[17] reported metal contents in the leaves and stems of the medicinal plant *Artemisia herba-alba* and also their soil samples were analyzed. Jena et al.[18] evaluated the heavy metals concentration in the *Mentha longifolia* medicinal plant. Shah et al.[19] examined heavy metals in four selected medicinal plants *Rhazya stricta*, *Capparis spinosa*, *Tamarix articulate* and *Peganum harmala*. Annan et al.[20] examined 5 minerals lead, mercury, arsenic, aluminum and cadmium were measured in 10 medicinal plants from 5 different locations. Stanojkovic-Sebic et al.[21] assess the heavy metals in selected medicinal plants *Mentha piperita*, *Matricaria chamomilla*, *Foeniculum vulgare* and *Melissa officinalis*. The present research concluded that the results of heavy metals in the studied Humogley type of plants and soil were within the allowable limits. The chief objectives of the proposed research are to assess the trace and heavy metals in medicinal plants and their soil in the selected area of Sindh.

2. Materials and method

2.1 *Study area*

The district Kamber/Shahdadkot has coordinates 27°35′21″ N 68°00′00″ E and a total area of 14.53 lakh hectares and 13.41 lakh population with 2.8% population progress rate. The district is distributed into 7 different taluka including Nasirabad, Warah, Kamber, Miro Khan, Shahdadkot, Sijawal Junejo and Qubo Saeed Khan. The district Kamber/Shahdadkot border is connected with three districts of Baluchistan Province including Jhal Magsi, Jaferabad and Khuzdar. It is also bordered connected with three districts of Sindh Province including Larkana, Jacobabad and Dadu. The district possessed khirthar mountain range for nearly 300 km from east of Baluchistan to west of the Arabian Sea. Khirthar range contains limestone hills and agriculture lands including wetlands such as Hamal Lake, Drigh Lake and Langh Lake.[22]

2.2 *Geological condition of study area*

The sample was collected from adjoining areas of the famous Hamal Lake. These Hamal Lake possessed sandy rocks collected from limestone, sandstone and claystone.[23] The main cultivated crops of district Kamber/Shahdadkot are rice and wheat whereas some crops including maize, sorghum, and sesame are cultivated.

2.3 *Collection of plants and soil samples*

The five plant samples were collected from the district Kamber-Shahdadkot Sindh. The five different parts of plants such as the root, stem, leave, seed and flower of the five medicinal plants collected. A totalof five soil samples were collected from the same location from plant samples were collected at a 90 cm deep ditch. One side of the ditch was made vertical and marks at 40, 60 and 90 cm depth were put. Soil samples were collected from surfaces 40, 60 and 90 cm and mixed to homogenous the soil with different depths. A total 1 kg of each soil sample was taken and packed in polyethylene bags.[24]

2.4 *Sample preparation*

The plant samples were dried under shade for about 15-30 days and ground. Further; plant material was grinded and made finely powdered which were stored in the tight bags. The soil samples were also grinded by mortar and pestle and the sample was used for analysis.

2.5 *Physiochemical parameters analysis*

The 40 g of soil was taken and added to the 120 ml of distilled water and then the pH sample was analyzed by the pre-calibrated (Orion 5 Star) pH meter. The soil water extract 1 : 3 was prepared and electrical conductivity (EC) and total dissolved solids (TDS) were measured using Orion 5 Star conductivity and TDS meters. For the determination of Chloride 10 ml of 1 : 3 soil water extract was taken in the conical flask and added few drops of indicator potassium chromate and mixture was titrated with 0.05 N solution of silver nitrate till brick red precipitates were obtained. The total hardness was analyzed by complex metric titration method taking 5 ml of soil sample (1 : 3) added 1 ml of ammonia buffer solution and some Eriochrome Black T (EBT) as indicator was added and then titrated against (0.01 N) Na_2EDTA solution and the color of the solution was changed from wine red to blue at the endpoint. The alkalinity was analyzed by titration method taken 5 ml of soil sample 1 : 3 water extract in a conical flask and a few drops of methyl orange were added and then titrated against 0.01 N solution of HCl and the yellow color turned reddish at the endpoint.[25]

2.6 *Acid digestion method for metal analysis*

The 1.0 gram of sample was placed in volumetric flask and were added 5 ml of the HNO_3 and 2.5 ml of hydrogen peroxide, then sample was placed at room temperature for three hour. Volumetric flask was covered by watch glass and after 3 hours sample was heated at 95 °C on hot plate until volume was reduced to 0.5 ml and clear solution was obtained then sample was cooled. After that 5 ml of HNO_3 1% was added to the sample and then solution was filtered by whatman filter paper.[26] The final volume 25 ml was made up by deionized water finally mineral analysis were done through atomic absorption spectrophotometer (AA. 800 Perkin Elmer). Using recommended procedure by manufacture. First analyzed the five standard with different concentration 2.0, 4.0, 6.0, 8.0 and 10 ppm to create the calibration curve. If R^2 value of calibration curve was 0.999 then samples were analyzed. The samples were measured triplicate with delay time 3 second.[23] During the samples digestion used mask, hand gloves, acid-washed equipment, reagent blanks to avoid cross-impurities between samples.

3. Results and discussion

3.1 *Minerals content in medicinal plants*

It is investigated that the metal content in medicinal plants is different from spot to spot, plant to plant and also different part to part of plants which depends upon the chemical composition of the soil. Plants absorb minerals and water from the soil and also heavy metal transportation occurrs the same way. These metals are accrued in plants and then arrived into the biological chain after consumption of plants by humans and animals. The appropriate amount of minerals present in the various parts of the medicinal plants. The concentration of Na, K, Ca and Mg varied from 368 to 2,480 mg/Kg, 866 to 1,349 mg/Kg, 455 to 1,530 mg/Kg and 1,840 to 17,360 mg/Kg respectively (Table 1). The concentration of Calcium was found to be higher than other major elements. The highest concentration of potassium is present in the leafy materials than other nutrients. One major feature of potassium is the high rate taken up by plant tissues. The higher concentration of iron investigated in the roots of most plants may be due to the higher absorption capability of iron in the roots and the greater concentration of iron in the soil. The results of iron in the different parts of medicinal plants varied from 10.96 to 1,115.2 mg/kg. The present finding indicated that most parts of *Achyranthes aspera* were the richest sources of iron whereas the highest concentration of Fe (1,115.2 mg/Kg) was found in the seeds of *Achyranthes aspera*. It will be beneficial for consumers because of iron. The 20 mg/Kg World Health Organization (WHO) recommendation level of iron in the medicinal plants whereas nutritional consumption is 10-28 mg/day.[27]

Table 1. Principle Macro minerals composition in the soil and medicinal plants

Botanical name of plants	Parts	Calcium mg/Kg	Potassium mg/Kg	Magnesium mg/Kg	Sodium mg/Kg
Solanum Surrattense	Soil	1,704.8	63.76	541.52	340.4
	Roots	12,640	1,221.6	870.2	1,760
	Stem	16,000	1,349.6	903.3	1,360
	Leaves	17,360	1,257.6	912.8	1,736
	Flowers	2,656	1,278.4	695.4	1,600
	Fruits	1,840	1,274.4	728.1	504
Rhazya Stricta	Soil	1,741.6	65.44	519.28	152
	Roots	3,360	1,055.2	455.4	800
	Stem	2,000	1,214.4	660.2	368
	Leaves	9,760	1,312	988.8	1,048
	Flowers	2,100	1,132	1,250	700
	Seeds	2,080	1,245.6	1,530	2,480
Moringa oleifera	Soil	1,701	55	535	320
	Roots	12,534	1,204.8	864.2	1,768
	Stem	15,103	1,212.8	903.1	1,136
	Leaves	17,241	1,312.8	562.9	1,680
	Flowers	2,532	1,101.6	679.6	1,300
	Seeds	1,782	1,200	650.5	1,600
Achyranthes aspera	Soil	1,816.8	122.32	528.08	296.8
	Roots	3,760	1,280	618.7	1,760
	Stem	9,120	1,284.8	971.2	1,752
	Leaves	11,280	1,361.6	669.8	608
	Seeds	2,100	1,338.4	567.5	1,600
Ricinus communis	Soil	1,524.8	124.72	611.04	274.64
	Roots	2,960	1,235.2	693.9	1,384.8
	Stem	4,664	1,333.6	767.2	1,056.8
	Leaves	2,048	1,093.6	757.3	971.2
	Flowers	8,100	866.4	1,039.3	1,100
	Seeds	9,760	1,245.6	1,122.6	1,576.8

Table 2. Trace elemental composition in the soil and medicinal plants

Botanical name of plants	Parts	Iron mg/Kg	Zinc mg/Kg	Lead mg/Kg	Cadmium mg/Kg	Nickel mg/Kg	Copper mg/Kg	Manganese mg/Kg	Cobalt mg/Kg	Chromium mg/Kg
Solanum Surrattense	Soil	194.5	1,323.2	3.52	0.2	6.56	47.44	480.8	55.28	21.28
	Roots	112.34	38.48	14.64	BDL	3.52	BDL	20.96	7.6	4
	Stem	212.8	30.16	0.32	BDL	3.28	BDL	9.6	BDL	3.04
	Leaves	437.76	24.48	25.28	BDL	3.44	6.96	BDL	8.76	0
	Flowers	289.04	37.76	9.12	BDL	3.04	BDL	BDL	BDL	2.48
	Seeds	19.12	8.48	20.96	BDL	3.44	BDL	19.96	3.6	4.88
Rhazya Stricta	Soil	175	856	5.12	0.129	8.4	45.92	361.68	34.64	6.16
	Roots	249.2	26.32	17.44	BDL	2.32	BDL	BDL	BDL	0.32
	Stem	337.92	27.2	3.52	BDL	2.64	8.08	44.08	6.88	0
	Leaves	114.72	38.48	4.88	BDL	2.96	BDL	59.04	BDL	7.68
	Flowers	156	20.8	11.68	BDL	0.64	9.76	BDL	BDL	0
	Seeds	154.32	56.48	BDL	BDL	2.4	BDL	BDL	15.24	0
Moringa oleifera	Soil	198.2	1,204	4.2	0.22	7.4	50	450	45.1	20.4
	Roots	35.12	2.24	0.56	BDL	1.68	BDL	45.04	BDL	0
	Stem	312.48	15.2	5.68	BDL	2.72	BDL	BDL	25.68	0
	Leaves	625.52	17.6	10.8	BDL	3.12	BDL	BDL	BDL	0
	Flowers	460.88	14.64	15.24	BDL	1.52	19.12	BDL	BDL	0.8
	Seeds	10.96	26.0	BDL	BDL	2.8	4.8	BDL	BDL	0
Achyranthes aspera	Soil	158.9	752.08	5.0	0.24	6.72	49.2	210.4	35.44	3.12
	Roots	637.2	16.08	14.72	BDL	0.88	20.68	BDL	1.68	0
	Stem	340.56	24.0	3.76	BDL	2.64	BDL	BDL	BDL	0
	Leaves	371.44	20.16	12.96	BDL	2.48	BDL	BDL	17.2	0.56
	Seeds	1,115.2	18.16	14.72	BDL	1.76	17.72	40.2	BDL	0
Ricinus communis	Soil	190	952.8	2.64	0.248	6.64	37.6	308.16	40.32	24.08
	Roots	211.28	BDL	BDL	BDL	1.2	64.8	BDL	BDL	0
	Stem	371.68	1.12	3.28	BDL	1.92	49.12	BDL	BDL	0
	Leaves	169.84	1.28	1.28	BDL	2.08	22.48	BDL	BDL	0
	Flowers	207.2	54	1.54	BDL	1.12	20.24	BDL	BDL	0
	Seeds	169.28	BDL	BDL	BDL	1.68	20.8	BDL	BDL	0

BDL-below detection limit

The result of manganese was observed to range from (BDL-59.04 mg/Kg), copper was observed to range from (BDL-64.8 mg/Kg). The cadmium was not present in the plant samples. Present finding chromium was observed to range from (BDL-7.68 mg/Kg) which was lower than the reported range between (2.6-30 mg/Kg). The result of lead was observed to range between (BDL-25.28 mg/Kg) which was lower than the reported range between (2.0-16.5 mg/Kg). The result of iron was observed to range between (10.96-1,115.2 mg/Kg) which is lower than the reported range between (274-341 mg/Kg).[19] The plants get sufficient levels of these elements from the soil where plants grow. The higher concentration of trace elements including copper exist in the ground parts of the plants due to plants having absorption capacity to get the trace elements from soils. Copper is very essential for the growth of plants. The results of copper varied from BDL to 20.68 mg/Kg. The result of manganese was observed to range from (0-59.04 mg/Kg). WHO limit of Mn in plants is 200 mg/kg, and the daily intake is 11 mg.[27] The Zn Content of the medicinal plants ranged between 0-56.48 mg/Kg and 50 mg/Kg WHO recommendation Level in the medicinal plants whereas the Zn intake in the food was 11 mg/Kg.[19] The Nickel Content of the medicinal plants ranged between 0.88-8.40 mg/Kg and 1.5 mg/Kg WHO recommendation level in the medicinal plants whereas Nickel intake in the food was 1 mg/day.[27] Nickel plays a key role in the metabolism of cholesterol, glucose and fat. Nickel deficiency causes hyperglycemia, decreased sperm count, and increased body fat whereas nickel's high concentration leads to toxic and carcinogens.[28] The Cr contents in the medicinal plants ranged from (BDL-7.68 mg/Kg) (Table 2). Chromium range may be depended on the absorption of chromium content from the polluted air and 1.5 mg/Kg WHO recommendation Level in medicinal plants whereas Cr intake in food 0.2 mg/Kg).[27] Parveen et al.[14] reported analyses on metals Cd, Co, Ca, Zn, Cr, Fe, Cu, Mg, Pb, Mn and Sr) from the 8 selected medicinal plants (*Phyllanthus emblica*, *Carrisa opeca*, *nigrum*, *Zizyphus*, *Solanum nummularia*, *Physalis minima*, *Zizyphus mauritiana*, *Phoenix dactylifera* and *Opuntia dillenii*) and their soil samples. The obtained average results of Zn (125 mg/kg), Cr (19.0 mg/kg) and Cu (14.4 mg/kg) in the fruits of nummularia, *Physalis minima* and *Carrisa opeca*, while *O. dillenii* indicated the mean values for Sr (61.4 mg/kg), Cd (3.49 mg/kg), Mn (44.6 mg/kg), Ca (6.62%) and Mg (0.21%). Though, highest average results in Pb (41.7 mg/kg) and Co (38.4 mg/kg) were obtained in *Z. mauritiana*. Sajad et al.[15] analyzed chromium in the different parts of plants and soil of different sites and plant parts (roots and shoots) was found in soil 0.33-48.73, roots 8-1,233.3 and 10.23-568.33 mg/kg respectively. The highest level of Cr was found in soil 41 (48.73 mg/kg) followed by site 18 (47.83 mg/kg). The highest level of Cr was found in the root of *Cannabis sativa* (1,233.3) while the shoot of *Allium griffithianum* (568.33) was reported. Hosseini et al.[16] examined the soils and two main herbaceous species *Cardaria draba* and *Achillea wilhelmsii*. The results showed that the average value of Cu, Cd, Ni, Zn and Pb in soil samples from 18.74, 0.26, 18.21, 62.25 and 14.98 mg/kg respectively. Moreover, the average value of *A. wilhelmsii* was Cu 4.52, Cd 0.16, Pb 1.91, Ni 1.70 and Zn 44.80, while *Cardaria draba*, mean values were found 0.16, 2.29, 2.58, 1.60, and 31.29, for Cd, Cu, Pb, Ni and Zn respectively. Massadeh et al.[17] reported metal contents in the leaves and stems of the medicinal plant *Artemisia herba-alba* and soil samples were analyzed. The mean value of soil samples varied were Pb 63.2, Cu 26.69, Zn 126.43, Cd 11.92, Ni 70.35, and Fe 28,257 µg/g respectively. The *A. herba-alba* leaves were greater than the stems. The heavy metal results varied from Fe 334.77 µg/g, Cu 19.88, Pb 20.92, Ni 4.13 and Zn 25.64 µg/g and higher level Cd 2.40 µg/g was obtained in stems of *A. herba-alba*. Jena et al.[18] evaluated the heavy metals concentration in the *Mentha longifolia* medicinal plant. The Cr level was found in leaves at 43 mg/kg and roots at 23 mg/kg, Mn 300 to 350 mg/kg, Fe varied from 5,689 mg/kg in root and 4,980 mg/kg in leaf, Cu 0.58 mg/kg in leaves and Zn 0.84 mg/kg in leaves. Shah et al.[19] examined heavy metals in four selected medicinal plants *Rhazya stricta*, *Capparis spinosa*, *Tamarix articulate* and *Peganum harmala*. The results of heavy metals in selected plants were obtained in increasing order as Pb < Cd < Cr < Ni < Cu < Mn < Zn < Fe. Annan et al.[20] examined 5 minerals lead, mercury, arsenic, aluminum and cadmium were measured in 10 medicinal plants from 5 different locations. Stanojkovic-Sebic et al.[21] assess the heavy metals in selected medicinal plants *Mentha piperita*, *Matricaria chamomilla*, *Foeniculum vulgare* and *Melissa officinalis*. The present research concluded that the results of heavy metals in the studied Humogley type of plants and soil were within the allowable limits.

3.2 *Minerals content in soil*

The appropriate amount of minerals present in the soil samples. The concentration of major elements like sodium, potassium, calcium and magnesium varied from 152 to 340 mg/Kg, 55 to 124 mg/Kg, 1,524 to 1,816 mg/Kg and 519 to 611 mg/Kg respectively (Table 1). The concentration of calcium and magnesium was exceeded as compared to sodium and potassium, which may be due to the geological nature of the soil. The concentration of trace elements varied from

Fe 158 to 198 mg/Kg, Zn 752 to 1,353 mg/Kg, Pb 2.64 to 5.12 mg/Kg, Cd 0.12 to 0.25 mg/Kg, Ni 6.56 to 8.4 mg/Kg, Cu 37.6 to 50 mg/Kg, Mn 210 to 480 mg/Kg, Co 34.64 to 55.28 mg/Kg and Cr 3.12 to 24.1 mg/Kg respectively. The higher concentration of zinc and iron present in the soil as compared to other trace elements and cadmium and lead showed the lowest concentration as compared to other elements (Table 2).

The physiochemical study of the soil is depended on the different parameters including pH, conductivity, total dissolved solids, salinity, alkalinity, total hardness, chloride, SO_4, dissolve oxygen. In the present study, the pH of the soil ranged from 8.30 to 8.43 which indicated that samples were slightly alkaline, which may lead to soil nutrient deficiency. The deficiency of nutrients including iron, zinc, manganese, copper and boron lead to a decrease in the growth of plants. Electrical conductivity and TDS value ranged from 717 to 3,950 µS/cm and 458 to 2,528 mg/Kg, however, samples show excess content of soluble salts may be due to excess usage of fertilizer including P and K. The total dissolved solids are complexes of minerals including calcium, sodium, magnesium, sulphate, bicarbonate chloride and a few organic molecules. Salinity results ranged from 0.4 to 2.1 g/Kg which is considered slightly saline.

The result of alkalinity, total hardness, chloride, sulphate and dissolved oxygen of the soil ranged from 100 to 260 mg/Kg, 160-400 mg/Kg, 56 to 150 mg/Kg, 23 to 279 mg/Kg and 4.14 to 4.73 mg/Kg respectively. It is revealed that alkalinity in the soil is due to the presence of bicarbonate, carbonates and hydroxides. The main sources of alkalinity are rocks and sediment weathering. The total hardness shows the presence of magnesium and calcium in the soil. The higher SO_4^{2-} concentration which effect gastrointestinal irritation and a cathartic effect. Chloride is present in the soil including inorganic substances, fertilizers, agriculture landfills, irrigation wastes, animal feeds and contaminated sea water. The chloride is formed complex with metal ions to make soluble salts. Dissolved oxygen is most important for life which is required for breathe of living organisms (Table 3).

Table 3. Physical and chemical parameters of soil selected for wild medicinal plants

Botanical name of plants	pH	EC µS/cm	TDS mg/Kg	Sal g/Kg	Alk mg/Kg	TH mg/Kg	Cl mg/Kg	SO_4 mg/Kg	DO mg/L
Solanum surrattense (SS)	8.30	1,725	1,104	0.9	140	320	133	72	4.62
Rhazya stricta (RS)	8.43	717	458	0.4	100	160	41	23	4.14
Moringa oleifera (MO)	8.32	1,800	1,005	0.8	160	350	150	80	4.5
Achyranthes aspera (AA)	8.30	3,950	2,528	2.1	260	240	442	279	4.21
Ricinus communis (RC)	8.43	1,158	741	0.6	120	400	56	32	4.73

3.3 *Correlation analysis*

The coefficient of determination was observed in the parameters of the sampling site.[29] The pH is less correlated with K, Mg, Fe, Ni and Cr (< 0.5) whereas negatively correlated with all other parameters. The alkalinity is well correlated with Mg and Cr (0.746-0.976), chloride was well correlated with Cu but moderately correlated with Ca, SO_4 and Na (0.5-0.7). Sulphate was well correlated with Fe, Zn and Mn. Calcium was well correlated with Pb and Cu. Fe was well correlated with Zn, Mn, Cr and Zn also well correlated with Mn and Cr. The Cd was moderately correlated with EC, alkalinity, K, Mg and Na (0.535-0.728), less correlated with Cl, Fe and Zn, and negatively correlated with other parameters (Table 4). The correlation indicated that major parameters are well correlated with each other and indicated samples are similar sites.

Table 4. Correlation determination of soil samples parameters

Parameters	pH	EC	Alk	Cl	SO_4	Ca	K	Mg	Na	Fe	Zn	Pb	Cd	Ni	Cu	Mn	Cr
pH	1.000																
EC	-0.720	1.000															
Alk	0.373	-0.266	1.000														
Cl	-0.962	0.664	-0.442	1.000													
SO_4	-0.479	-0.207	0.082	0.529	1.000												
Ca	-0.573	0.597	-0.929	0.628	-0.138	1.000											
K	0.177	0.455	0.477	-0.312	-0.691	-0.238	1.000										
Mg	0.449	-0.279	0.976	-0.560	-0.062	-0.927	0.565	1.000									
Na	-0.777	0.473	0.281	0.685	0.635	-0.066	0.040	0.189	1.000								
Fe	0.038	-0.615	0.478	-0.005	0.838	-0.623	-0.527	0.372	0.379	1.000							
Zn	-0.395	-0.316	0.128	0.380	0.955	-0.238	-0.655	0.037	0.603	0.865	1.000						
Pb	-0.191	0.350	-0.894	0.323	-0.337	0.898	-0.242	-0.893	-0.450	-0.668	-0.469	1.000					
Cd	-0.342	0.535	0.654	0.252	0.086	-0.337	0.642	0.594	0.728	0.067	0.025	-0.536	1.000				
Ni	0.486	-0.492	-0.501	-0.284	-0.177	0.266	-0.522	-0.515	-0.824	-0.109	-0.253	0.618	-0.843	1.000			
Cu	-0.762	0.495	-0.800	0.868	0.346	0.870	-0.530	-0.892	0.244	-0.190	0.189	0.707	-0.219	0.191	1.000		
Mn	-0.179	-0.552	-0.060	0.227	0.884	-0.162	-0.866	-0.143	0.267	0.841	0.924	-0.261	-0.334	0.130	0.225	1.000	
Cr	0.052	-0.465	0.746	-0.099	0.685	-0.801	-0.159	0.672	0.521	0.917	0.751	-0.901	0.385	-0.432	-0.434	0.604	1.000

3.4 *Cluster analysis*

The method of cluster analysis was applied for the five soil samples of the areas to investigate similarity among soil samples (Figure 1) and the samples were grouped into clusters in the dendrogram.[30] The diagram comprises three cluster groups, cluster 1 comprises two samples 1, 3 and cluster 2 comprises also two samples 2, 5 and cluster 3 comprise only samples 4. It is revealed that cluster samples have higher level parameters than groups 1 and 2. The cluster 2 possesses higher values in terms of average concentration than cluster 1.

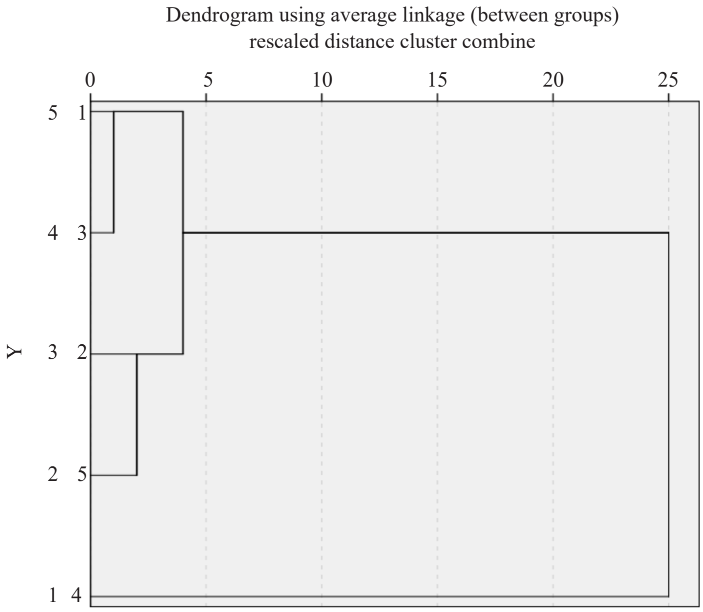

Figure 1. Cluster analysis of soil samples parameters

3.5 *Hydro chemical faces analysis*

It is used to explain the hydrochemical arrangement in the two similar triangles with a diamond at the top of the plot.[31] The piper diagram showed the dominancy of anions and cations. The cations are gathered as Ca, Na, Mg, K in the left triangles and anions SO_4, HCO_3 and Cl in the right triangles which shows the soil nature. The five samples applied for the piper diagram indicating the hydrochemical composition of the sampling site (Figure 2). The right triangle indicated that HCO_3 was predominance in two samples and three samples gathered in the middle of the triangle showed mixed-type water. The left triangle indicated a higher predominance of Ca towards Na and K and Mg all sample dots gathered towards the Ca side which indicates Ca rich soil. The Cl, SO_4 and Ca, Mg is found at both sides simultaneously and arrows are raised upwards within a diamond shape. The most of samples grouped upwards Ca and Cl which predominance of $CaCl_2$.

3.6 *Principal component analysis (PCA)*

The PCA was applied to describe the variance of a large data set with a small set of independent variables. The variance was varied from each PCA The loading of PCA depends on the eigenvalues, with higher eigenvalues indicating strong positive loadings of parameters in the PCA. The variance varied across different PCA (Table 5, Figure 3). Loading components are included for the rotated matrix, eigenvalues for the components three and cumulative percent of the variance which is defined by each component.[32-33] The three rotated principle rotated components relation together for 97.677% of the total variance of the set of data in which first component relations for 43.212%, second 29.029% and third 25.441%. The eigenvalues of the first component were greater than others (first 9.507, second 6.385 and third

5.597), which can be utilized for evaluation of the leading hydrogeochemical process. Component 1 is loaded 43.212% which indicates the parameters alkalinity, total hardness, DO, Mg, Cd and Cr. Similarly, component 2 which has 29.029% showed high loading for sulphate, Fe, Zn, Mn and Co component 3 has been loaded at 25.441% which showed good and positive loading for EC, TDS, salinity, Cl, and Na.

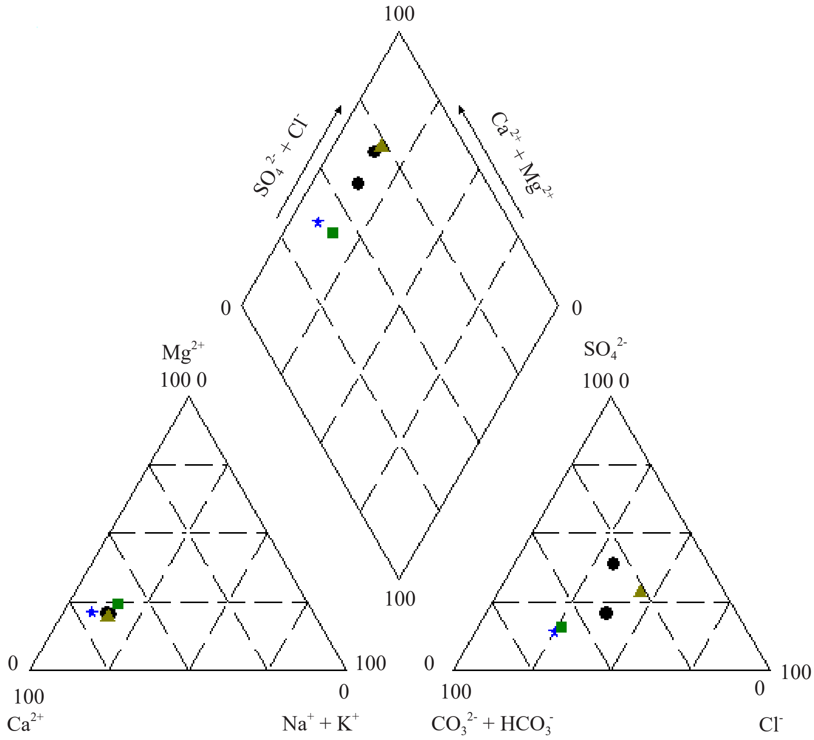

Figure 2. Piper chart for anions and cation of soil samples

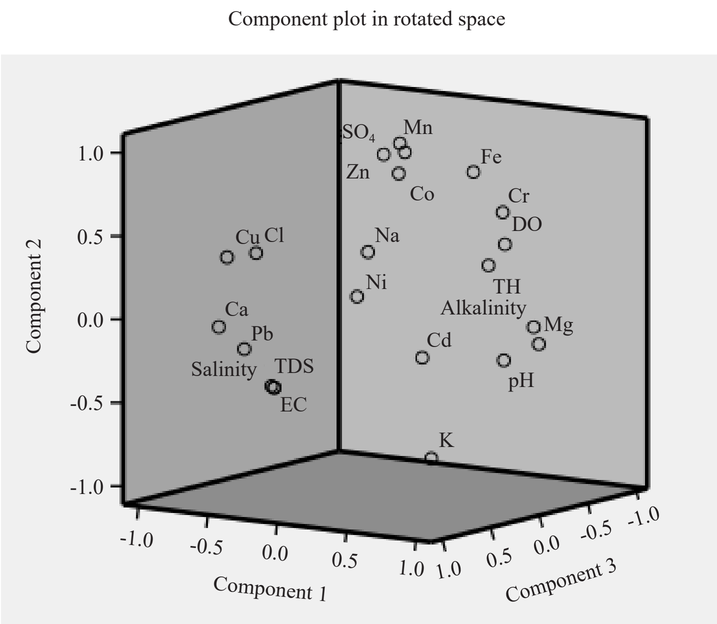

Figure 3. Rotated principal components analysis of soil samples parameters

Table 5. Principal component analysis of soil samples

Parameters	Components 1	2	3
pH	0.237	-0.397	-0.883
EC	-0.149	-0.339	0.929
TDS	-0.149	-0.339	0.929
Salinity	-0.170	-0.332	0.927
Alkalinity	0.973	-0.017	-0.138
TH	0.876	0.391	0.187
Cl	-0.361	0.430	0.812
SO_4	0.089	0.971	0.144
DO	0.869	0.491	0.008
Ca	-0.877	-0.116	0.460
K	0.536	-0.787	0.290
Mg	0.974	-0.126	-0.190
Na	0.408	0.507	0.759
Fe	0.433	0.837	-0.290
Zn	0.174	0.979	0.046
Pb	-0.935	-0.304	0.114
Cd	0.721	-0.111	0.649
Ni	-0.671	-0.076	-0.669
Cu	-0.773	0.322	0.524
Mn	-0.072	0.964	-0.253
Co	0.244	0.881	0.209
Cr	0.745	0.648	-0.146
Eigenvalues	9.507	6.385	5.597
% of variance	43.212	29.029	25.441
Cumulative %	43.212	72.236	97.677

4. Conclusion

The present study explored the metal contents in the medicinal plants and their soil in the selected area district Kamber-Shahdadkot Sindh. Different metals were analyzed such as Na^+, Ca^{2+}, K^+, and Mg^{2+}, and heavy metals Fe, Zn, Cu, Co, Cr, Pb, Mn, and Ni. The metal content in plants is directly proportional to their soil because plants take metal from the soil. The soil varies from place to place and time which directly affects the metal contents in the soil. The process of trace element uptake by plants is complex. It depends on several factors, including soil pH, organic matter, metal bioavailability, plant species, and absorption ratios of plants because plants absorb water and minerals from the soil, and trace element uptake occurs in the same ways. Heavy metals pose various health problems for humans because they consume plants. Soil is the main source of heavy metals in plants, if a particular heavy metal in soil is rich then it comes into plants, and then these plants are consumed by humans directly or indirectly. Toxic heavy metals like Cr, Cd, Pb, etc reach the human body and show a negative impact on human health, they must be checked out for contaminated loads of plants and also for further pharmaceutical purposes and local human consumption. The multivariate statistical analysis like correlation coefficient and principle component analysis indicated that major parameters were good positive loading for each other and the Piper diagram indicated calcium is predominance for all anions and cations in the soil samples.

Authors' contributions

The first was collected the soil and plants samples, second author analyzed the samples for metal analysis and also preparation of the manuscript, third author give methodology for analysis and fourth author helped for the preparation of the manuscript and final checking.

Conflicts of interest

The authors declare no competing financial interest.

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