

Phytoremediation Studies for Removal of Copper & Chromium Using Azolla Pinnata and Water Hyacinth

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ABSTRACT: Phytoremediation includes all the natural processes taking place within certain aquatic plants to accumulate or degrade polluting compounds. Water hyacinth and Azolla are amongst aquatic plants that are being investigated for removal of heavy metals Chromium and Copper in the present work from synthetic solutions having 50 and 10 ppm separately. Based on observations, results & discussion, it can be said that water hyacinth can survive in copper and Chromium concentration less than 50 ppm for around 15 days. The effective uptake for 50 ppm initial concentration is observed to 29% and 14% for copper and chromium respectively for 15 days. Similarly Azolla is effective to the extent of 6 and 62.5% copper and chromium removal respectively over 28 days period. The same figures for 10 ppm initial concentration for Water hyacinth are 13% and 71% for copper and chromium removal respectively..The present study has successfully addressed to the novel and upcoming method of removal of metallic ions by plants.

KEYWORDS: Phytoremediation, Copper, Chromium, Azolla pinnata, Water hyacinth

I. INTRODUCTION

The rapid growth in industries and increased agricultural activities over the last few decades have resulted in generation & accumulation of large quantities pollutants in the environment. These pollutants are distributed over wide areas by means of air and water. This has caused detrimental effects to the ecosystem and to human health.

Continuous efforts are being made to develop technologies that are easy to handle, sustainable and economically feasible in order to maintain good quality of soils and waters and keep them free from contamination. Physicochemical approaches have been widely used for remedying polluted soil and water, especially at a small scale. However when it comes to large scale water processing, like river cleaning, these conventional methods are not feasible economically. Phytoremediation may provide the effective alternative. It includes all the natural processes taking place within certain plants to accumulate or degrade polluting compounds in soil, water, or air. Aquatic ferns in particular exhibit exorbitant potential to remove various contaminants including heavy metals, organic compounds, and radio nuclides from the environment. The Water hyacinth and Azolla, these aquatic plants are used for removal of high concentration of heavy metals namely Chromium and Copper.

A number of research papers have been published in various journals over decades related to removal of metallic ions from water. Some of the papers referred in present work are cited here. Marieta Baysa et al [1] reported determination of concentration of lead & cadmium in the top, middle & bottom edible portions of Ipomoea aquatica. Ranjana Julias Thilakar et al [2] & Santosh Kumar et al [3] in separate work reported phytoremediation studies of chromium & copper and chromium & cobalt respectively using Pistia stratiotes. Malai rajan Singanan et al [4] & N. Gandhi et al [5] studied the removal chromium from industrial waste water using biomaterials & Ipomoea aquatica respectively. Review papers by Annie Melinda et al [6] & Nelson et al [7] give detailed information about the potential of the aquatic plants in

International Journal of Innovative Research in Science, Engineering and Technology

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removal of pollutants and take a stock of present status of the theme with future applications. Punita Parikh & Soma Mazumder [8] studied the determination of *Azolla pinnata* to absorb heavy metals from waste water of oil & petroleum refinery at Vadodara. Similarly Wang & Dong [9] and Nuzhat Shafiet et al [10] in separate studies reported the phytoremediation findings using wet land plants and accumulation of heavy metals by *Azolla* plant of Dal lake ecosystem.

II. PRESENT WORK

The present work is aimed at study of the uptake of Chromium and Copper ions from synthetic water solutions separately, using technique of phytoremediation. Removal of these metals from waste water is necessary due to their hazardous nature & potential threat to aquatic life, human beings and environment. It is reported in the literature that Water hyacinth and *Azolla*, have capacity to remove these metallic ions.

The present work is divided in two parts. In first part, study of uptake for concentrations of 50 ppm of copper sulphate & potassium dichromate in water using Water hyacinth is conducted. In second part the solution concentrations are reduced to 10 ppm and phytoremediation experiments are conducted *Azolla pinnata* as well as Water hyacinth plants.

2.1 METHODOLOGY

2.1.1 Materials:

Aquatic Plants: Healthy Water hyacinth and *Azolla* plants are obtained from local water body sources. These plants are first washed with tap water to remove impurities and dirt.

Chemicals: Stock solutions of 50 and 10 ppm of Potassium dichromate and Copper sulphate in water are prepared.

2.1.2 Experiment Setup and Procedure:

- Known quantity and concentration of stock solutions of copper sulphate & potassium dichromate in water are prepared.
- The aquatic plant samples of *Azolla* & Water hyacinth are weighed & placed into 12 lit capacity plastic containers containing known volume & concentration of the metallic compound in water. The experimental set up is kept in partially covered conditions.
- The water level is maintained by addition of distilled water to make up for the evaporative losses every 3rd day.
- The water samples from containers are collected after every 7th day for analysis purpose.
- The plant condition is visually observed after every 7th day.
- The plant is removed after 28th day, weighed and replaced back into its original water source.
- Fig no 1 & 4 give the photographic details of set up.

2.1.3 Analysis of metal ion concentration in water solution samples from time to time:

The analysis of metal ion concentration in water samples collected every week is done by UV Spectrophotometer. Based on the readings of absorbance of the known solution samples, standard graph is plotted between the absorbance & concentration of solution. This is referred the respective absorbance in determination of the concentration of water solution of samples removed from the container from time to time.



Fig. No.1 – Water hyacinth plant in 50 ppm of Copper Sulphate solution and potassium dichromate solution

III. EXPERIMENTAL RESULTS

3.1 Removal of Chromium and Copper at 50 ppm using Water hyacinth plant –

Fig. No. 2 and 3 give the standardization curves for copper and chromium

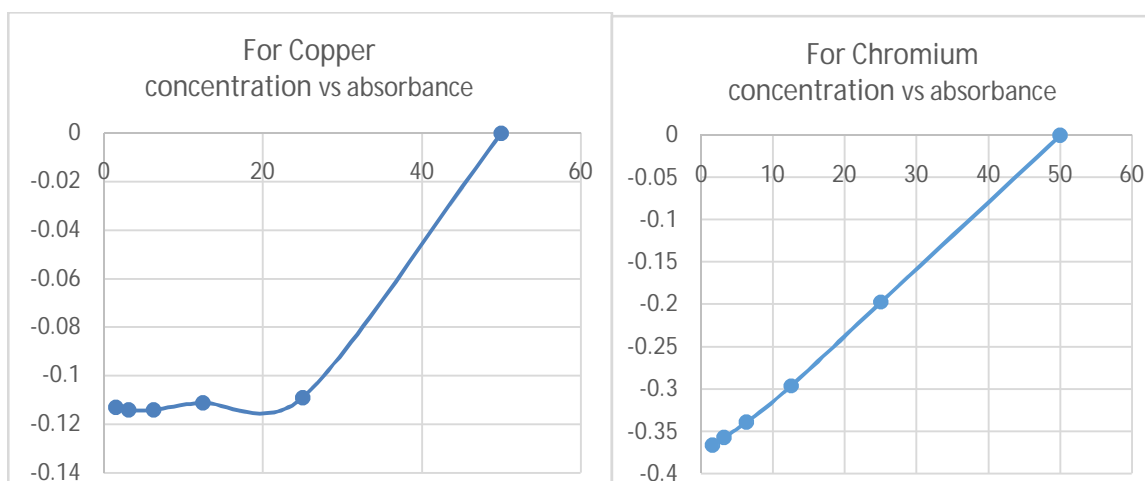


Fig. No. 2: Standardisation curve for Copper Fig. No. 3: Standardisation curve for Chromium

The Spectrophotometer readings for aqueous sample containing Cu and Cr are given in table no.1

Sr. No.	Sampling time (days)	Spectrophotometer Reading for copper	Spectrophotometer Reading for chromium
1	15	-0.053	-0.055

Table No.1: Spectrophotometer readings for Cu and Cr sample solution

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The details of observations & calculated values of weight and percentage removal for Cu and Cr after referring graphs 2 & 3 are given in table no.2.

Days	Component	Aquatic plant	Initial Concentration (ppm)	Final Concentration (ppm)	Weight of Component Removed (gm)	Percentage Removal (%)
15	Cu	Water hyacinth	50	35.5	0.145	29%
15	Cr	Water hyacinth	50	43	0.07	14%

Table No. 2: Weight and percentage removal of Cu and Cr

The concentrations of samples of solution after phytoremediation experimentation using Water hyacinth after 15 days for copper and chromium are 35.5 ppm and 43 ppm respectively. The amounts of copper and chromium removed from water in 15 days are 0.145 and 0.07 gm respectively. The percentage removal of copper and chromium is 29% and 14% respectively. The plant did not grow after 15- 20 days, due to which final results are considered after 15 days.

3.2 Removal of Chromium and Copper from 10 ppm solution using Water hyacinth and Azolla



Fig. No.4: A & B for copper sulphate solution using Azolla and C & D for potassium dichromate solution using Water hyacinth

The standardization curves for 10 ppm copper and chromium compounds in water are given in Fig. No. 5 and 6 respectively.

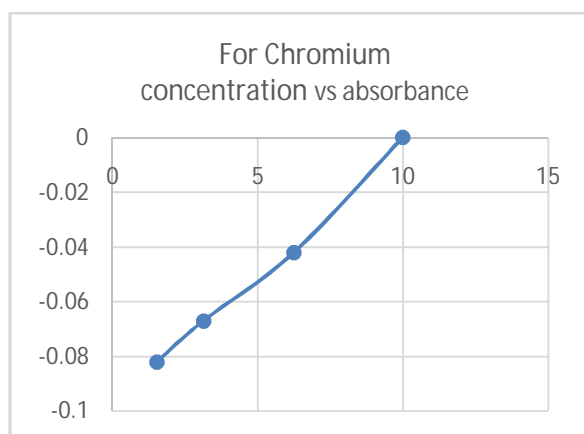


Fig. No. 5: Standardisation curve for Copper

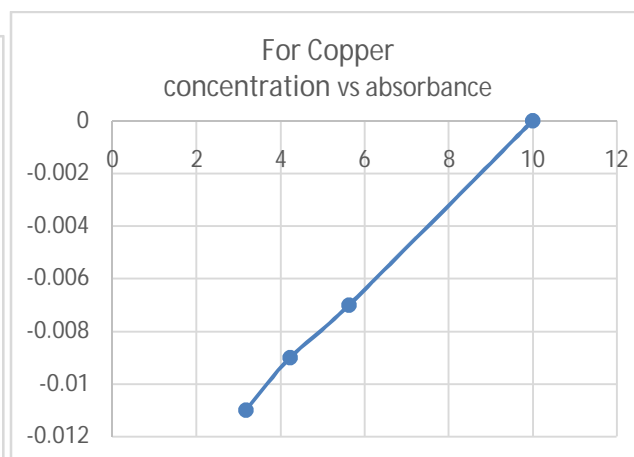


Fig. No. 6: Standardisation curve for Chromium

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The Spectrophotometer readings for the samples of solution during phytoremediation experimentation are given in the table 3. After completion of each week, the samples are taken from pot A, B and C for four weeks and the sample is taken for pot D after the 15 days.

Sr. No.	Sampling time (Completion of week)	Spectrophotometer Reading for copper		Spectrophotometer Reading for chromium	
		Azolla	Water hyacinth	Azolla	Water hyacinth
1	1 st week	0.027	0.025	-0.029	-0.055
2	2 nd week	-	-0.001	-0.038	-0.061
3	3 rd week	0.001	-0.002	-	-0.065
4	4 th week	-0.001	-0.002	-0.062	-0.069

Table No. 3: Spectrophotometer readings for Cu and Cr sample solutions

Table No. 4 gives the concentration of copper and chromium samples collected after every week estimated by referring the respective standardisation curves.

Sr. No.	Sampling time (Completion of week)	Concentration for Copper (ppm)		Concentration for Chromium (ppm)	
		Azolla	Water hyacinth	Azolla	Water hyacinth
1	Initial (0)	10	10	10	10
2	1 st week	-	-	7.4	4.65
3	2 nd week	-	9.4	6.4	3.9
4	3 rd week	9.4	8.7	-	3.4
5	4 th week	9.4	8.7	3.75	2.9

Table No. 4: Estimated concentration for copper and chromium on weekly basis

The table no.5 gives the details of effectiveness of Water hyacinth and Azolla in removal of chromium and copper.

Days	Metallic Component	Aquatic plant	Initial Concentration (ppm)	Final Concentration (ppm)	Weight of Component Removed (gm)	% Removal
28	Cu	Azolla	10	9.4	0.006	6
28	Cr	Azolla	10	3.75	0.0625	62.5
28	Cu	Water hyacinth	10	8.7	0.013	13
28	Cr	Water hyacinth	10	2.9	0.071	71

Table No. 5: Weight and percentage removal of Cu and Cr in experimentation

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- The amount of Copper removed after one month using water hyacinth is 0.013 gm and percentage removal is 13%.
- The amount of Copper removed after one month using Azolla is 0.006 gm having percentage removal of 6%.
- The amount of Chromium removed after one month using Azolla is 0.0625 gm & percentage removal is 62.5%.
- The amount of Chromium removed after 28 days using Water hyacinth is 0.071 gm having percentage removal of 71%.

IV. CONCLUSION

The present work is aimed at phytoremediation studies in removal of copper & chromium present in aqueous solution using Azolla & Water hyacinth plants. Two different initial concentrations of 50 & 10 ppm are studied separately. Based on observations, results & discussion, it can be said that water hyacinth can survive in copper and Chromium concentration less than 50 ppm for around 15 days. The effective uptake for 50 ppm initial concentration is observed to 29% and 14% for copper and chromium respectively for 15 days. Similarly Azolla is effective to the extent of 6 and 62.5% copper and chromium removal respectively over 28 days period. The same figures for 10 ppm initial concentration for Water hyacinth are 13% and 71% for copper and chromium removal respectively.

The present study has successfully addressed to the novel and upcoming method of removal of metallic ions by plants. It has positively indicated that these plants have potential in the abatement of heavy metal pollution to some extent in aquatic ecosystems receiving industrial effluents and municipal wastewater.

The present work is demonstrative & it is felt that more number of experimental findings involving combinations of plant & metallic ions are necessary for further development of the theme.

V. ACKNOWLEDGEMENT

Authors are thankful to director of L.I.T. Nagpur & Head of Department of Botany, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur, for encouragement & analytical facilities.

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