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STUDIES ON REMOVAL OF TOXIC HEAVY METALS FROM WATER BY *Eichhornia crassipes*

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ABSTRACT

Under present investigation *Eichhornia crassipes* (water hyacinth) has been tested for removal of two important toxic heavy metals chromium (Cr) and zinc (Zn) from water under experimental conditions. The plant biomass was grown on pond water added with four concentrations of Cr and Zn, i.e. 5.0, 10.0, 15.0 and 20.0 mg / l for 2-15 days. The plant performed extremely well in removing the Cr and Zn from their solution. It was capable of removing up to 100% of zinc and chromium during 10-15 days incubation period. Addition of Cr and Zn at lower concentration (5.0 mg / l) was found harmless, without any symptom of toxicity even after 15 days, but at 10.0, 15.0 and 20.0 mg / l of Cr, the plants have shown morphological symptoms of toxicity. The leaves started rotting, turned black and ultimately the whole plant decayed after12-15 days. On the other hand Zn was removed safely at concentrations 5.0 and 10.0 mg / l, but not at 15.0 and 20.0 mg / l, where they showed signs of toxicity and decayed after 15-20 days.

KEY WORDS : Water pollution, heavy metals , *Eichhornia crassipes*

Water has great importance in our lives. Mankind needs to be made aware that the water we are getting is actually not free. Nature has used a considerable amount of its energy in recycling it through hydrological cycle. Therefore the minimum we are expected is to make wise use of it for continuity of life on earth. Water bodies are the main targets for disposing the pollutants directly or indirectly. The main hazardous contents of the water pollution are heavy metals. The prevailing purification technologies used to remove the contaminants are too costly and sometimes non-eco friendly also. Therefore, the research is oriented towards low cost and eco friendly technology for water purification.. Aquatic macrophytes like water hyacinth absorb these metallic ions and deposit them in different parts of the plant body depending upon their affinity towards that particular metal. Thus, absorption and accumulation mechanism of the macrophytes render the services of cleaning of water body from the heavy metal contamination. The potential toxic metal elements such as chromium, lead, copper, zinc etc. are identified to cause health hazards in biota (Sivakumar et al.,2001). Work done by different scientists shows that the different submerged / emergent plants including certain alga and vascular plants play a significant role in removing water pollutants from lakes, rivers or ponds; by assimilating the same in their bodies (Dunigan et al. ,1975 and Sutton, and Ornes, 1975).

This work is done to test the hypothesis that nutrient enrichment enhances metal tolerance of relative macrophyte and discusses the potential of aquatic plant to purify water and wastewater.

MATERIALS AND METHODS

Two heavy metals; Chromium and Zinc were selected for the study. *Eichhornia crassipes* was selected as study plant for removal of chromium and zinc under experimental conditions. The plant has been used in the remediation process because it has elaborate root system providing much binding sites for heavy metals.

The plants of *Eichhornia crassipes* were collected from the site (Vaishali nagar, Bhilai), and kept in plastic containers in open, providing the natural conditions. They were kept under observation for 3-4 weeks, before performing the experiment in different sets. The different sets were according to the different biomasses of plants and different concentrations of heavy metals for different periods. A stock solution (1,000 mg/l) of Zn and Cr ($K_2Cr_2O_7$) was prepared in distilled water, which was later diluted as required. The plants were maintained in five litres of pond water supplemented by heavy metals, by pouring a certain volume of the metals stock solution, in order to get the final concentration of 5, 10, 15 and 20 mg/l of Cr and Zn respectively in different plastic tubs containing *Eichhornia*

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crassipes as per the sets of experiment requirement in three replicates.

Plastic tubs with zinc and chromium concentrations without plants served as control. Pond water was added in order to compensate for water loss through plant transpiration, sampling and evaporation. Fresh water was continuously collected from the site and its supply was maintained throughout the study.

An EI make spectrophotometer was used to study absorbance and s-diphenyl carbazide colorimetric method was used for detection of hexavalent chromium and dithizone method was used for detection of zinc.

Observations were recorded for amount of heavy metal present in water after 2, 4, 7 and 10 days of incubation of biomass. Effect of biomass size and different concentrations of heavy metals was also evaluated. Results are expressed in terms of % loss/ absorption of heavy metals from water assuming the fact that amount depleted is absorbed by the plant biomass.

RESULTS AND DISCUSSION

The gradual absorption of zinc and chromium by 500g and 1500g of *Eichhornia crassipes* at 5, 10, 15 and 20 mg/l. is depicted in Figures 1-6. From the figures, it is clear that at lower concentration (5mg/l) the rate of absorption was highest and complete absorption took place in 4-6 days. For the concentrations of 10, 15 and 20 mg/l initially the rate of absorption was slow but it geared up after four days and showed complete absorption in 10 days. It was observed that at all the concentrations, the heavy metal pollutant chromium showed lower rate of absorption than zinc at any stretch of time which may be because Zn (II) was much more mobile than Cr (VI) due to their sizes and charges. According to Maine et al., (2004) Cr uptake takes place through direct contact between the leaves and the solution and is the main cause of the increase of Cr in the aerial parts, Cr being poorly translocated from the roots to the aerial parts. It was also observed that though complete absorption took place in 8-12 days, but in conditions when water doped with higher concentrations (15 &20 ppm) of Cr and Zn, plants got destroyed in 15-20 days; while the plants put in lower concentrations heavy metals could survive. However, this result does not agree with the findings of Mishra and Tripathi ,(2009) according to whom *E. crassipes* removed Zn safely at all concentrations i.e. 5.0, 10.0, 15.0 and 20.0 mg / l.

The findings from figures (1-6) also tell us that biomass of plant also has some effect on percentage absorption of heavy metals. The more is the biomass the more is the absorption, and such plants showed delayed decaying symptoms (2-5 days).

The use of low-cost waste materials as adsorbents of dissolved metal ions provides economic solutions to this global problem and can be considered as eco-friendly (Volesky and Holan, 1995). Emphasis is given to the utilization of biological adsorbents for the removal and recovery of heavy metal contaminants (Young et al.,2006). The bio-accumulation characteristic of the macrophyte which otherwise is a weed, is helpful in filtration of the metallic contaminants from the pond. Maintaining of proper density of the weed in the water body by way of controlled harvesting followed by disposal may regulate the heavy metal contamination in the pond ecosystem without introducing any foreign chemical substance. The impact of bio-filtration of metals by using weeds is not only a sustainable technique but it is also cost effective with no maintenance. Overall this methodology is safe for the removal of Zn and Cr and can be utilized at large scale after few further investigations.

The macrophyte acts as natural biofilter and helps in removing the toxic pollutants from water bodies. Water hyacinth has been used for removal of nutrients and heavy metals from sewage and sludge ponds (Vietmeyer ,1975). A positive correlation has been reported between water hyacinth and Copper, Cadmium, chromium, humic acid and Pb and Zn (Sutton and Ornes, 1975 and El-Gendy et al., 2006).

It may be suggested that *Eichhornia crassipes* plant can be utilized as the scavenger of Cr and Zn from waste water.

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Fig. - 1 % absorption of Chromium by 1500 g of *Eichhornia crassipes* over different incubation periods.

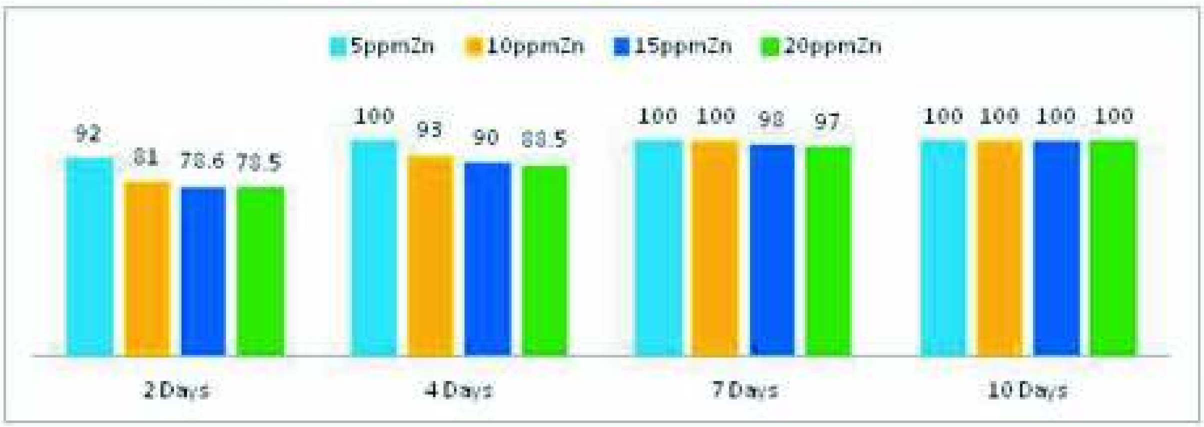

Fig. - 2 % absorption of Zinc by 1500 g of *Eichhornia crassipes* over different incubation periods.

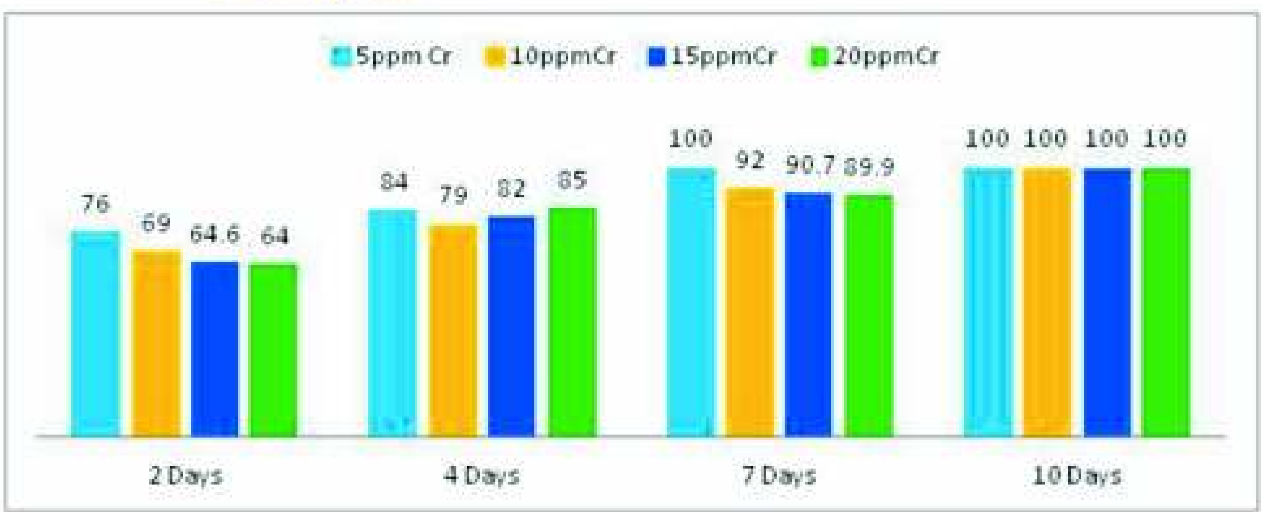

Fig.- 3 % absorption of Chromium by 500 g of *Eichhornia crassipes* over different incubation periods

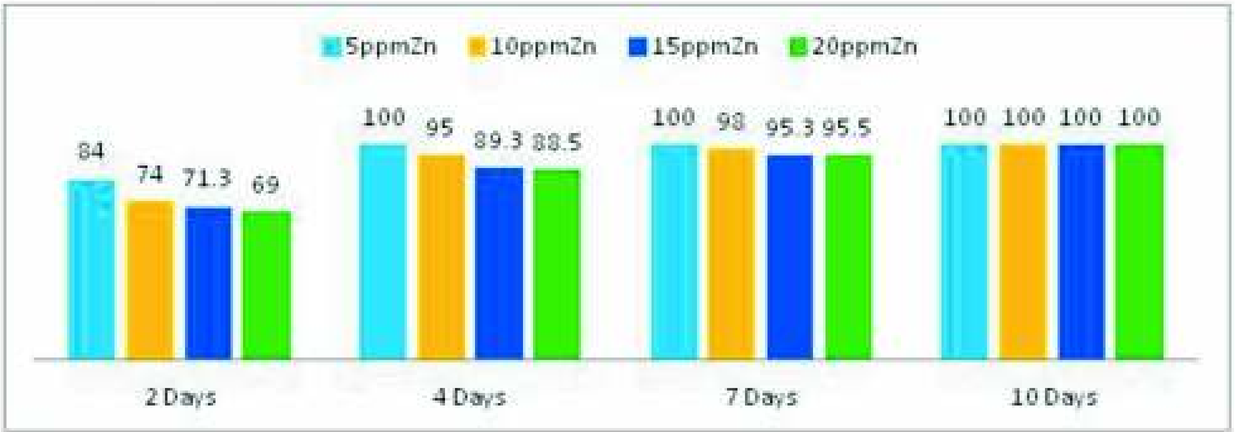

Fig.- 4 % absorption of Zinc by 500 g of *Eichhornia crassipes* over different incubation periods

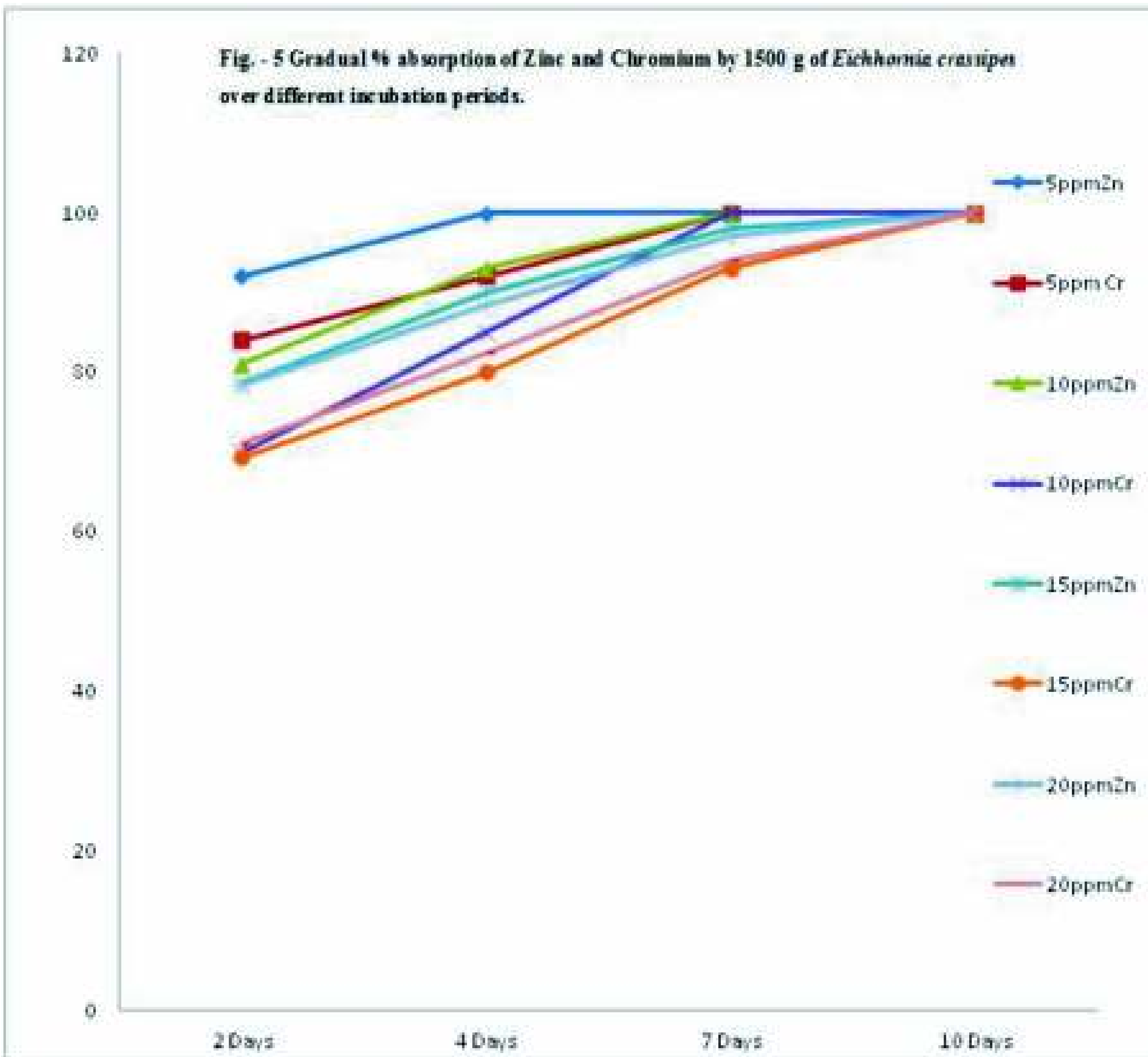

Fig. - 5 Gradual % absorption of Zinc and Chromium by 1500 g of *Eichhornia crassipes* over different incubation periods.

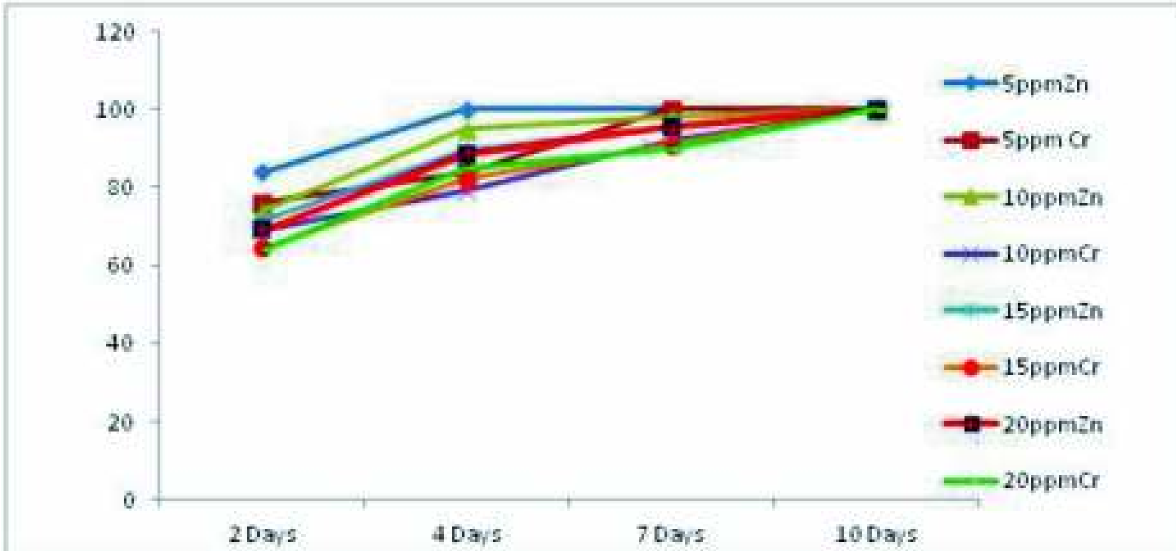

Fig.- 6 Gradual % absorption of Zinc and Chromium by 500 g of *Eichhornia crassipes* over different incubation periods

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