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A STUDY ON THE EFFECT OF LOW LEVEL NUTRIENT STRENGTH ON THE UPTAKE OF CHROMIUM BY *Lemna minor*

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INTRODUCTION

The environment is polluted by a variety of metals that can interfere with biogeochemical cycles. Pollution which is a major issue in the world is due to various human activities. Heavy metals are major environmental pollutants and are considered to be cytotoxic, mutagenic and carcinogenic. Phytoremediation has been accepted widely for its potential to clean up polluted sites. It can be defined as the use of plants including trees and grasses to remove, destroy or sequester hazardous contaminants from media such as soil, water and air. Plant species are selected for phytoremediation based on their potential to accumulate metals, their growth rates and yield, and depth of their root zone. This ability of the plant species can be used to remove the heavy metals in the contaminated sites. Advantages of phytoremediation over traditional treatments include lower cost, ease of monitoring plants, possibility of the recovery and re-use of valuable metals (phytomining); it is the least harmful method since it uses naturally occurring organisms and preserves the environment in a more natural state.

The uptake of metals is affected by the nutrients in the aquatic medium because the other cations in the medium can compete with the metal. Therefore it is important to optimize the nutrient strength for the potential uptake of heavy metals. Previous work (Gothberg et al. 2004) had shown that metal uptake decreased with decreasing metal/nutrient ratio. Our work (Thayaparan, 2009) on uptake of nutrients with varying nutrient strength from 10% to 75% showed that the uptake of metals decreased with increasing nutrient level. We report here the results of our study on the effect of nutrients on the uptake of Cr by *Lemna minor* at lower levels of nutrients.

MATERIALS AND METHODOLOGY

The plant species *Lemna minor* was collected from a waterway in the Rajagiriya area and acclimatized in a fresh water tank in the green house in the premises of the Open University of Sri Lanka.

A stock solution (1000 ppm) of chromium was prepared by dissolving 2.827 g potassium dichromate in 1 L distilled water and diluted appropriately. Test solutions of varying Cr concentration (2, 4, 6, 8 and 10 ppm) with different strengths (2%, 4%, 6%, 8% and 10%) of Hoagland nutrient solution were prepared. Three grams of *Lemna minor* taken from the fresh water tank was cultured in black basins, each filled with 2 liter test solution. The pH of the test solution was 5.0 - 6.0. The experiment was performed at ambient temperature of 30 ^{0}C – 32 ^{0}C in the green house for 5 days. Experiments were carried out in triplicates. The plant species that were exposed to nutrient solutions only, served as controls in the experiment. About 25 cm^3 of distilled water was added daily to compensate for the water loss due to evapo-transpiration. Plant species were harvested on the 5th day, pre treated by washing with distilled water and rinsing with 20 mM EDTA solution and distilled water and weighed. The Relative growth and the metal accumulation were calculated.

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Relative Growth

Relative growth of control and treated plants were calculated as follows:

$$\text{Relative Growth} = \frac{final\,wet\,weight}{initial\,wet\,weight}$$

Metal Accumulation

The plant biomass was subjected to dry ashing at 450 °C for 4 hours in a muffle furnace and then digested with concentrated HNO_3 followed by H_2O_2 (5 ml) and the total accumulation of chromium was determined using an Atomic Absorption Spectrometer (VARIAN AA 280 FS).

RESULTS AND DISCUSSION

The *Lemna minor* plants were normal and fresh up to 10 ppm of Cr concentration in all the test solutions with 2% - 10% Hoagland nutrient strengths. Relative growth indicates the ability of plant to grow and the values at all nutrient levels indicated growth of *Lemna minor* under these stressful conditions (Figure 1). The plants grown in the 6% nutrient solution showed an anomalous growth, perhaps due to climate conditions or experimental error, where only the growth was affected.

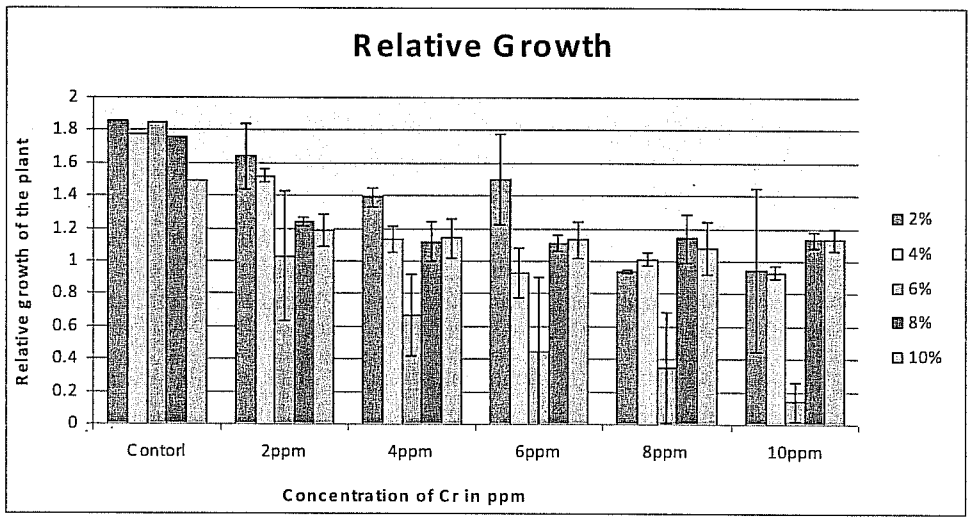

Figure 1. Relative growth of *Lemna minor* in different strengths of Hoagland nutrient solution with varying concentrations of chromium.

Uptake of chromium by *Lemna minor* in different strengths of Hoagland nutrient solution with varying concentrations of chromium is given in Figure 2.

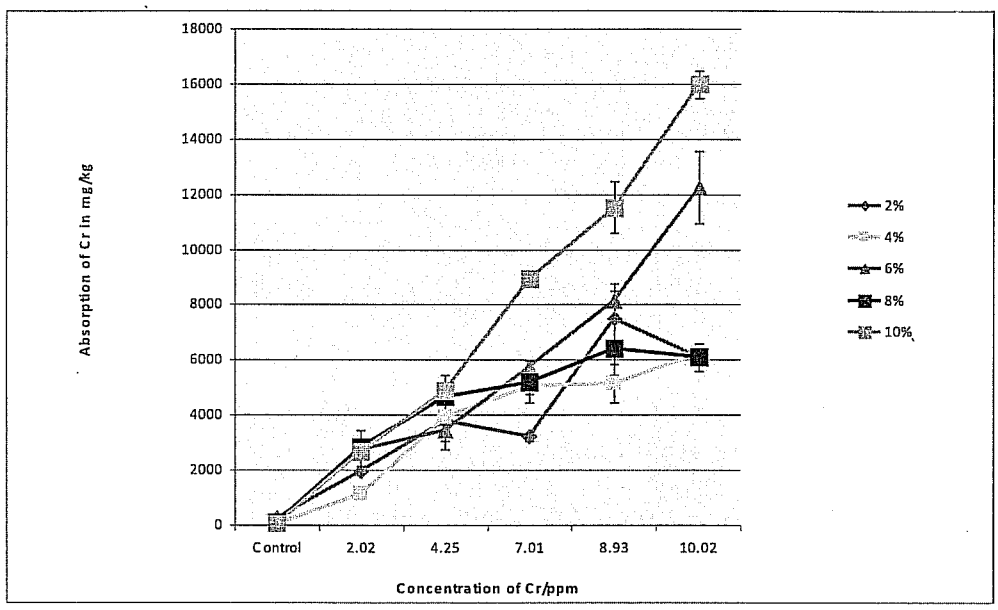

Figure 2. Average absorption of Cr by *Lemna minor* at different metal concentrations with varying nutrient strength

The results showed that the Cr uptake increased with increasing Cr concentration and at a particular Cr concentration it increased with the increasing ambient nutrient strength, showing an absorption of 16000 mg/kg at 10% nutrient strength.

The metal uptake in plants varies considerably. In a nutrient enriched environment, uptake of metal can be affected by bio-available fraction of metals that may be reduced as a result of binding to nutrient anion and competition, since nutrient cation competes with the metal for the uptake sites (Greger, 1999, cited by Gothberg et al. 2004).

In this study, a generous availability of nutrients has promoted plant growth, which in turn has created an increasing number of uptake sites for metals in plants. Thus, the uptake of chromium increases with increasing nutrient strength. This is in contrast with the results from the previous study carried out with 10-75% of Hoagland nutrient solution (Thayaparan, 2009) where the uptake of Cr decreased with increasing nutrient strength from 8000 mg/kg at 10% to 5500 mg/kg at 75% in a 10 ppm Cr test solution. This may be attributed to the fact that the nutrient cations also compete with the metals for uptake sites, thus affecting uptake of heavy metals.

CONCLUSIONS

The results show that Cr uptake increases with increasing nutrient strength of Hoagland solution from 2 – 10%.

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