# Spectroscopic Study of Elements in Various Therapeutic Plants and Soil

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**ABSTRACT**

**Objective:** The study was designed with the aim to find out the concentrations of essential and non essential heavy metals such as Nickel, Copper, Iron, Zinc, Chromium, Cadmium and Lead in selected therapeutic plant samples and soil.

**Methods:** Plant samples like *Malva parviflora, Polygonum aviculare, Anagallis arvensis, Solanum nigrum, Coronopus didymus, Aerva tomentosa, Alternanthera pungens* and *Cenchrus ciliaris* were collected from District Karak, Khyber Pakhtunkhwa, Pakistan. Dry method was adapted to digest the plant material and then heavy metals were investigated by using Flame Atomic Absorption Spectrophotometer.

**Results:** Results showed that highest concentration of zinc was found in *Polygonum aviculare* 80.13 mg/kg followed by *Anagallis arvensis* 66.14 mg/kg. Similarly maximum amount of iron was recorded in *Anagallis arvensis*, 75.35 mg/kg followed by *Cenchrus ciliaris* 53.10 mg/kg. The copper concentration was found beyond the permissible limit in all therapeutic plants.

**Conclusion:** The metals content in soil was higher as compared to the plant samples. The concentration of metals in each plant was also significantly different which may be due to the metals uptake rate of plants from the soil or metabolism of the plant.

**KEYWORDS**: Therapeutic plants, Soil, Elements, Atomic Absorption Spectrophotometer

## 1. INTRODUCTION

Therapeutic plants are world widely employed to treat various diseases of human beings because of their availability, low toxicity, effectiveness, affordability and acceptability as they contain active constituents from natural sources and are of great concern for scientists [1]. The Medicinal and dietary values as well as the toxicity of plants depend on the chemical composition including metal ions. All plants contain heavy metals in trace or negligible amount as micronutrients and when the uptake of heavy metals become greater, they contaminate the environment thus leads to adulterate food supply [2]. These metals have the potential to accumulate in different organs of the body for a long period of time as some of them possess longer biological half-lives thus can cause toxicities and unwanted effects [3]. Therapeutic plants are easily contaminated during growth, development and processing. Heavy metals pollution is one of the problems that arise due to the increased uses of fertilizers and other chemicals to meet the higher demands of food production for human consumption. As food safety is a major public health problem of concerned worldwide. It is therefore necessary to control the level of toxic metals and other contaminants in Therapeutic plants [4]. The selection of these plants was based on the fact that these plants were not previously screened for such perspective.

## 2. MATERIALS AND METHODS

**2.1. Chemicals and Reagents:** Analytical grade 65% $HNO_3$ were purchased from Sigma- Aldrich Company for digestion purposes, while standard solutions of selected elements were used as a reference materials.

**2.2. Instrument and Apparatuses:** Flame Atomic Absorption Spectrophotometer model Perkin Elmer 400 was used for the investigation of selected elements. All glassware were soaked in $HNO_3$, washed with deionized water and then rinsed with distilled water to avoid contamination.

**2.3. Sample collections:** Fresh samples of eight therapeutic plants were collected from District Karak, Khyber Pakhtunkhwa, Pakistan. Plants were washed with water to remove any dust particles and then rinsed properly with deionized water, dried under shed, grinded and stored in clean, dried plastic bottles. Similarly soil sample was taken from the upper 8-10 cm of soil from the spot of collected plant samples.

### 2.4. Digestion and Analysis of Samples

Weighed quantity of grinded powdered plant samples was kept in oven at $105^0C$ for 1 hour and then in desiccators to remove moisture. Then the moisture free sample was placed in furnace. The furnace temperature was gradually increased from room temperature to $550^0$C in one hour and the samples were ashed for 6 hours. The contents of crucible were cooled to room temperature in desiccators and 2.5mL of 6M $HNO_3$ solution was added into crucibles and when necessary, the mixture was heated to dissolve its content. The solution was filtered through whatman filter paper (#42) into 25mL volumetric flask. The solutions were stored in clean and dry plastic bottles. The soil sample was digested with a mixture of $HNO_3$ and $HClO_4$ [5, 6]. All the plant and soil samples were analyzed for the elements of interest like Zn, Fe, Mn, Ni, Cu, Cr, Cd, and Pb by Flame Atomic Absorption Spectrophotometer (Perkin Elmer 400) with suitable hollow cathode lamps.

## 3. RESULTS

Soil and plant samples like *Malva parviflora, Polygonum aviculare, Anagallis arvensis, Solanum nigrum, Coronopus didymus, Aerva tomentosa, Alternanthera pungens* and *Cenchrus ciliaris* were analyzed for heavy metals load and results were tabulated in table 2. The levels of Zn, Fe, Mn, Ni, Cu, Cr and Pb in soil sample were 99.34 mg/kg, 201.76 mg/kg, 150.23 mg/kg, 23.33 mg/kg, 59.01 mg/kg, 4.87 mg/kg 2.45 mg/kg and 16.09 mg/kg respectively. It is clear from table 2 that highest concentration of zinc was found in *Polygonum aviculare* 80.13 mg/kg followed by *Anagallis arvensis* 66.14 mg/kg and *Cenchrus ciliaris* 41.30 mg/kg while lowest level was noted in *Coronopus didymus*11.40 mg/kg. Similarly maximum amount of iron was recorded in *Anagallis arvensis* 75.35 mg/kg followed by *Cenchrus ciliaris* 53.10 mg/kg while minimum level was noted in *Coronopus didymus* 8.73 mg/kg. The concentrations of manganese in selected therapeutic plants were in the range of 33.71-88.31 mg/kg. As indicated by table 2 that level of Ni in *Polygonum aviculare* was noted high 15.09 mg/kg and lower in *Cenchrus ciliaris* 0.99 mg/kg. It was 1.28 mg/kg, 1.99 mg/kg, 8.37 mg/kg, 14.10 mg/kg, 10.00 mg/kg and 1.04 mg/kg in *Malva parviflora*, *Anagallis arvensis*, *Solanum nigrum*, *Coronopus didymus*, *Aerva tomentosa* and *Alternanthera pungens* respectively. The copper concentration was found beyond the permissible limits in all therapeutic plants as shown in table 2. It was observed maximum for *Alternanthera pungens* 35.70 mg/kg while lowest 11.57 mg/kg was recorded in *Solanum nigrum*. It is revealed from table 2 that chromium concentration was found in detectable range of 1.01 mg/kg for *Cenchrus ciliaris* to below detection level for *Anagallis arvensis*. Minute concentrations in other therapeutic plants of chromium were observed. Analysis of heavy metals in the plant samples show considerable ranges of cadmium as shown in table 2. High concentration of Cadmium 1.17 mg/kg was found in *Coronopus didymus* collected followed by *Solanum nigrum* 1.09 mg/kg to below detection level for *Aerva tomentosa*. It is revealed from the table 2 that Lead concentration was found variable in all therapeutic plants under observations. It was noticed high in *Solanum nigrum* 13.80 mg/kg followed by *Malva parviflora* 11.30 mg/kg to below detection level in *Anagallis arvensis.*

## 4. Discussion

Therapeutic plants are used worldwide to treat and cure various diseases, due to which the researchers have great concern to aware the public about the level and permissible limits of heavy metals in these species. Various therapeutic plants were collected and analyzed for heavy metals load, i.e. Iron, Zinc, Nickel, Copper, and Cadmium, Chromium and Lead. The deficiency and efficiency of these metals may cause harmful effects in both plants and humans. Exceed limits of Zn causes many complications and has adverse effects on brain development. Iron deficiency in plants produces chlorosis; however its high concentration also affects plant growth [7]. Increased concentration of Nickel leads to kidney damage and disorders of liver [8]. . High levels of copper may cause metal fumes fever with flue like symptoms, hair and skin discoloration, dermatitis, irritation of the nasal mucosa and nausea [9]. An elevated concentration of chromium between 5-30 mg/kg can lead to yield reduction in plants and bleeding tendencies, ulcer, lack of immune system [10]. Cadmium is highly toxic for the human bio-system, taken up from the soil, water, fertilizers, pesticides treatment and anthropogenic operations even at very low levels of intake [11].The concentration of metals in each plant was different which may be due to uptake rate or metabolism of the plants. Plants may be contaminated with metals from air, water and soil pollution. The therapeutic plants should be collected from non polluted areas and also each therapeutic plant should be thoroughly analyzed for heavy metals load used in the preparation of herbal products as local healer and standardized extracts before processing for Medicinal purposes**.**

**Author Contributions**

AR, HR, WA, A, LK and HI were involved in plant collection, processing and carrying out the experimental work. IA supervised the overall study. AR and AW drafted the article.

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**Ethical Approval**

The study was approved by the Ethical Committee of Kohat University of Science & Technology, Kohat, Kpk, Pakistan.

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Table 1. Local names and Medicinal uses of Therapeutic plants

| **Botanical Name** | **Local Name** | **Family** | **Medicinal Properties** |
|---|---|---|---|
| *Malva parviflora* | Marsh mallow | Malvaceae | Dysnea kidney disorders, antimicrobial properties, bruises and blister |
| *Polygonum aviculare* | Knotgrass | Polygonaceae | Dysentery, lung disorders, asthma, jaundice, |
| *Anagallis arvensis* | Red chickweed | Primulaceae | Antiseptic, hepatospleenomegaly |
| *Solanum nigrum* | Black nightshade | Solanaceae | Antipyretic agent, analgesics anti-tumorigenic, anti oxidant, diuretic |
| *Coronopus didymus* | Lesser swine-cress | Brassicaceae | Asthma, malaria, anticancer, emphysema, bronchitis |
| *Aerva tomentosa* | Desert cotton | Amaranthaceae | Analgesic, rheumatism, anthelmenthic, diuretic, astringent |
| *Alternanthera pungens* | Khaki weed | Amaranthaceae | Diuretic, dysentery, edema, gout, febrifuges, lactation stimulant, naso-pharyngeal infections, venereal diseases |
| *Cenchrus ciliaris* | Buffel grass | Poaceae | Anodyne, diuretic, emollient, folk remedies for kidney pain, tumors, sores and wounds |

Table 2: Concentration of heavy metals (mean + SD, n=3) in Therapeutic plants (mg/kg)

| Sample | **Zn** | **Fe** | **Mn** | **Ni** | **Cu** | **Cr** | **Cd** | **Pb** |
|---|---|---|---|---|---|---|---|---|
| Soil | 99.34 ±2.23 | 201.76 ±3.98 | 150.23 ±2.90 | 23.33 ±1.10 | 59.01 ±2.90 | 4.87 ±0.01 | 2.45 ±1.23 | 16.09 ±1.20 |
| *Malva parviflora* | 30.64 ±0.23 | 18.30 ±0.41 | 70.14 ±0.15 | 1.28 ±0.08 | 24.90 ±0.12 | 0.01 ±0.01 | 0.79 ±0.02 | 11.30 ±0.07 |
| *Polygonum aviculare* | 80.13 ±0.13 | 35.46 ±0.16 | 60.10 ±0.23 | 15.09 ±0.11 | 31.45 ±0.10 | 0.03 ±0.01 | 0.03 ±0.03 | 2.90 ±0.06 |
| *Anagallis arvensis* | 66.14 ±0.45 | 75.37 ±0.11 | 63.00 ±0.12 | 1.99 ±0.05 | 23.46 ±0.15 | BDL | 0.01 ±0.01 | BDL |
| *Solanum nigrum* | 31.37 ±0.42 | 21.46 ±0.21 | 48.20 ±0.43 | 8.37 ±0.13 | 11.57 ±0.16 | 0.19 ±0.01 | 1.09 ±0.03 | 13.80 ±0.03 |
| *Coronopus didymus* | 11.40 ±0.35 | 8.73 ±0.16 | 88.31 ±0.46 | 14.10 ±0.11 | 28.90 ±0.43 | 0.10 ±0.01 | 1.17 ±0.02 | 4.51 ±0.11 |
| *Aerva tomentosa* | 33.98 ±0.21 | 19.32 ±0.13 | 40.65 ±0.75 | 10.00 ±0.09 | 32.40 ±0.19 | 0.24 ±0.03 | BDL | 13.01 +0.31 |
| *Alternanthera pungens* | 26.46 ±0.31 | 18.55 ±0.10 | 33.71 ±0.12 | 1.04 ±0.10 | 35.70 ±0.34 | 0.30 ±0.02 | 0.11 ±0.04 | 9.00 ±0.08 |
| *Cenchrus ciliaris* | 41.30 ±0.18 | 53.10 ±0.12 | 75.30 ±0.45 | 0.99 ±0.03 | 11.90 ±0.13 | 1.01 ±0.03 | 0.31 ±0.03 | 5.46 ±0.90 |

BDL= Below Detection level