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Phytoremediation Potentials of Dieffenbachia bownanii and Eleusine indica for Cadmium, Lead, Zinc and Cobalt.

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Abstract.:*Solving the problem of heavy metal pollution and its effects on the biota have remained a frontline issue in the public health matters of developing , and even the developed countries. Non-edible African plants – Dieffenbachia bownanii and Eleusine indica – were used to study the absorption of Cadmium, Lead Zinc and Cobalt from soils inoculated with the metal ions. 0.1M, 0.5M and 1M solutions of the metal ions were used in the inoculation. The Leaves, stems and roots of Dieffenbachia bownanii and the shoots and roots of Eleusine indica were collected in the first instance at six weeks, and then, at ten weeks of planting. Flame photometry was used to determine the metal ion concentration in the plants' parts. Lead was more absorbed by Dieffenbachia bownanii than did Eleusine indica, with the highest absorption of 1.71±0.015ppm in the former occurring in the roots. Absorption increased as the concentration of the inoculant solution increased, and also on moving from 6 weeks' to 10 weeks' samples. Cadmium was the least absorbed of the three metal ions, with a highest value of 0.59±0.015ppm in the stem of Dieffenbachia bownanii at 6 weeks. Zinc was more absorbed by Eleusine indica than did Dieffenbachia bownanii, with the highest absorption of 2.56±0.00ppm in the former occurring in shoots. Absorption increased as the concentration of the inoculants solution increased. Cobalt was most absorbed by Eleusine indica with the highest value of 2.53±0.00ppm found in the shoot. Phytotoxicity was shown in the plant at inoculants concentration above 0.1M, after 6 weeks. The tolerance, mean absorption and range, for Lead by Dieffenbachia bownanii show a good promise for its phytoremediation and recovery.*

Keywords: *Dieffenbachia bownanii; Eleusine indica; Phytoremediation; Phytotoxicity; Lead; Cadmium; Cobalt.*

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I. Introduction.

The decontamination of soil and water polluted with anthropogenic chemical is a global problem that has consumed considerable economic resources[1]. Heavy metal has evolved as a term that is used to describe some metallic elements and even metalloids, that are either heavy in some cases, with density greater than 5, or light in others, which raise environmental health concerns at certain levels of concentrations. The various boundaries created by various proposed definitions lack scientific basis of cohesion [2]. Though some of these metals (depending on the oxidation state) are toxic at any concentration, some are required by living organisms in trace amounts. The health risks posed by these metals have continued to be of global concern, and have made the European Union to place thirteen metals on the High-Risk-Monitor level. These include Arsenic, Cadmium, Cobalt, Chromium, Copper, Mercury, Manganese, Nickel, Lead, Tin, and Thallium. Phytoremediation is defined as efficient use of naturally occurring or genetically engineered plants to remove, detoxify or immobilize environmental contaminants in a growth matrix (soil, water or sediments) through and other physical activities/process of the plants[3].

Lead, Cadmium, Zinc and Cobalt have been used in this work to study the ability of two nonedible African plants - *Dieffenbachia bownanii and Eleusine indica* – to phytoremediate soils polluted with the metal ions in their +2 oxidation states.

II. Methods.

Twenty six seedlings, each, of the two plants were grown on soils isolated in polyethylene pots. Twenty four pots were inoculated with 0.1M, 0.5M and 1M solutions of Pb^{2+}, Zn^{2+}, Co^{2+} and Cd^{2+}, while controls were left. The plants' parts were harvested after the sixth and eighth week of inoculation. The harvested plants were washed, dried, and ashed at 450^oC. After digesting with concentrated HNO_3, SMART spectrophotometer was used to determine the metal ions concentrations absorbed in the plants' parts, adjusted for, with the controls.

Codes: D= *Dieffenbachia bownanii;* E= *Eleusine indica;* R=Root; S=Stem; T=Shoot; L=Leaf; 1, 4, 7 and 10=0.1M; 2, 5, 8 and 11=0.5M; 3, 6, 9 and 12=1M solutions.

III. Results And Discussions.

Table 1: Concentration of Lead absorbed by Dieffenbachia bownanii in mg/kg

Stem (DS)	1st Harvest	2nd Harvest
Ds_1	0.37±0.021	0.62±0.031
Ds_2	0.031±0.020	0.82±0.015
Ds_3	1.05±0.015	1.36±0.017

Root(DR)	1st Harvest	2nd Harvest
DR_1	0.38±0.021	0.63±0.00
DR_2	0.50±0.32	0.28±0.32
DR_3	1.65±0.32	1.71±0.015

Leaf(DL)	1st Harvest	2nd Harvest
DL_1	0.85±0.00	1.06±0.021
DL_2	1.29±0.010	1.39±0.006
DL_3	1.53±0.023	1.59±0.015

Table 2: Concentration of Lead absorbed by *Eleusine indica* in mg/kg

Shoot(ET)	1st Harvest	2nd Harvest
ET_1	-0.32±0.021	-0.52±0.026
ET_2	1.00±0.015	0.18±0.021
ET_3	-0.61±0.025	-0.74±0.006

Root(ER)	1st Harvest	2nd Harvest
ER_1	0.54±0.015	0.96±0.015
ER_2	0.33±0.015	1.35±0.031
ER_3	0.31±0.020	0.41±0.015

Table 3: Concentration of Cadmium absorbed by Dieffenbachia bownanii in mg/kg

Stem (DS)	1st Harvest	2nd Harvest
Ds_4	0.01±0.00	0.02±0.014
Ds_5	0.00±0.00	0.03±0.006
Ds_6	0.59±0.015	0.03±0.28

Root(DR)	1st Harvest	2nd Harvest
DR_4	0.000±0.00	0.03±0.025
DR_5	0.00±0.00	0.08±0.015
DR_6	0.00±0.00	0.09±0.012

Leaf(DL)	1st Harvest	2nd Harvest
DL_4	0.00±0.00	0.00±0.00
DL_5	0.00±0.00	0.48±0.012
DL_6	0.00±0.00	0.05±0.017

Table 4: Concentration of Cadmium absorbed by Eleusine indica in mg/kg

Shoot(ET)	1st Harvest	2nd Harvest
ET_4	0.00±0.00	0.00±0.00
ET_5	0.00±0.00	0.00±0.00
ET_6	0.00±0.00	0.00±0.00

Root(ER)	1st Harvest	2nd Harvest
ER_4	0.00±0.00	0.00±0.00
ER_5	0.24±0.00	0.00±0.00
ER_6	0.47±0.047	0.00±0.00

Table 5: Concentration of Cobalt absorbed by Dieffenbachia bownanii in mg/kg

Stem (DS)	1st Harvest	2nd Harvest
Ds_7	0.05±0.021	0.15±0.020
Ds_8	0.10±0.015	0.31±0.012
Ds_9	0.20±0.012	0.25±0.006

Root(DR)	1st Harvest	2^{nd} Harvest
DR_7	0.06±0.021	0.13±0.012
DR_8	0.18±0.006	0.19±0.021
DR_9	0.20±0.00	0.29±0.015

Leaf(DL)	1st Harvest	2^{nd} Harvest
DL_7	0.06±0.021	0.14±0.017
DL_8	0.07±0.010	0.08±0.015
DL_9	0.17±0.010	0.28±0.010

Table 6: Concentration of Cobalt absorbed by Eleusine indica in mg/kg

Shoot(ET)	1st Harvest	2^{nd} Harvest
ET_7	0.05±0.021	0.28±0.012
ET_8	1.27±0.015	-0.47±0.015
ET_9	2.53±0.00	-0.47±0.015

Root(ER)	1st Harvest	2^{nd} Harvest
ER_7	0.05±0.006	0.41±0.010
ER_8	0.04±0.012	-0.65±0.020
ER_9	2.35±0.00	-0.65±0.20

Table 7: Concentration of Zinc absorbed by Dieffenbachia bownanii in mg/kg

Stem (DS)	1st Harvest	2^{nd} Harvest
Ds_{10}	0.19±0.012	0.10±0.012
Ds_{11}	0.31±0.010	0.36±0.00
Ds_{12}	0.32±0.015	0.46±0.006

Root(DR)	1st Harvest	2^{nd} Harvest
DR_{10}	0.18±0.006	0.34±0.010
DR_{11}	0.25±0.015	0.37±0.010
DR_{12}	0.33±0.010	0.75±0.017

Leaf(DL)	1st Harvest	2^{nd} Harvest
DL_{10}	0.02±0.012	0.12±0.015
DL_{11}	0.03±0.021	0.29±0.012
DL_{12}	0.12±0.00	0.48±0.015

Table 8: Concentration of Zinc absorbed by *Eleusine indica* in mg/kg

Shoot(ET)	1st Harvest	2^{nd} Harvest
ET_{10}	0.05±0.015	0.29±0.010
ET_{11}	1.3±0.015	0.11±0.010
ET_{12}	2.56±0.00	1.38±0.023

Root(ER)	1st Harvest	2^{nd} Harvest
ER_{10}	0.05±0.006	0.53±0.010
ER_{11}	0.16±0.012	0.76±0.012
ER_{12}	2.47±0.00	2.47±0.00

IV. Discussions

Chlorosis was observed initially in the plants. Dieffenbachia bownanii had a better tolerance for same metal ion and concentration than Eleusine indica. Phytotoxicity in ELeusine indica had the trend of Cd>Co>Pb>Zn. Generally, the metal absorption decreased with altitude ie root>stem>leaf. Cadmium was the least absorbed of the four metal ions by the two plants. Eleusine indica absorbed more Zn and Co than Dieffenbachia bownanii with no sign of phytoaccumulation, as 6^{th} week> 10 week generally. Lead was absorbed more by Dieffenbachia bownanii than did Eleusine indica.

V. Conclussions

Dieffenbachia bownanii showed a good potential of extracting Pb^{2+} from soil matrix. Cd^{2+} has low phytoavailability with respect to the two plants.

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