Investigations of Heavy Metals in Different Medicinal Plants

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ABSTRACT
The present study was conducted to determine the concentration of heavy metals in some selected medicinal plants taken from District Karak, Khyber Pakhtunkhwa, Pakistan. Essential and non essential heavy metals such as Zn, Fe, Mn, Cu, Ni, Cr, Pb and Cd were investigated in Rhyza stricta, Withania coagulans, Conyza canadensis, Steleria media, Medicago denticulata, Parthenium hysterophorous, Malvastrum tricuspidatum and Launaea nodicaulis by using Atomic Absorption Spectrometry. Plants showed different metal concentration in the range of: 10.11-55.98mg/kg for Zn, 40.47-101.87mg/kg for Fe, 29.11-105.46mg/kg for Mn, 15.06-34.52mg/kg for Cu, 1.02-10mg/kg for Ni, 0.01-0.76mg/kg for Cr, 0.99-15.46mg/kg for Pb and 0.10-1.41mg/kg for Cd. High contents of Fe and Mn were found in all eight plants. Other heavy metals were present in low quantity. The purpose of this study was to identify each type of metal associated with a given plants contaminated by environmental pollution and also to highlight the toxic heavy metals present in these plants.

INTRODUCTION
Medicinal plants are worldwide used in various disciplines of health care systems such as herbal, Ayurvedic, Unani and homeopathic systems of medicines in the form of herbs and standardized extracts. According to the advanced researches it has been suggested that plants contain secondary metabolites which are not only contain toxic substances (alkaloids), but they are also contaminated with environmental pollutants specially heavy metals, which are very dangerous to all living organisms upon long term exposures (Itanna, 2002; Lasis et al., 2006; Obi et al., 2006). Heavy metals are classified in two main categories i.e. essential and non essential heavy metals. Essential heavy metals (Cu, Cr, Zn, Fe, and Co) are present in very little concentration in the body for the proper functioning of enzyme systems, vitamin synthesis and hemoglobin formation in men and also required for the growth, development and photosynthesis in plants. On the other hand toxic metals (Pb, As, Cd and Hg) are not needed to perform specific function in the body and they have deleterious effects even at very low concentrations (Darwish et al., 2009; Friberg et al., 1986). According to the advanced research which has shown that crude extract of herbal origin can prove fatal for the health because these drugs may contain toxic metabolites or Some trace elements which cause damages to health. (Islam et al., 2007; Sing et al., 2006) Some heavy metals are needed by the body in very low concentration for proper functioning to synthesis various biomolecules inside the body. These trace elements are called essential heavy metals. Heavy metals are present in the environment which is subjected to bioaccumulation in food chains (WHO, 2007). Anthropogenic processes, involving the organic manure, synthetic fertilizers, industrial residues and lime upon exposer contribute various amounts of heavy metals to the ecosystem (Khan et al., 2002, Martins et al., 2008). Heavy metals cannot be decomposed by the microorganisms as they resistance to biodegradation (WHO, 2007). During cultivation process addition of synthetic fertilizers or lime is one cause which lead to enhance the concentration of heavy metals to the soil from where they are absorbed by the plants. Industrial exhaust, vehicle exhaust and careless handling of wastes are also the main cause of producing heavy metals which may pollute the environment (Khan et al., 2002). These contamination of heavy metals in medicinal plants remain continue during storage and transportation process of plants where these are exposed to environmental pollution, and heavy metals. The major source of accumulation of heavy metals in human organs because these medicinal plants are not only used as folk medicines and food supplements, but many of them is utilized as condiments in daily routine. WHO/FAO has put forward this critical issue and analyzed heavy metals in the herbal medicines along with other necessary
chemical, biological, and environmental analysis in their guidelines (WHO, 1993,) and also suggested the absorption, elimination, and toxic profiles of heavy metals. Although herbal drugs are utilized on large scale by the people but these may be contaminated with heavy metals beyond their recommended level. The biological effect caused by these heavy metals necessitates the need to assess the heavy metals level of medicinal plants before they are utilized or taken for medicinal purposes (Rehman et al., 2013).

EXPERIMENTAL

Sample Collection

Samples of different medicinal plants including *Rhyziza stricta*, *Withania coagolans*, *Conyza canadensis*, *Steleria media*, *Medicago denticulata*, *Parthenium hysterophorus*, *Malvastrum tricuspidatum* and *Lauinae nodicaulis* were collected from different areas of Khyber Pakhtunkhwa and were identified by Plant Taxonomist, Department of Botany, Kohat University of Science & Technology, Kohat, Pakistan. The samples were washed thoroughly with distilled water to eliminate dirt, dust and other possible parasites and then were properly rinsed with deionized water. The rinsed plants were dried under shade at 25-30°C. The dried samples were powdered by mortar and pistol and then stored in clean, dried plastic bottles for further processing.

Analysis of Plant Samples

Specified weight of powdered plant sample was taken in china dish for heating in an oven at 110°C for several hours to remove moisture. Then the moister free sample was placed in furnace. The furnace temperature was gradually increased from room temperature to 600°C in 1 hour. The sample was ashed for about 5 hours until a grey or white ash residue was obtained. The contents of china dish were cooled to room temperature in desiccators and 2 mL of 6 M HNO₃ solution was added into china dish and the mixture was heated to dissolve its content. The solution was filtered through whatman (#42) filter paper into 25 mL flask and was diluted to the mark. The solutions were then stored in clean and dry plastic bottles (Rehman et al., 2013, Iqbal et al., 2013). Estimation of heavy metals like Zn, Fe, Mn, Cu, Ni, Cr, Pb and Cd were carried out on Flame Atomic Absorption Spectrophotometer (Parkin elmer 400).

RESULTS AND DISCUSSION

The present study was designed to determine the concentration of essential and non essential heavy metals in eight different medicinal plants having their medicinal properties are mentioned in table 1. The concentration of Zn, Fe, Mn, Cu, Ni, Cr, Pb and Cd in selected medicinal plants are given in table 2. According to the given information appended in table 2. High concentration of Zn, Mn and Fe was recorded in all eight plants. *P. hysterophorus* contained higher concentration of Zn 55.98mg/kg followed by *M. tricuspidatum* 40.32 mg/kg. The level of Zn in other plants was 11.23mg/kg, 10.11mg/kg, 26.71mg/kg, 21.45mg/kg, 30.92mg/kg and 15.41 mg/kg in *R. stricta*, *W. coagolans*, *C. canadensis*, *S. media*, *M. denticulata* and *L. nodicaulis* respectively. High concentration of Fe 101.37 mg/kg was found in *S. media* while *L. nodicaulis* contained low concentration of Fe 40.47 mg/kg. Range of Fe in other plants 88.37mg/kg, 99.41mg/kg, 89.26mg/kg, 60.81mg/kg, 60.30mg/kg and 51.38mg/kg were detected in *R. stricta*, *W. coagolans*, *C. canadensis*, *M. denticulata*, *P. hysterophorus* and *M. tricuspidatum* respectively. *W. coagolans* and *R. stricta* showed maximum concentration of Mn 100.02mg/kg, 105.46mg/kg. All other plants had the following contents of Mn *C. canadensis* 58.23mg/kg, *S. media* 40.56mg/kg *M. denticulata* 58.32 mg/kg, *P. hysterophorus* 50.56mg/kg, *M. tricuspidatum* 29.11mg/kg and *L. nodicaulis* 78.76 mg/kg. Highest concentration of Cu 34.52 mg/kg, 34.37mg/kg was found in *C. canadensis* and *P. hysterophorus* while the minimum concentration of Cu 15.06 mg/kg was detected in *L. nodicaulis*. *M. tricuspidatum* contained 16.80 mg/kg, *M. denticulata* 27.74 mg/kg, *S. media* contained 29.96 mg/kg and *W. coagolans* contained 18.70 mg/kg and *R. stricta* contained 31.23 mg/kg respectively. *R. stricta* showed the maximum concentration of Ni 10.11mg/kg while *C. canadensis* showed low concentration of Ni 1.02 mg/kg. The contents of Ni in other plants was 8.04 mg/kg in *W. coagolans*, 1.09 mg/kg in *S. media*, 4.36 mg/kg in *M. denticulata*, 7.40 mg/kg in *P. hysterophorus*, 3.21 mg/kg in *M. tricuspidatum* and 5.00 mg/kg in *L. nodicaulis*. The concentration of Cr found in different plants were *R. stricta* 0.76 mg/kg, *W. coagolans* 0.41 mg/kg, *C. canadensis* 0.07mg/kg, *S. media* 0.08mg/kg, *M. denticulata* 0.01mg/kg, *P. hysterophorus* 0.39mg/kg, *M. tricuspidatum* 0.21mg/kg and *L. nodicaulis* 0.43mg/kg. The highest concentration of Cr was found in *R. stricta* 0.76 mg/kg. The maximum concentration of Pb 15.46mg/kg was recorded in *M. denticulata*. *Pb* was below the detection level in *M. tricuspidatum*. The range of Pb in other plants were: *R. stricta* 11.01 mg/kg, *W. coagolans* 7.04 mg/kg, *C. canadensis* 4.98 mg/kg, *S. media* 10.61 mg/kg and *P. hysterophorus* contained 3.21 mg/kg. *S. media* showed the maximum concentration of Cd 1.41 mg/kg, *C. condensis* and *L. nodicaulis* had almost the same concentration of Cd 1.00 mg/kg and 1.01 mg/kg. All other plants showed low concentration of Pb.

![Fig. 1: Determination of heavy metals in medicinal plants.](image-url)
Thymus serpyllum L.

01

Table 1: Pharmacognostic properties of medicinal plants.

<table>
<thead>
<tr>
<th>S. no</th>
<th>Botanical Name</th>
<th>Family</th>
<th>Common Name</th>
<th>Medicinal Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Rhyzics stricta</td>
<td>Apocyacae</td>
<td>Senhwar</td>
<td>Fever, allergy, diabetes, dysentery, stomach problem and asthma.</td>
</tr>
<tr>
<td>02</td>
<td>Withania coagolans</td>
<td>Solonaceae</td>
<td>Indian Rennet</td>
<td>Anticancer, dyspepsia, intestinal infection, asthma, ulcer, rheumatism, bronchitis, Alzheimer's disease, antifungal, antibacterial, antihyperglycemic and antide inflammatory.</td>
</tr>
<tr>
<td>03</td>
<td>Conyza canadensis</td>
<td>Asteraceae</td>
<td>Horseweed</td>
<td>Antispasmodic, anti-inflammatory, slightly astringent, febrifuge, strongly tonic, epilepsy, anxiety and neuralgia.</td>
</tr>
<tr>
<td>04</td>
<td>Steleria media</td>
<td>Caryophyllaceae</td>
<td>Chickweed</td>
<td>Treatment for dry, cracked, inflamed tissue, sores, rashes, upset stomach and asthma.</td>
</tr>
<tr>
<td>05</td>
<td>Medicago denticulata</td>
<td>Fabaceae</td>
<td>Alfalfa</td>
<td>Treatment for digestive, kidney disorder, diabetes, bladder, anemia and premensural syndrome alleviator.</td>
</tr>
<tr>
<td>06</td>
<td>Parthenium hysterophorous</td>
<td>Asteraceae</td>
<td>Carrot weed</td>
<td>Herbicidal, nematicidal, insecticidal, anti-amebic dysentery and antihysteric.</td>
</tr>
<tr>
<td>07</td>
<td>Malvastrum tricuspidatum</td>
<td>Malvacae</td>
<td>False mallow</td>
<td>Diaphoretic, inflamed sores, chest and lung diseases, dysentery and preventing vomiting.</td>
</tr>
<tr>
<td>08</td>
<td>Launaea nadicaulis</td>
<td>Asteraceae</td>
<td>Jangli booti</td>
<td>Constipation, to relieve fever, itches of skin, ulcer swelling, eczema, eruption, rheumatism and toothache.</td>
</tr>
</tbody>
</table>

Table 2: Contents of heavy metals (mg/kg) in some medicinal plants.

<table>
<thead>
<tr>
<th>Plants Name</th>
<th>Zn</th>
<th>Fe</th>
<th>Mn</th>
<th>Cu</th>
<th>Ni</th>
<th>Cr</th>
<th>Pb</th>
<th>Cd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhyzics stricta</td>
<td>11.23</td>
<td>88.37</td>
<td>105.46</td>
<td>31.23</td>
<td>10.11</td>
<td>0.76</td>
<td>11.01</td>
<td>0.59</td>
</tr>
<tr>
<td>Withania coagolans</td>
<td>10.11</td>
<td>99.41</td>
<td>100.02</td>
<td>18.70</td>
<td>8.04</td>
<td>0.41</td>
<td>7.04</td>
<td>0.81</td>
</tr>
<tr>
<td>Conyza canadensis</td>
<td>26.71</td>
<td>89.26</td>
<td>58.23</td>
<td>34.52</td>
<td>1.02</td>
<td>0.07</td>
<td>4.98</td>
<td>1.00</td>
</tr>
<tr>
<td>Steleria media</td>
<td>21.45</td>
<td>101.37</td>
<td>40.56</td>
<td>29.96</td>
<td>1.09</td>
<td>0.08</td>
<td>10.61</td>
<td>1.41</td>
</tr>
<tr>
<td>Medicago denticulata</td>
<td>30.92</td>
<td>60.81</td>
<td>58.32</td>
<td>27.74</td>
<td>4.36</td>
<td>0.01</td>
<td>15.46</td>
<td>0.10</td>
</tr>
<tr>
<td>Parthenium hysterophorous</td>
<td>55.58</td>
<td>60.30</td>
<td>50.56</td>
<td>34.37</td>
<td>7.40</td>
<td>0.39</td>
<td>3.21</td>
<td>0.09</td>
</tr>
<tr>
<td>Malvastrum tricuspidatum</td>
<td>40.32</td>
<td>51.38</td>
<td>29.11</td>
<td>16.80</td>
<td>3.21</td>
<td>0.21</td>
<td>Nd</td>
<td>Nd</td>
</tr>
<tr>
<td>Launaea nadicaulis</td>
<td>15.41</td>
<td>40.37</td>
<td>78.76</td>
<td>15.06</td>
<td>5.00</td>
<td>0.43</td>
<td>0.99</td>
<td>1.01</td>
</tr>
</tbody>
</table>

Nd: Not detected

CONCLUSION

The present study was aimed to identify the essential and non-essential elements in the given medicinal plants. These plants were properly identified i.e. their common name, family name and medicinal uses and also checked for the presence of heavy metals. The concentrations of heavy metals were investigated in eight medicinal plants which were different in all plants.

REFERENCES


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