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# Screening & Assessment of Heavy Metal Accumulation Potential of Amaranthus Spinosus & Cassia Tora In & Around the Vicinity of Anand, Gujarat

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***Abstract: The negative impact of escalating number of industries has been witnessed by many sections of land resources. It has turned many segments of fertile land barren and unproductive, a grazing pasture into a pool of heavy metals, a crop bearing land to an unpleasant and abandoned site. The present study deals in analyzing and comparing the sequestration potential of three heavy metals namely Pb, Cd and Zn in context with abundantly growing phytoindicator plant species Amaranthus spinosus and Cassia tora collected from two antithetical sites, one site which is regularly inundated with the heavy metal bearing effluents from the hub of industries and the other site as an undisturbed piece of lands. Based on the results obtained a clear demarcation in the magnitude of heavy metals concentrated at the sites showed high accumulating affinity and translocation factor for zinc and lead in case of both the plants, but Cassia tora has high translocation factor >1 with respect to Zn and Pd when compared to Amaranthus spinosus which makes it a better choice for heavy metal extraction. The magnitude of heavy metal extraction for both the plants followed a sequence of Zn> Pb> Cd.***

***Keywords: Amaranthus spinosus, Cassia tora, Phytoindicator, Translocation factor, Accumulation***

## I. INTRODUCTION

The leading trend of mechanization has brought man into dilemma where he has to deal with the turmoil of waste management. Waste generation is analogous with the exponential growth in the development sector which needs a logistical management approach (Madhuri et al, 2014). There is enough space to set a manufacturing device and run it for decades, but to deal with its extraneous by-products is challenging. Fortunately, with advancement in technologies there are several ways of dealing with numerous pollutants which make its way into the natural sinks of the environment every second, but to accomplish this task in a sustainable manner is a matter of prime concern at present (Audrone & Saulius, 2005). So far, many methods have been practiced to get the soil rid of the heavy metals, these methods encompasses physical, chemical, thermal and biological approach, but on the contrary such mechanisms takes refuge under conventional sources of energy to carry out the remediation process making it an unsound and costly way of dealing with the pollutants. These methods also have certain protocols to be followed for its efficient functioning (Audrone & Saulius, 2005). That's when the surge to find the remedy in plants was proposed and after much research the concept was finally accepted due to high accumulating traits observed amongst certain plants (Cunningham et al, 1995). Plants not only plays a pivotal role in filtering the air but also indicates the health status of the land resource on which it inhabits and propagates accordingly, the tolerant plants manage to thrive and the sensitive ones are washed away from that place (Laila, Naaila, Mouhsine, Ahmed, & Mandi, 2017). There are several plant species capable of sequestering heavy metals in its biomass with minute change in its morphology and biochemical constitution (Baker et al, 1989). Plants possessing this innate quality are been configured and post-harvest management practices feasible and economical. In the present study three heavy metals namely Zn, Cd and Pb are selected due to the adverse effects observed on the biota when they get bioaccumulated in the flora and fauna at different levels of the food chain (Justin et al, 2010). The results obtained also gave an in depth analysis of the extent of heavy metal pollution faced by several piece of land due to carless incorporation into the things and activities of day to day life (Panda et al, 2015).

## II. MATERIALS & METHODS

*A. Selection of site*

Two antithetical sites bearing some of the common plant species were selected for the present study. A site amidst an industrial estate inundated with various heavy metal rich effluents in GIDC area of Anand was selected as a contaminated site and a piece of land least affected by the anthropogenic pressures near a farmland in the suburbs of Anand near Bakrol Gate was chosen as a control site for comparative analysis of the heavy metal uptake potential of selected plant species.

*B. Selection of plant species*

Two species namely Cassia tora and Amaranthus spinosus were selected for the study after scrutinizing them from many sparsely growing plants on the basis of their occurrence, abundance, morphology and the biomass richness.

## III. ANALYSIS OF THE PLANTS TO CHECK THE HEAVY METAL ACCUMULATION:

*A. Preparation*

Fresh and healthy plants of Cassia tora and Amaranthus spinosus, devoid of any physical damage by the cohabiting fauna were randomly selected from two sites. They were carefully uprooted and immediately brought to the laboratory in polythene bags, they were thoroughly washed under running tap water to remove the adhering soil particles and impurities. The plant parts were segregated into root and shoot and were allowed to dry under direct sunlight.

*B. Procedure of Heavy Metal Digestion*

Post drying, the plant parts were powdered using mortar and pestle. One gram sample of each root and shoot plant part of both selected species of both study area was collected and acid-digested on the hot plate using 7.5ml concentrated $HNO_3$, 2.5 ml HCL, and l ml $H_2O_2$. The samples were boiled until the volume reduced to half and finally made upto 25ml volume using distilled water. The digested plant samples were analyzed using ICP-OES by calibrating with blank prepared in a similar manner using distilled water.

1) *Calculations:* The detection of heavy metals was done using ICP-OES with a detection limit of 0.0059 mg/l, 0.0027 mg/l and 0.0420 mg/l for Zinc, Cadmium and Lead respectively. The actual heavy metal concentration in the plant samples were calculated using a formula (Mihaly- Cozmuta et al, 2005)

$$C = C_C \times D_F / m$$

Where;

C = concentration of heavy metal in the plant sample,

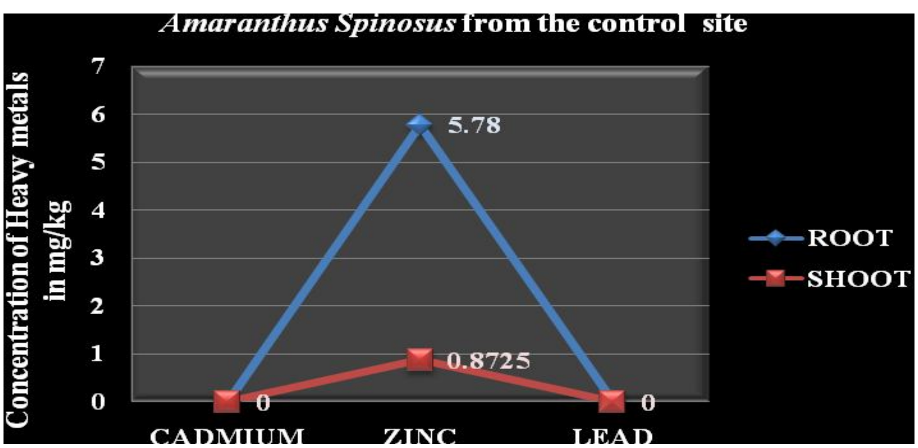
$C_C$ = concentration of heavy metal obtained from the calibration curve in mg/l,

$D_F$ = dilution factor and,

m = mass of 1 gram of the dried plant material

## IV. RESULTS & DISCUSSION

The results obtained for the extent of heavy metal pollution at both the sites are graphically presented as below:



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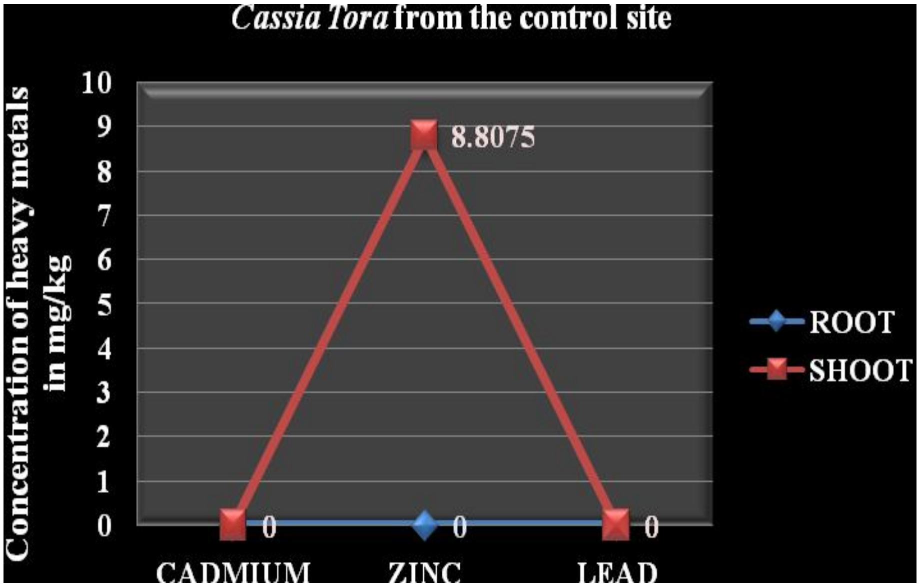
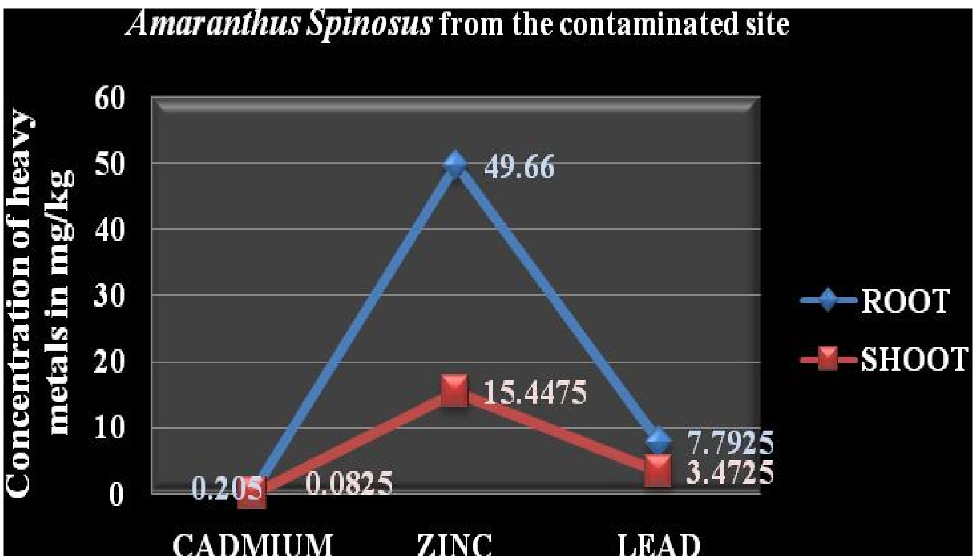
Analysis of heavy metals in root and shoot of Amaranthus spinosus collected from the control site rendered positive result in case of Zn which accounted to 5.78 mg/kg accumulation in the root and with a low level translocation of nearly 0.87 in shoot whereas Pb and Cd were absent.




Root and shoot samples of Cassia tora from the control site revealed high Zn concentration in the shoot which was nearly 8.80 mg/kg and it was observed to be below detection limit in case of root which proves high translocation potential of this studied plant species for Zn sequestration in the aerial parts. Pb and Cd were absent in both underground and aboveground parts of the plant.




*Amaranthus spinosus* yielded high amount of Zn accumulation in its root which was 49.66 mg/kg with an effective translocation of 15.44 mg/kg in its shoot, it also accumulated 7.79 mg/kg in its root and stored 3.47 mg/kg of Pb in its shoot and in the case of Cd it showed accumulation of 0.20 mg/kg in its root and 0.08 in its shoot. The concentration of heavy metals quantified in this study was above the permissible limits set by WHO (1996) for the levels of heavy metals in plants (Ogundele et al, 2015).

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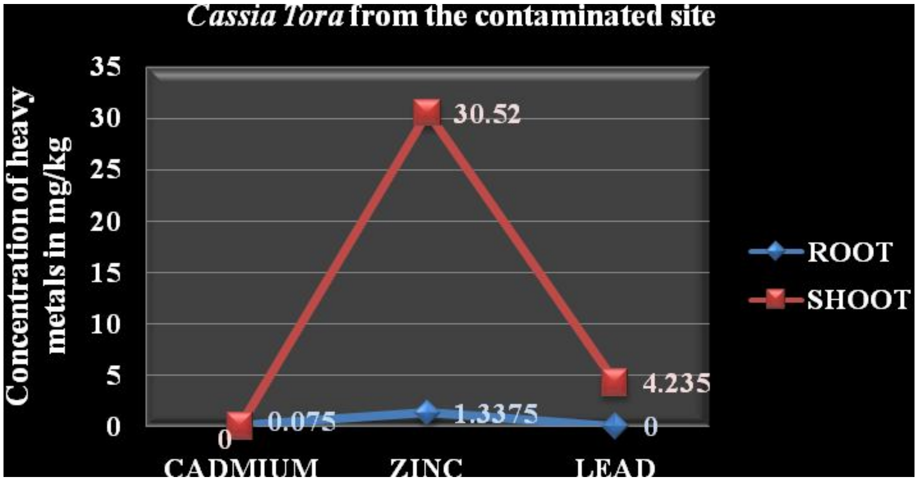


The underground and aboveground accumulation of Zn showed high uptake and translocation potential amounting to 1.33 mg/kg in root and 30.52 mg/kg in the shoot whereas in the case of Pb it was recorded below detection limit in the root but 4.23 mg/kg concentration in the shoot which makes it an effective sequestration tool for Pb and the Cd concentration was recorded to be 0.07 mg/kg but no translocation to the aerial parts of *Cassia tora*. The quantification of heavy metals to check the sequestration potential of *Cassia tora* yielded concentrations which are above the permissible limits set by WHO (1996).

*A. Translocation Ratio*

Translocation ratio measures the amount of heavy metal transferred from the roots to the shoots via plant vessels, it is calculated using the formula (Al-Farraj et al , 2010).

$TF = C_{SHOOT} / C_{ROOT}$

Where,

$C_{SHOOT}$ = concentration of heavy metals in shoot

$C_{ROOT}$ = concentration of heavy metals in root

| Control Site | Translocation Factor of *Amaranthus spinosus* | Translocation Factor of *Cassia tora* |
|---|---|---|
| Lead | BDL | BDL |
| Cadmium | BDL | BDL |
| Zinc | 0.15 | 8.8075 |

The results obtained clearly state the demarcation in the heavy metal concentration between the control and the contaminated site with the former site having accumulated extremely low concentration of Pb and Cd which falls under BDL whereas the high accumulating efficiency of both the plants in the case of Zn, where the translocation ratio of Cassia tora which is 8.80 is evident of higher magnitude when compared to Amaranthus spinosus.

| Contaminated Site | Translocation Factor of *Amaranthus spinosus* | Translocation Factor of *Cassia tora* |
|---|---|---|
| Lead | 0.44 | 4.235 |
| Cadmium | 0.40 | BDL |
| Zinc | 0.31 | 22.81 |

A comparative assessment of translocation factor in case of plants obtained from the contaminated site proved Cassia tora to be of more potential compared to Amaranthus spinosus for two heavy metals namely Zn and Pd with translocation factor of 22.81 and 4.23 respectively, but the translocation factor for Cd is 0.40 which is high in the case of Amaranthus spinosus.

## V. CONCLUSION

The present analysis to check the accumulation of three heavy metals namely Cd, Zn and Pb amongst two native plant species Amaranthus spinosus and Cassia tora showed high affinity of plants towards uptake of Zn and Pb. It also indirectly highlighted the status of the soils from which they were selected, showing high level of heavy metal accumulation in the flora of the contaminated site. Amongst the two plants Cassia tora showed high accumulation of Zn and Pb with a translocation factor of >1which makes it a potent candidate for incorporating into phytoremediation studies.

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