

Phytoremediation of heavy metals by *Alternanthera sessilis* and *Croton bonplandianus*, in akka-tangi park pond, Tumakuru

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Abstract- The purpose of this work is to estimate the assemblage of heavy metals like, Cd, Ar and Pb in water and soil and their transfer from the contaminated soils and water to the plants in terms of transfer factor (TF). The Heavy metals cannot be breakdown and cleaned up usually. Most of the ordinary remedial techniques are unaffordable and decreases the soil fecundity, this causes the adverse impact on the ecosystem. Phytoremediation is eco-friendly cost effective and most suitable for developing countries. This research reports the proximity of heavy metals in soil, water and plant parts. Paper discuss the accumulation of heavy metals in plants. After the phytoremediation process the bioavailability of metal ions in the plant can be recycled from the polluted soil, water and then it can be neutralized by enzymes for less toxicity of environment.

Keywords: Heavy metals, Phytoremediation, Transfer factor, *Alternanthera sessilis*, *Croton bonplandianus*.

I. INTRODUCTION

Environmental pollution has become serious concern in the developing countries is due to the disposal of uncontrolled industrial waste released by industries like semiconductor industries producing home applications and computers releases some traces elements of Cadmium, Nickel, Lead, Chromium into the atmosphere and Paint industry is also accountable to releasing heavy metals while producing different colors by using Pigments and Stabilizers, then large scale industries like Alloys, Metallurgical tannery chemical manufacturing mining pulp and paper oil refining, electrical rubber processing fertilizer etc.

Which includes heavy metals get directly discharged into soil and water (Meena et.al.,2008). The major cause for the environmental pollution is the direct discharge of toxic metals into the ecosystem which eventually reaches to human through food chain. When the heavy metals get discharged into the water bodies like pond lake etc these toxic metals absorbed by the planktonic organism which are present at the base of the aquatic food chain. By the Bio magnification process, a small quantity of heavy metals get enters into the food chain, even at low concentration of heavy metals in the ecosystem has the great effect on human growth and development

due to heavy metals causes serious health hazards such as kidney injury, renal failure and liver damage (Al-Rikabi et al 2021).

In addition to that they have great effect on plant growth and communities on the earth cover and also have the adverse effect on soil micro flora. It is cleared that heavy metals it is not possible to removed or dissolute by chemical process, instead of that they will be removed physically or transformed into non-toxic compounds. Heavy metals which are occurred in the environment are removed by earlier people who usually preferred the current methods for remediation of heavy metals in the contaminated sites. Current methods are usually the excavation of contaminated site and remediate by chemical, physical and biological methods.

Excavation of contaminated soil can be done by using two methods. i.e. remediation outside the contaminated site and remediation within the contaminated site. Ex-situ method is used to peel of heavy metals from polluted site with toxic metals by complete excavation of contaminated soil from the site and treated by chemical, physical, and biological methods and returning to the resorted site. In-situ method is used to remove the toxic metals from the polluted site without excavation of contaminated soil from the site (Ghosh M., and Singh S. P. 2005).

Current outside remediation from polluted region involves the removal of soil from the polluted site for the treatment of contaminants causes adverse effect to the soil structure and fertility. Most of these conventional remediation technologies are expensive to implement and cause further disturbance to the already damaged environment. Conventional in-situ remediation is favored over the ex-situ remediation where in which remediation of heavy metals by using plants in the polluted site collectively referred to as Phytoremediation. Phytoremediation is being the best practice of in-situ treatment which is being adopted mainly for the removal of toxic heavy metals from the polluted site by using green plants.

In 1983 this idea was first put forwarded for the disposal of heavy metals using heavy metal accumulating green plants. This technique is applicable for both organic and inorganic contaminants present in soil, water and air. Phytoremediation is cost effective and environment friendly technique. Based on the accumulation process of heavy metals. Phytoremediation is broadly categorised into Rhizofiltration, Phytostabilisation, Phytoextraction, Phytovolatilization, and Phytodegradation. Rhizofiltration is a process where in which roots play an very important role in the removal of heavy metals like lead, cadmium, copper, arsenic, nickel, zinc and chromium where they are primarily retained in roots both in aquatic and terrestrial contaminated sites.

The plants that are used in this process are to treat the industrial sewage discharge, agricultural runoff or acid rain drainage can be used for Phytostabilization process where plants break down the pollutants by producing root exudates which stabilize, immovable and bind the metal contaminants which are present in the soil matrix which in turn helps in the reduction of their mobility and their bioavailability which led to the prevention of distribution of toxic metals from contaminated area to other areas (Berti, W.R. and Cunningham, S.D., 2000) and remediates the contaminants in soil, sediment and sludges which decreases the water percolating through soil which ultimately helps to

prevent the soil erosion sequentially. Phytovolatilization is a process which also involves contaminants up take by the plants from the soil, which in turn get transformed into volatile form and get transferred into atmosphere.

Usually growing trees which are taken up the water, organic and inorganic contaminants, some of these contaminants reach the leaves of a plant and get volatilise into the atmosphere at low concentrations (Mueller, K. E. (2005). Phytoextraction is the best practice which is being used to remove the contaminants likes metals, metalloids radio nuclides, non metals organic contaminants from the soil without disturbing the soil structure and fertility by using some specific plants which can have the great efficiency to absorb and hyper accumulate the metal contaminants in root and shoot tissue, this process is well suitable when the contaminants are occur at relatively low concentrations. Phytosiderophores are the secretion of plants into rhizosphere play a major role in solubilizing the metals present in the soil. Green plants absorb toxic heavy metals in the form of ion by roots, and then metal ions are translocated into aerial parts of the plant.

Akka-Tangi park pond has 1 km distance from the Tumakuru city. It covers 15 acres of land and the pond has been received untreated city sewage. The untreated sewage has gotten mixed up with domestic waste, small scale industrial waste and some insecticides or pesticides which were used by the farmers for controlling disease caused by pests and insects to the crops. Sewage water was directly dumped into the pond without primary treatment of sewage water with invisible contaminants in the waste water.

This water got entered into the pond and got mixed up with rain water which was already present in the pond. Due to the release of sewage water into the pond the whole pond was contaminated by sewage water. Since the sewage water was accumulated with some trace amounts of heavy metals like Cd, Ar, Ni, Pb, etc. These heavy metals are toxic for living beings those depends on the pond for the purpose of drinking water (birds and animals) animal grazing near the pond. These metals may take the entry into

the humans and animals which leads to various serious diseases. So as to overcome from all these problems phytoremediation practices has been selected. The plants selected for the remediation of toxic heavy metals Phytoextraction method. The green plants used in this process are Alternanthera sessilis and Croton bonplandianus.

II. MATERIALS AND METHODS

Water analysis

The domestic sewage water discharged directly into the pond. Sewage water was collected at the region of sewage enter into the pond and the rain water which is already present in the pond are collected at another region using collecting bottles. The collected samples were subject to analysis as follows.

Estimation of pH of water sample

The pH of the water samples were analyzed by utilizing the glass electrode pH meter. About 15ml of water was measured and it was stirred for 15 minutes and then the glass electrode was dipped into the samples and values were noted down.

Estimation of Electrical Conductivity of water samples

The EC of the water was analyzed by using the EC bridge instrument. Collected samples were measure about 20ml and conductivity cell was dipped in the samples and EC of the water samples were noted down.

Estimation of Chloride in Water Samples

Estimation of Chloride in given Water samples by Mohr's method Take 25 ml of the given water sample in a conical flask and add 3-4 drops of potassium chromate solution and mixed well then Slowly add standard silver nitrate solution from the burette and shake the solution well. At the end point, light yellow color starts changing to red color finally red colour persists.

Estimation of Dissolved Oxygen in water samples

BOD bottle filled with water without entering the air bubble to the BOD bottle put stopper, then add 2ml of manganese sulphate and same volume of potassium iodide solution reaction takes place

between manganese sulphate solution with already oxygen present in the water samples by forming the brownish precipitation. After the formation of brownish precipitation add 2 ml of concentrated sulphuric acid care should be take while adding strong acid to the bottle. The concentrated acid dissolves the earlier formed precipitation. Take 50 ml of this solution add 2 drops indicator blues colour forms then titrated against the sodium thiosulphate solution taken in burette the blue colour solution turns into colour less solution.

Plant samples analysis

• Collection of sample and Sampling

Plant analysis is the determination of the amount of an element in a sample from a particular part of a plant sample at a particular phase of morphological development. Plant analysis is based on the principle that the amount of a nutrient within the plant is an integral value if all the factors that have integrated to affect it. The whole plant is collected as the sample for quantitative estimation of heavy metals. In that defined area Alternanthera sessilis and Croton bonplandianus, have the more vegetation in the pond water.

The samples of plants were collected in the early morning about 7am and in the month of December and the samples were carried by using the polythene bag. Collected plant samples were dried under the shadow region. After drying the plants samples were grounded into fine powder and the prepared powdered samples were subjected for analysis.

Plant samples analysis also have been carried in the laboratory of the Department of Soil Science and Institute of Horticultural Research Hirehalli Tumakuru rural.

Micro and Macro nutrient of plant samples were determined as follows

• Estimation of Nitrogen by Kjeldahl method

1g weight of powdered plant sample was transferred onto a sheet of paper, and then prepare a packet and it was then added to Kjeldahl's digestion flask. To this 2-3g of digestion mixture was added, and 10 ml of con.H₂SO₄ was added. The contents were digested in a fume cupboard (digestion chamber) over a low

flame, light bluish green color residue was obtained. Then the contents were cool down and 100ml of volume was made by using distilled water. 10ml of the digested sample was pipette out into a micro-distillation flask. And 10 ml of distilled water was added. And then about 25ml of 4 per cent boric acid was taken in a receiving flask. The delivery tube was dipped in boric acid during distillation. To this 10ml of 40 % sodium hydroxide was added to the distillation flask and the contents were stirred and distilled. After completion of distillation, the receiving flask was disconnected and the contents was titrated against Standard acid till pink color was obtained. The burette reading was recorded and the percentage of nitrogen was calculated.

Estimation of Ca, Mg by complexometric titration method

• Estimation of Calcium

5ml of digested sample was measured and poured onto a porcelain basin and it was diluted by adding 10ml of distilled water. And 5 ml of 10% NaOH was already measured (ph of sample solution will reach more than 12). To this 0.5g of murexide indicator was added. The content was titrated against with the standard EDTA with continuous stirring until it becomes violet in colour. And amount of calcium was calculated.

Estimation of Ca and Mg

Another 5ml of digested sample was measured and poured onto a porcelain basin and it was diluted by adding 25ml of distilled water. To this 5ml of buffer solution was added, 3-5 drops of Eriochrome black T- indicator was also added. Then the contents were titrated against with the Standard. EDTA by stirring, then it becomes sky blue in color. The burette reading was recorded . The Ca titrated value was gotten by subtracting the titrated value of Ca + Mg, Then the value of Mg was obtained.

Estimation of Heavy metals in collected water and plant samples

• Atomic Absorption Spectrophotometer

Collected samples of soil, water and plants were subjected to analysis of heavy metals in the AAS. To analyses heavy metals in plants, samples were kept in a microwave digestion with 4.0mL nitric acid and

0.5mL perchloric acid or hydrogen peroxide over 24 hours. After the digestion the standard solutions are prepared by using deionising water and prepared standard solutions were subjected to estimate the heavy metals. Samples of soil and water were directly analyzed using the AAS instrument and recorded the quantity of heavy metals.



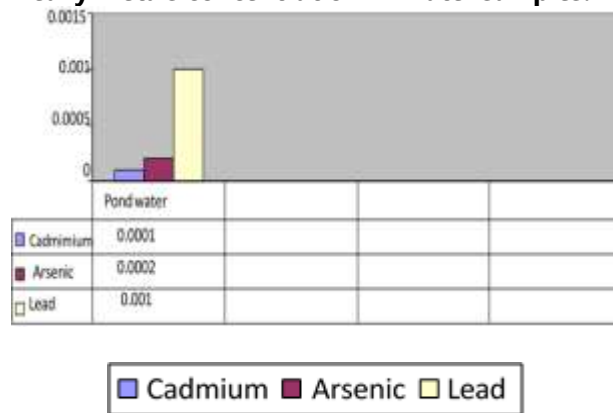
RESULT

Water analysis results

Properties	Water sample	Critical limits	Remarks
	Pond water		Pond water
pH(1:2)	6.2	6.50-7.50	Less
EC(dS/m)	0.21	<1	Less
Chloride	5.8	<3.0	High
Bicarbonate (me/l)	3.4	1.50-7.50	Less
Residual Sodium Carbonate (me/l)	3.7	< 2.50	High
Dissolved oxygen	0.6	6.8-8 Mg/L	Low
Cd (ppm)	0.0001	0.005	Less
Ar (ppm)	-0.02	0.02	Less
Pb (ppm)	0.001	0.05	Less

The analyzed report of different water samples are as fallows. The pH of pond water samples are of 6.2 and The EC of pond water samples are of 0.21 dS/m. The heavy metal concentration for cadmium is 0.0001 ppm pond for Arsenic -0.02ppm and for lead it is 0.001ppm pond water samples respectively.

Heavy metals concentration in Water samples.



Plant sample analysis result.

1. Alternanthera sessilis

Micro elements	
Properties	Obtained
Fe	286.2 ppm
Zn	7.5ppm
Cu	3.75ppm
Mn	2.5ppm
Macro elements	
Properties	Obtained
N (%)	33.2
Ca (%)	0.63
Mg (%)	0.16

Heavy metals			
Properties	Obtained	Critical limit	Remarks
Cd (ppm)	18.75	0.02	High
Ar (ppm)	10.0	10	Less
Pb (ppm)	21.25	2	Less

Analyzed report of Alternanthera sessilis

The analyzed plant report is as follows. In Alternanthera sessilis the concentration of macro & micro nutrients like Nitrogen 33.29 %, available calcium and magnesium is 0.63% & 0.16% respectively, Iron is in 286.2ppm and for Zinc is 7.5 ppm for Copper 3.75ppm, for Manganese 2.5ppm. The amount of Heavy metals like cadmium is 18.75 ppm, the available Arsenic concentration is 10.0 ppm and the available amount of lead is 21.25 ppm. The cadmium and lead accumulated in higher concentrations compared to other heavy metals.

2. Croton bonplandianus

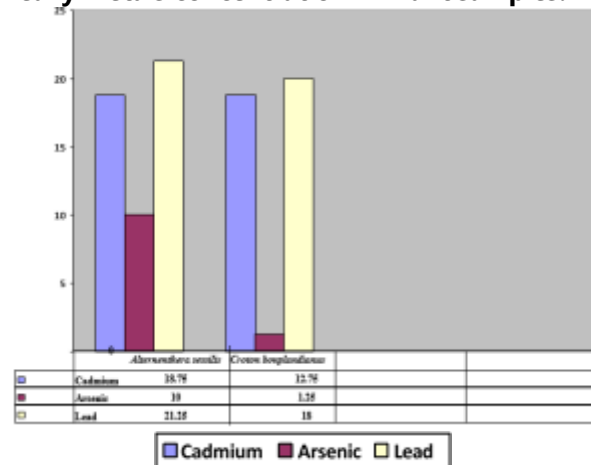
Micro elements	
Properties	Obtained
Fe	202.5 ppm
Zn	5.0 ppm
Cu	2.5 ppm
Mn	1.25 ppm
Macro elements	
Properties	Obtained
N (%)	27.29
Ca (%)	0.89
Mg (%)	0.11

Heavy metals			
Properties	Obtained	Critical limit	Remarks
Cd (ppm)	18.75	0.02	High
Ar (ppm)	1.25	1.30	Less
Pb (ppm)	20.0	10	Less

Analyzed report of Croton bonplandianus

The analyzed plant report is as follows. In Croton bonplandianus concentration of macro & micro nutrients like Nitrogen 27.29 %, available calcium and magnesium is 0.63% & 0.16% respectively, Iron is in 286.2ppm and for Zinc is 5.0 ppm for Copper 2.5 ppm, for Manganese 1.25 ppm. The amount of Heavy metals like cadmium is 18.75 ppm, the available Arsenic concentration is 1.25 ppm and the available amount of lead is 20.0 ppm. The cadmium and lead accumulated in higher concentrations compared to other heavy metals.

Heavy metals concentration in Plant samples.



III. DISCUSSION

Heavy metals are the major threat to the living environmental communities. In recent years fast developing countries releases enormous amount of toxic heavy metals into the environment. The amount of heavy metals in the environment reaches more than its permissible limits may cause various serious diseases to living beings. These metals are removed usually from the environment. The green plants have the ability to withstand stress caused by the heavy metal and get accumulated it in their tissues such as Cd, Ar, Cr, Ni and Pb etc.

The study area receives the sewage contaminated with heavy metals by small scale industries. The plants which are selected naturally grown under contaminated site have been up taken the heavy metals in it. The study area selected plants were *Alternanthera sessilis* and *Croton bonplandianus*. The experiment has been done by the (Subhalakshmi, A et al 2013). A to prove that the heavy metal accumulating capacity of *Alternanthera sessilis* under the harsh conditions.

Study area selected the plants *Alternanthera sessilis* and *Croton bonplandianus* accumulating the some trace amount of heavy metals from the their soil such as Cd, Ar, and Pb. The study of both the plant analysis of shows the accumulating concentration of Cd by *Alternanthera sessilis* and *Croton bonplandianus* in the ratio of 18.75 and 12.75. In addition to this some amount of Ar and Pb also accumulates in very less concentration.

IV. CONCLUSION

Heavy metals are toxic to the living environment. Higher amounts of these metals increases the toxicity of the environment. This increase in concentration of Heavy metals may take entry into the living ones and causes the various diseases like respiratory, kidney and stomach disease. These metals were removed usually from environment become pollution free.

Earlier peoples preferably use conventional methods for remediate Heavy metals in the soil. Conventional

methods are negative impact on soil structure and fertility. The evolution of new technique called Phytoremediation is fastest technique for remediates Heavy metals in environment using plants. In recent days it is an most attractive field for research. Phytoremediation is a cost effective and environment friendly technique.

Through this technique the plants can absorb Heavy metals from soil without disturbing the soil structure and fertility and translocate into their biomass. The study area receives some trace amounts of toxic Heavy metals from the Tumakuru city sewage. The amount of toxic heavy metals in the study area and the accumulating capacity of naturally growing plants the area polluted with heavy metals. In study area *Alternanthera sessilis* and *Croton bonplandianus* plants were selected for the study. These plants accumulate the trace amount of Heavy metals present in the study area.

Among the two plants *Alternanthera sessilis* accumulates more amount of heavy metal compared to *Croton bonplandianus* such as Cd, Ar and Pb respectively. In this study *Alternanthera sessilis* has more potential for accumulating Heavy metal from the polluted site. *Croton bonplandianus* accumulates same metals but it has low potential for accumulating heavy metals in the study area.. Phytoremediation is the best technique for overcoming these environmental imbalance. Phytoremediation is a time consuming process it takes several years together for remediation process.

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