Abstract

There has been much interest recently in the use of plant based technology such as phytoremediation, for the removal of toxic heavy metals from polluted water ways. Heavy metals produce undesirable effects on human and animal life even if they are present in extremely minute quantities. Aquatic plants are well known in accumulating and concentrating heavy metals.

The specific research objectives were

- to select the most suitable species to absorb Cr, Cd, Pb, Ni,and Hg - **Screening Experiment**.
- to investigate the effect of the strength of the ambient nutrient solution for uptake of metals by aquatic plants – **Nutrient Analysis.**
- to investigate the potential for metal uptake by the selected plant species- **Capacity Assessment.**
- to investigate the removal efficiency of the heavy metal- **Time course Experiment**.
- to estimate the possibility of metal adsorption by non-living biomass of aquatic plants.
- to carry out a survey on selected waterways in the Rajagiriya and Biyagama areas for Cr, Cd, Pb and Ni from August 2007 to April 2008.

In the screening experiment, 12 aquatic species were screened for uptake of Cr, Cd, Pb, Ni and Hg. Each species was exposed to 2 ppm solution of the individual metal ion. This study showed that *Lemna minor* (3240 mg of Cr/kg DW and 2380 mg of Hg/kg DW), *Azolla pinnata* (2310 mg of Pb/kg DW) , *Salvinia molesta* (1330 mg of Cd/kg DW) and *Hydrilla verticillata* (3510 mg of Ni/kg DW) would be promising candidates for phytoremediation of wastewater polluted with those metals.

To determine the effect of external nutrient solution on the uptake of metals by the aquatic plant, a nutrient analysis was carried out with randomly selected plants such as *Lemna minor* and *Azolla pinnata*. In this study, *Lemna minor*

and *Azolla pinnata* were exposed to different concentrations of Cr and Pb respectively at varying strength (10%, 25%, 50% and 75%) of Hoagland nutrient solution. This study revealed that the strength of external nutrient solution is important for accumulation and toxicity of metals in both the plant species. In both cases the metal uptake at a particular metal concentration decreased with increasing nutrient strength of Hoagland solution. Both plant species showed higher absorption of the metals at 10% Hoagland nutrient solution. This 10% nutrient solution was used for the rest of the experiments in this research study.

To estimate the capacity of uptake of metals by the selected plants, capacity assessment was performed. Plant species that are identified as promising candidates were cultured in solutions of different concentrations of the respective metal supplemented with 10% Hoagland nutrient solution. The study showed that there were significant differences in the relative growth when concentration was increased. There was a significant increase of metal in plant tissues when the metal concentration was increased. The Bio Concentration Factor BCF, (>1000) of *Lemna minor* for chromium and that of *Azolla pinnata* for lead suggest the potential of those plants to accumulate the respective metals. The maximum values of BCF of *Salvinia molesta* for Cd and *Hydrilla verticillata* for Ni were 725 and 811 respectively suggesting that these plants were moderate accumulators of Cd and Ni and could be used to treat water contaminated with low levels of these metals.

In the Time course experiment, the selected plant species were cultured in solution using the best concentration of metals (in which plants showed normal growth with high accumulation) to determine the removal efficiency of metal from solution. These results indicated that metals such as Cr, Cd, Pb and Ni had effects on plant relative growth. In the case of *Lemna minor*, removal of chromium from the solution increased with increasing exposure time. But for plants such as *Azolla pinnata*, *Salvinia molesta* and *Hydrilla verticillata*,

there was no strong correlation between the removal efficiency and the exposure time.

To study the phytoremediation potential of chromium by *Lemna minor* in waste water, a trial experiment was carried out with an effluent collected from a leather tanning factory. The total chromium concentration was determined by digesting the effluent and it was found to be 14 ppm. At the same time when the effluent was filtered and analyzed for Cr without digesting, which gave the concentration of Cr (VI). *Lemna minor* showed an absorption of 480 mg Cr/kg DW with BCF 66. These results were significantly different from our capacity assessment and the Time course experiment. This can be explained on the basis of the bioavailability of Cr (VI) ions to *Lemna minor* in the effluent which would have been reduced by the aquatic plant rhizophere activity.

Along with these experiments a survey was carried out at selected waterways in the Rajagiriya and Biyagama areas. It was noticed in both Rajagiriya and Biyagama areas the concentration of heavy metals tested (Cr, Pb and Ni) were low with reference to the tolerance limit for the discharge of industrial waste into inland surface waters in Sri Lanka. Cadmium was not detected in any of these areas. Mercury was not analyzed due to unforeseen problems with regard to its analysis using atomic absorption spectrometer.