# Pollution Based Study of Heavy Metals in Some Selected Medicinal Plants by Dry Digestion Method

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**ABSTRACT** Study of heavy metals including Iron (Fe), Nickel (Ni), Manganese( Mn), Zinc (Zn), Copper (Cu), Cadmium (Cd), Chromium (Cr) and Lead (Pb) in four selected medicinal plants *Capparis spinosa*, *Peganum harmala* , *Rhazya stricta* and *Tamarix articulata* collected from polluted and unpolluted areas of Karak, Khyber Pakhtunkhwa Pakistan was performed by atomic absorption spectrophotometer. Dry Ashing method was adopted for sample preparation. In general the concentration level of heavy metals in the selected plants from polluted area was found to decrease in the order of Fe > Zn > Mn > Cu >Pb > Ni > Cr > Cd, and the same order was also found in unpolluted area. In polluted area Iron was found high 48.76 mg/kg in leaves of *Capparis spinosa* while least level (Below detection level) was that of Cadmium and in unpolluted area the level of iron was high 54.94 mg/kg in roots of *Rhazya stricta* while least concentration was that of Cd 0.02 mg/kg in leaves of *Peganum harmala*. These medicinal plants were selected for our investigation having in mind their extensive use in traditional medicine for various ailments by local physicians in the area from where these plants were collected. Monitoring such medicinal plants for heavy metals is a supreme importance in protecting the Public from the adverse and hazardous affects of these heavy metals.

**KEYWORDS:** Medicinal Plants, Heavy metals, Ash, Atomic Absorption Spectrophotometer.

## INTRODUCTION

Medicinal plants have been used in cure of diseases as a common strategy virtually by all populations around the world. In Brazil it is common in the poorest area as well as in big cities, to find medicinal plants in free markets, supermarkets and even in backyards of houses.[1] Chemist have derived a lot of compounds and Alkaloids from the plants by using isolations or other techniques which have a key role in the herbal medicines and others areas like food, cosmetics etc. Rhazya Stricta contains over 100 Alkaloids. Some very important alkaloids are rhazicine, strictamine N-oxide, postsecamidine, leepacine, rhazizine and isositsirikine acetate etc. Some of these alkaloids are used for the cancer treatment [2]. Similarly *Peganum harmala* Linn contains a mixture of Harmine, Harmaline, Norharman and their derivatives which are used as insecticidal, fungicidal and these also possessed the plant growth regulatory activities [3].

Plants contain trace heavy metals like Fe, Cu, Ni, Mn, Zn, Pb, Cd etc in various concentrations. It was also indicated that the accumulation of heavy metals is different from plant to plant of the same location. Environment has the profound effect on the heavy metals accumulation contents in plants. At the low concentrations some of the heavy metals excite some biological processes, but at threshold concentration these become toxic. Being non biodegradable, these metals accumulate at various tropic levels through food chain and can cause human health problems [4]. In humans, these metals hoard in living tissues and thus multiply the danger. Some metals cause physical distress while others may cause life-threatening illness, damage vital body system and cause other damages [5]. Thus, it support the idea that every medicinal plant must be tested for trace heavy contents before dealing out it for further their use in medications. These medicinal plants were selected for our investigation having in mind their extensive use in traditional medicine for various ailments by local physicians in the area from where these plants were collected. The medicinal values of selected medicinal plants have been reported in literature [6, 7, 8].

### Material and Methods

### Sample Collection

Plants samples of the medicinal plants *Capparis spinosa*, *Peganum harmala* , *Rhazya stricta* and *Tamarix articulata* and their soil samples were collected from two different places, polluted (spot-1) and unpolluted areas (spot-2) of District Karak. The plants samples were dried in shade at room temperature. The dried plant parts were crushed, powdered and homogenized, using an agate pestle and were kept in polyethylene

sampling bags for analysis. Soil samples were collected from spot of plants at about 8-10 cm depth of the soil and both plants and soil samples were placed in the polyethylene sampling bags.

**Digestion and Analysis of plant samples**

Specified weight of crushed and powder portion from each plants *Capparis spinosa*, , *Peganum harmala* , *Rhazya stricta* and *Tamarix articulata* was taken in crucible for heating in an oven at $105^0$C to remove moisture. Then the dried sample after charring was placed in furnace. The furnace temperature was gradually increased from room temperature to $600^0$C in 1 hour. The sample was ashed for about 4 hr until a white or grey ash residue was obtained. The content of crucible was cooled in desiccators and weighed. Then 2.5 ml of 6M $HNO_3$ was added to the ash samples of each plant to dissolve and digest the contents. The solutions were filtered by whatman (#42) filter papers, transferred to 25 ml volumetric flasks and were diluted to the marks [9, 10, 11].

Estimation of trace heavy metals like Mn, Fe, Cr, Ni, Cu, Zn, Pb, and Cd were carried out by using Flame Atomic absorption spectrophotometer (Parkin Elmer 400).

**Results and Discussion**

Environmental pollution has turn out to be a severe concern in both nationally and internationally. Among the various environmental pollutions, pollution of plants is a matter of great anxiety. Plants get polluted with the accumulation of many pollutants including toxic metals. In the present study ash contents and heavy metals like Fe, Cu, Zn, Ni, Cr, Cd and Pb in selected plants samples were investigated which are shown by tables 1 and 2-3 respectively.

Table . Percentage Ash contents in various parts of different Plants

| S. No | Plant Name | Plant Parts | Spot 1. % Ash | Spot 2. % Ash |
|---|---|---|---|---|
| 1 | *Capparis spinosa* | Leaves | 11.08 | 9.23 |
| | | Stems | 6.05 | 4.07 |
| | | Roots | 7.12 | 6.16 |
| 2 | *Peganum harmala* | Leaves | 5.02 | 5.06 |
| | | Stems | 7.36 | 6.08 |
| | | Roots | 8.23 | 12.07 |
| 3 | *Rhazya stricta* | Leaves | 6.14 | 5.13 |
| | | Stems | 4.16 | 4.13 |
| | | Roots | 7.11 | 6.05 |
| 4 | *Tamarix articulata* | Leaves | 6.21 | 7.07 |
| | | Stems | 5.97 | 4.62 |
| | | Roots | 8.22 | 9.11 |

Table 2. Concentration of Heavy Metals (mg/kg) in different medicinal plants of spot 1

| Plant Name | Sample | Fe | Cu | Mn | Ni | Cr | Zn | Cd | Pb |
|---|---|---|---|---|---|---|---|---|---|
| *Capparis spinosa* | Leaves | 48.76 ±0.20 | 15.55 ±0.01 | 6.14 ±0.10 | 3.70 ±0.10 | 2.24 ±0.03 | 28.97 ±0.20 | 0.10 ±0.02 | 8.79 ±0.01 |
| | Stems | 31.55 ±0.31 | 5.81 ±0.02 | 16.63 ±0.20 | 1.65 ±0.30 | 2.53 ±0.20 | 22.44 ±0.04 | BDL | 6.07 ±0.03 |
| | Roots | 35.57 ±0.10 | 5.91 ±0.01 | 17.14 ±0.06 | 0.81 ±0.10 | 1.51 ±0.10 | 8.55 ±0.05 | 0.06 ±0.01 | 4.40 ±0.01 |
| *Peganum harmala* | Leaves | 43.01 ±0.03 | 7.44 ±0.20 | 13.27 ±0.03 | 5.078 ±0.04 | 01.27 ±0.15 | 19.41 ±0.05 | 0.75 ±0.00 | 5.48 ±0.02 |
| | Stems | 45.86 ±0.01 | 8.22 ±0.07 | 21.03 ±0.09 | 3.26 ±0.03 | 1.76 ±0.13 | 27.04 ±0.14 | 0.13 ±0.00 | 2.52 ±0.01 |
| | Roots | 28.40 ±0.02 | 15.46 ±.02 | 20.63 ± .09 | 6.63 ± .015 | 2.28 ±0.11 | 28.16 ±.050 | 0.18 ±0.00 | 1.51 ±0.07 |
| *Rhazya stricta* | Leaves | 40.12 ±0.90 | 8.23 ±0.05 | 13.23 ±0.34 | 7.512 ±0.02 | 6.58 ±0.90 | 30.17 ±0.20 | 1.21± 0.020 | 5.51 ±0.02 |
| | Stems | 29.47 ±0.31 | 6.27 ±0.90 | 8.24 ±0.90 | 5.176 ±0.16 | 5.87 ±0.01 | 22.36 ±0.02 | 1.09 ±0.07 | 3.32 ±0.10 |
| | Roots | 45.76 ±0.09 | 8.09 ±0.10 | 15.19 ±0.80 | 3.19 ±0.09 | 3.07 ±0.01 | 31.38 ±0.21 | 1.47 ±0.22 | 4.29 ±0.02 |
| *Tamarix articulata* | Leaves | 30.98 ±0.02 | 4.64 ±0.90 | 5.78 ±0.02 | 7.93 ±0.02 | 4.55 ±0.02 | 19.33 ±0.02 | BDL | 2.67 ±0.01 |
| | Stems | 35.72 ±0.01 | 6..32 ±0.01 | 6.43 ±0.02 | 7.46 ±0.01 | 6.09 ±0.20 | 28.00 ±0.90 | 1.00 ±0.90 | 4.22 ±0.00 |
| | Roots | 45.76 ±0.05 | 4.10 ±0.02 | 10.66 ±0.21 | 9.15 ±0.15 | 3.21 ±0.09 | 31.10 ±0.07 | 1.55 ±0.09 | 2.89 ±0.01 |

Table 3. Concentration of Heavy Metals (mg/kg) in different medicinal plants of spot 2

| Plant Name | Sample | Fe | Cu | Mn | Ni | Cr | Zn | Cd | Pb |
|---|---|---|---|---|---|---|---|---|---|
| *Capparis spinosa* | Leaves | 48.76 ±0.20 | 15.55 ±0.01 | 6.14 ±0.10 | 3.70 ±0.10 | 2.24 ±0.03 | 28.97 ±0.20 | 0.10 ±0.02 | 8.79 ±0.01 |
| | Stems | 31.55 ±0.31 | 5.81 ±0.02 | 16.63 ±0.20 | 1.65 ±0.30 | 2.53 ±0.20 | 22.44 ±0.04 | BDL | 6.07 ±0.03 |
| | Roots | 35.57 ±0.10 | 5.91 ±0.01 | 17.14 ±0.06 | 0.81 ±0.10 | 1.51 ±0.10 | 8.55 ±0.05 | 0.06 ±0.01 | 4.40 ±0.01 |
| *Peganum harmala* | Leaves | 43.01 ±0.03 | 7.44 ±0.20 | 13.27 ±0.03 | 5.078 ±0.04 | 01.27 ±0.15 | 19.41 ±0.05 | 0.75 ±0.00 | 5.48 ±0.02 |
| | Stems | 45.86 ±0.01 | 8.22 ±0.07 | 21.03 ±0.09 | 3.26 ±0.03 | 1.76 ±0.13 | 27.04 ±0.14 | 0.13 ±0.00 | 2.52 ±0.01 |
| | Roots | 28.40 ±0.02 | 15.46 ±.02 | 20.63 ± .09 | 6.63 ± .015 | 2.28 ±0.11 | 28.16 ±.050 | 0.18 ±0.00 | 1.51 ±0.07 |
| *Rhazya stricta* | Leaves | 40.12 ±0.90 | 8.23 ±0.05 | 13.23 ±0.34 | 7.512 ±0.02 | 6.58 ±0.90 | 30.17 ±0.20 | 1.21± 0.020 | 5.51 ±0.02 |
| | Stems | 29.47 ±0.31 | 6.27 ±0.90 | 8.24 ±0.90 | 5.176 ±0.16 | 5.87 ±0.01 | 22.36 ±0.02 | 1.09 ±0.07 | 3.32 ±0.10 |
| | Roots | 45.76 ±0.09 | 8.09 ±0.10 | 15.19 ±0.80 | 3.19 ±0.09 | 3.07 ±0.01 | 31.38 ±0.21 | 1.47 ±0.22 | 4.29 ±0.02 |
| *Tamarix articulata* | Leaves | 30.98 ±0.02 | 4.64 ±0.90 | 5.78 ±0.02 | 7.93 ±0.02 | 4.55 ±0.02 | 19.33 ±0.02 | BDL | 2.67 ±0.01 |
| | Stems | 35.72 ±0.01 | 6..32 ±0.01 | 6.43 ±0.02 | 7.46 ±0.01 | 6.09 ±0.20 | 28.00 ±0.90 | 1.00 ±0.90 | 4.22 ±0.00 |
| | Roots | 45.76 ±0.05 | 4.10 ±0.02 | 10.66 ±0.21 | 9.15 ±0.15 | 3.21 ±0.09 | 31.10 ±0.07 | 1.55 ±0.09 | 2.89 ±0.01 |

**Iron**

It is clear from figure 1 that the concentration of Fe in analyzed plant samples of spot 1 was in the range 28.40-48.76 mg/kg. The highest concentration of Fe was found in the roots of *Capparis spinosa* of spot-1 while the *Rhazya stricta* stem of spot-1 had the least amount of Fe 29.47 mg/kg. Similarly in spot 2 the highest concentration 54.94 mg/kg of Iron was found in roots of Rhazya stricta while least concentration 21.49 mg/kg of Fe was found in stem of *Tamarix articulata*. World Health Organization (WHO) recommended level of iron in medicinal plant is 20 mg/kg. In comparison to the WHO limit, the entire analyzed sample showed exceeded concentration than recommended level. While it's dietary intake is 10-60 mg/day [12].

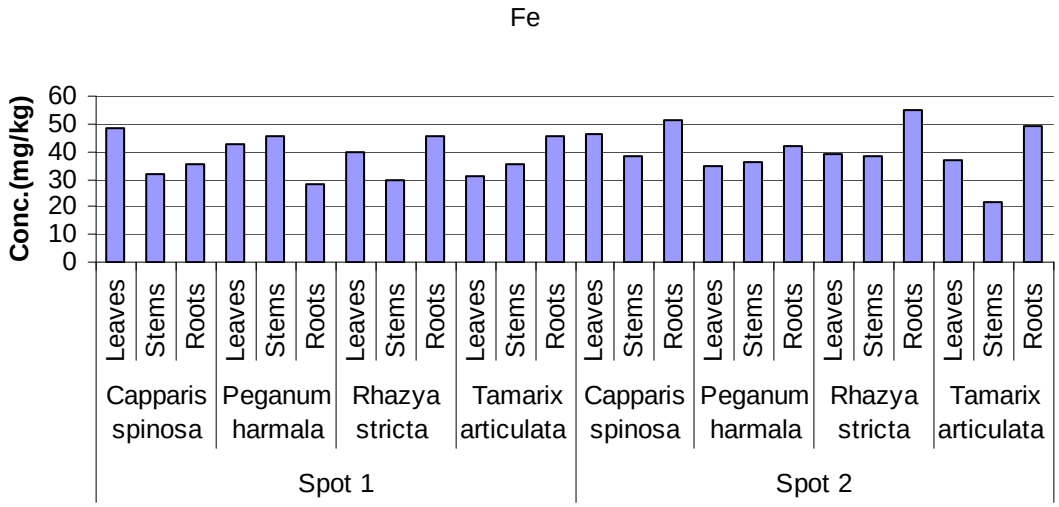


Figure 1: Level of Iron in different parts of various medicinal plants

**Copper**

Copper content was determined in different plant parts of selected medicinal plants. All the tested samples contained the significant amount of Copper. In plant parts Cu concentration in both spots occurred between the range of 3.14 -21.40 mg/kg, in which high concentration of Copper 21.40 mg/kg was found in roots of *Peganum harmala* collected from spot 2 followed by *Capparis spinosa* leaves of spot 1, 15.55 mg/kg. While the stem of *Capparis spinosa* of spot-2 contained the least concentration 3.14 mg/kg of Copper. WHO permissible limit of Copper in medicinal plant is 10 mg/kg while its intake in food is 2-3 mg/day [12].

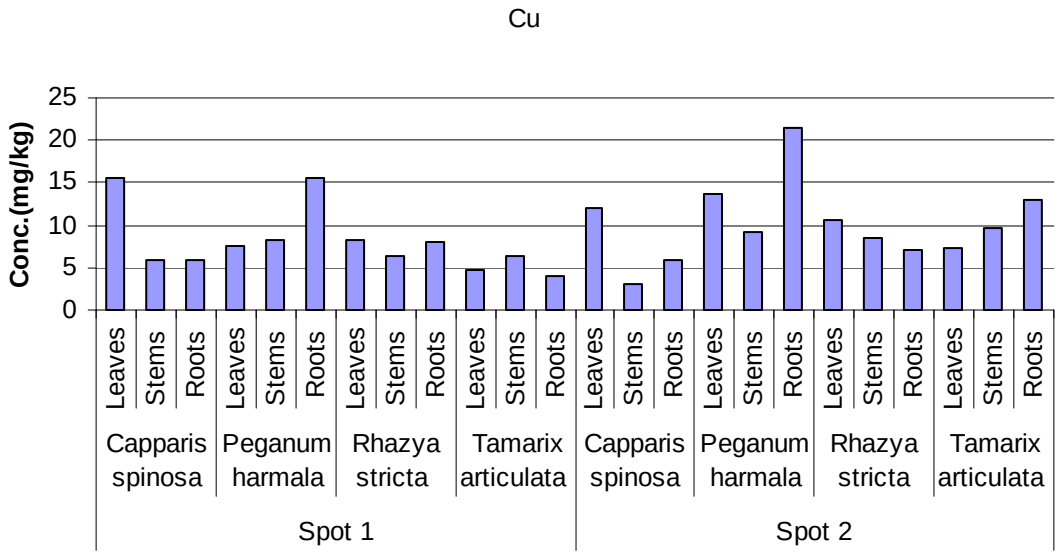


Figure 2: Level of Copper in different parts of various medicinal plants

**Manganese**

The concentration of Manganese has been illustrated by figure 3. Among the plant parts the Mn contents varied from 4.42-21.03 mg/kg. The *Peganum harmala* stem of spot-1 had the highest amount of Mn 21.03 mg/kg and the *Capparis spinosa* leaves of spot-2 contained the least contents 4.42 mg/kg of Mn. WHO maximum permissible limit in medicinal plant is 200mg/kg while its daily intake is 11mg [14]. All the analyzed samples were within the permissible limit recommended by WHO. As the plant samples of polluted area contained the high content of manganese, it may be due to the anthropogenic activities.

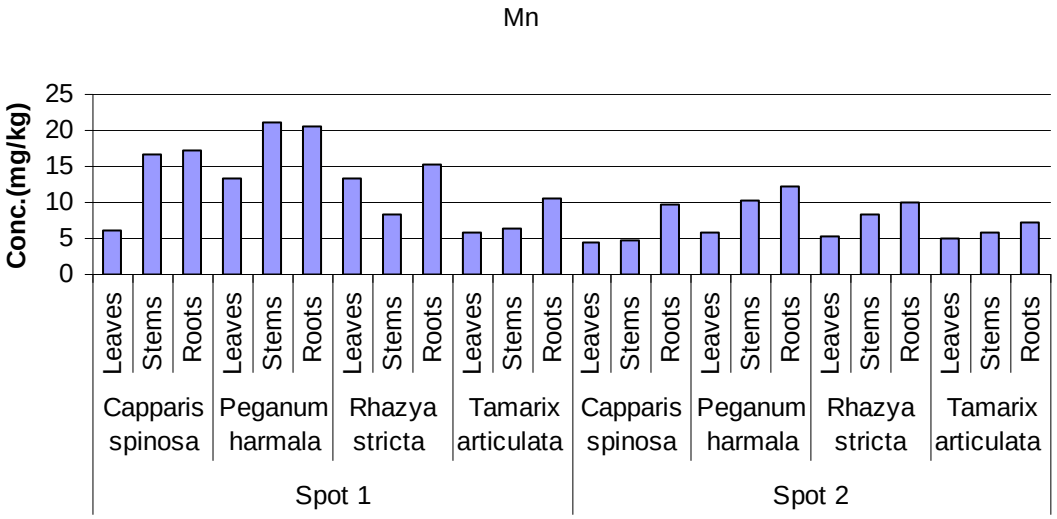


Figure 3: Level of Manganese in different parts of various medicinal plants

**Nickel**

The figure 4 shows that the level of Nickel in both spots ranges from 0.81-14.11 mg/kg, in which high level 14.11 mg/kg was recorded in root of *Tamarix articulate* of spot 2 followed by root 9.15 mg/kg of same plant collected from spot 1. In general, relatively low concentration of Nickel was recorded in different parts of Capparis spinosa and Peganam harmala of spot 2.According to United State Environmental protection Agency the permissible limit of Nickel in medicinal plant is 1.5mg/kg while it should be used than 1mg per day [15]. A few samples contained nickel in permissible limit.

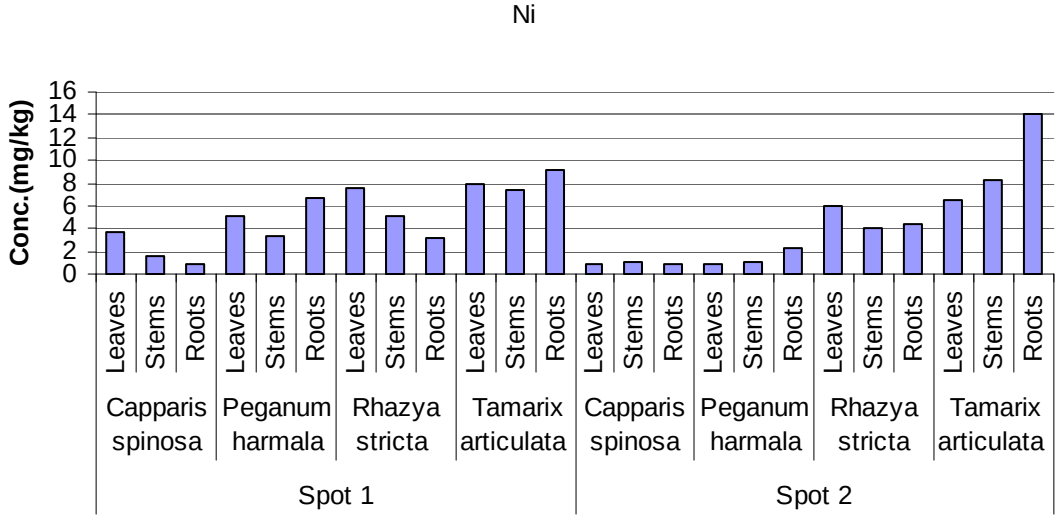


Figure 4: Level of Nickel in different parts of various medicinal plants

**Zinc**

It can be seen from figure 5 that the concentration of Zinc in analyzed plant samples collected from both spots were in the range 8.27-46.42 mg/kg. High concentration of Zinc was in the roots of *Peganum harmala* collected from spot 2 while least concentration was in roots of *Capparis spinosa* taken from the same spot. According to WHO maximum permissible limit of zinc in medicinal plant is 50mg/kg while its intake in food is 11mg/day [10]. In comparison to the WHO permissible limit all the analyzed samples were within the recommended level.

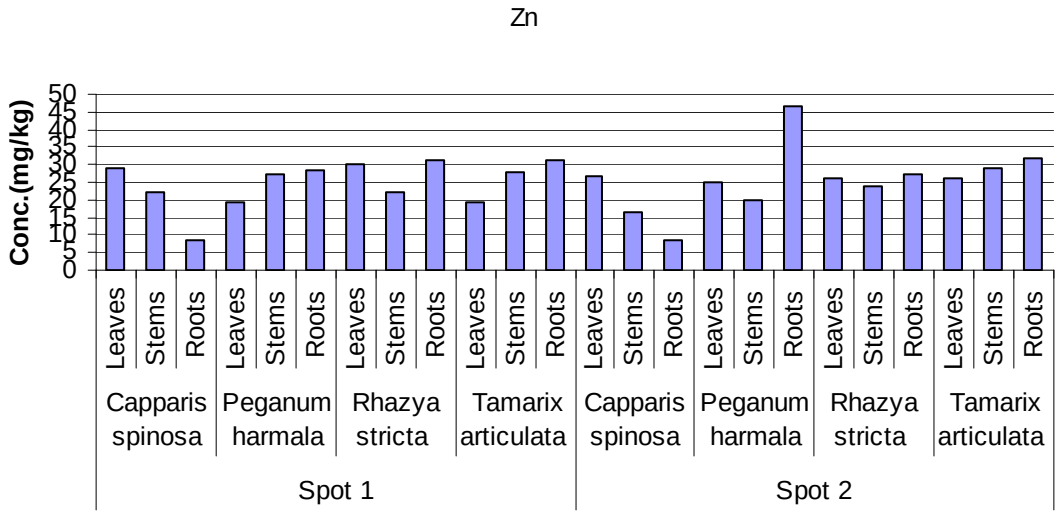


Figure 5: Level of Zinc in different parts of various medicinal plants

**Chromium**

The result of chromium in plant samples of spot 1 and spot 2 have been shown in figure 6. The chromium content was in the range 0.17- 8.00 mg/kg, In which high concentration of Cr 8 mg/kg was recorded in the leaves of *Rhazya stricta* collected from spot 2 followed by the roots of same plant 7.84 mg/kg while less concentration 0.17 mg/kg was found in roots of *Capparis spinosa* of the same spot 2. There is no permissible limit recommended by WHO, but According to United state environmental protection agency the maximum permissible limit of Chromium in medicinal plant is 1.5 mg/kg. So most of the samples has high concentration of Cr than permissible limit. The daily intake of Cr 0.05-0.2 mg/kg has been recommended for adults by US National Academy of Sciences [16].

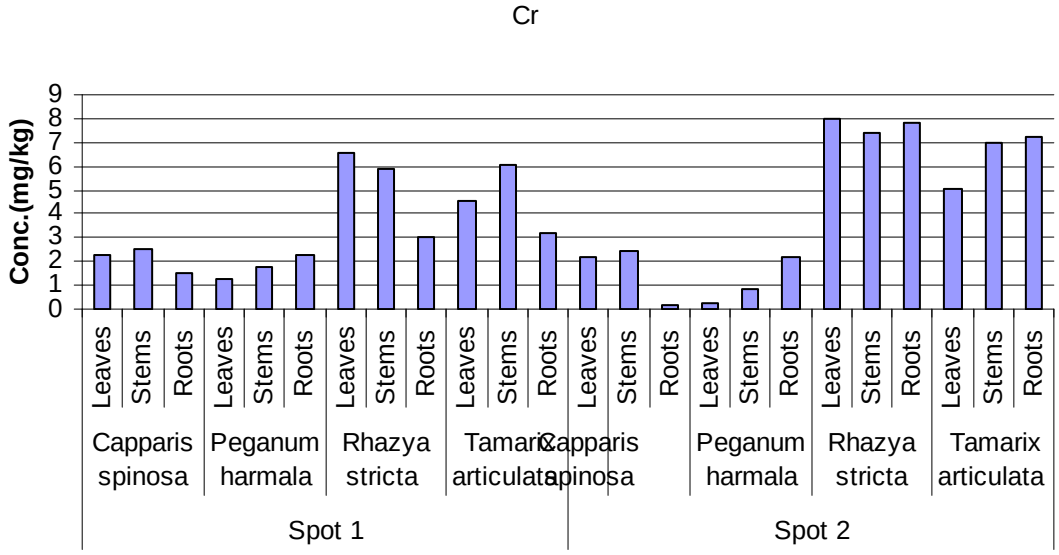


Figure 6: Level of Chromium in different parts of various medicinal plants

**Cadmium**

The concentration of cadmium analyzed in different plant samples collected from selected spots has been illustrated in figure 7. The high concentration was recorded in roots of *Tamarix articulata* collected from spot 1. No concentration of cadmium was recorded in stem of *Capparis spinosa* and leaves of *Tamarix articulate* of spot 1. Its concentration was low in all parts of *Peganum harmala* as compared to other plants. Cadmium is non essential element and not required to human or plants. However according to WHO the limit of Cadmium in Medicinal plant is 0.3 mg/kg [17].

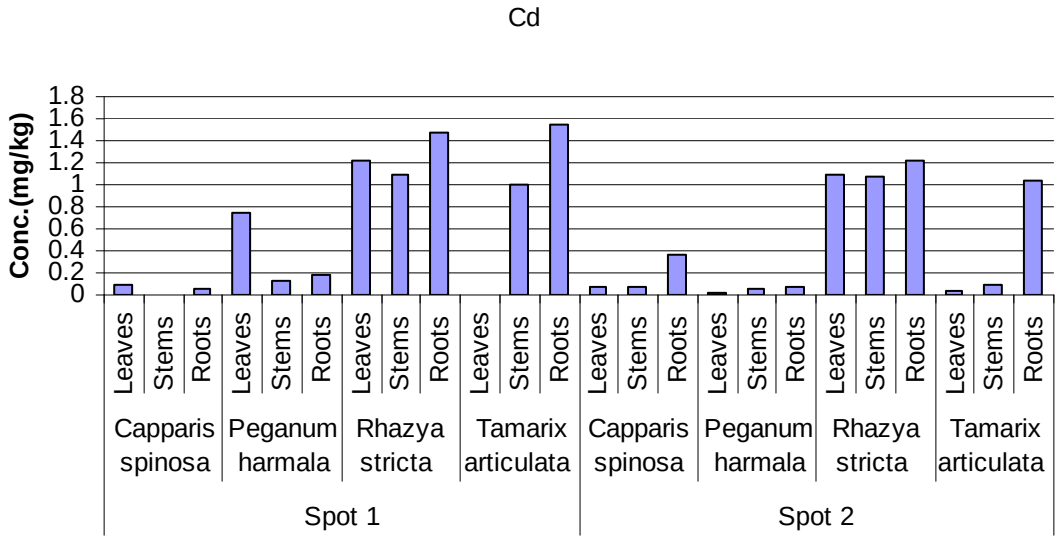


Figure 7: Level of Cadmium in different parts of various medicinal plants

**Lead**

Lead is another non essential element and carcinogenic which mainly comes from anthropogenic activities. Lead concentration has been tabulated in Figure 8. From which it is clear that leaves of *Capparis spinosa* has the highest concentration of lead followed by stem of the same plant collected from spot 1. The lead concentration was higher in Capparis spinosa plant of both spots as compared to other plants of these two spots. Its recommended level in medicinal Plant is 10 mg/kg [18].

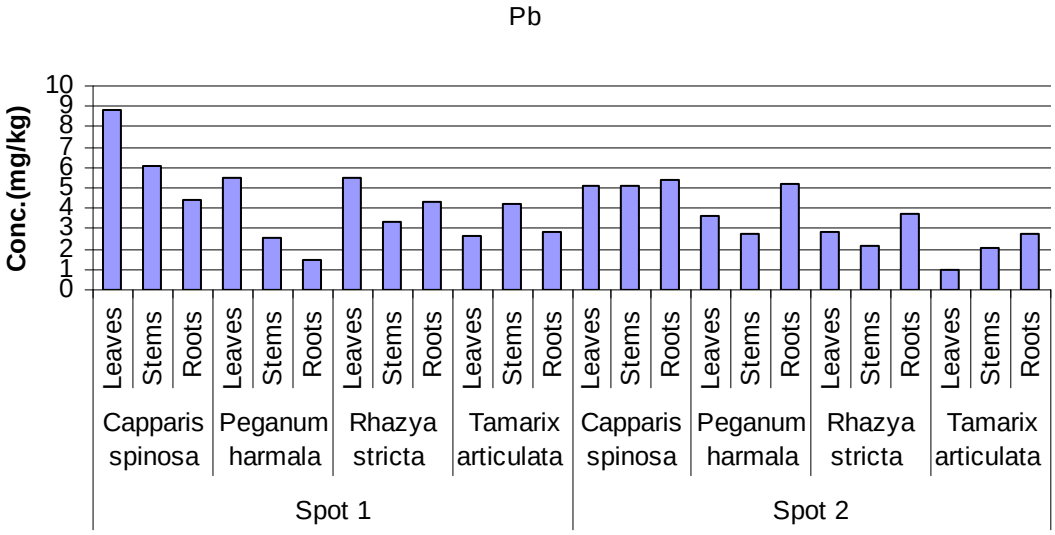


Figure 8: Level of Lead in different parts of various medicinal plants

## CONCLUSION

It was found from the present investigation that the amount of trace heavy metals are different in the same medicinal plant taken from environmentally different locations of the same region Thus, it reiterates our belief that each medicinal plant should be checked for contaminant load before processing it for further pharmaceutical purposes or for local human consumption

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