

**PHYTOREMEDIATION OF WATER AND SOIL
CONTAMINATED WITH LEAD AND NICKEL**

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INDIAN INSTITUTE OF TECHNOLOGY, DELHI

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PHYTOREMEDIATION OF WATER AND SOIL CONTAMINATED WITH LEAD AND NICKEL

by

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Submitted

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the



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DEDICATED TO
MY
LATE GRANDMOTHER
AND
PARENTS

CERTIFICATE

This is to certify that the thesis entitled “**Phytoremediation of Water and Soil Contaminated with Lead and Nickel**” is being submitted by Leela Kaur, to Indian Institute of Technology, Delhi for the award of Doctor of Philosophy. Miss Leela Kaur has worked under our guidance and fulfilled the requirements for the submission of thesis, which, to our knowledge has reached the requisite standard.

The result contained in this thesis has not been submitted in part or full to any other university or institute for the award of any degree or diploma.

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(Leela Kaur)

ABSTRACT

Heavy metal pollution in the environment is a major global concern which has provoked the emergence of phytoremediation technologies for cleaning soils, aqueous streams, mine wastes and sewage by use of plants.

In the present work *Lemna minor* was selected to study the effect of pH and chelants on Pb and Ni uptake from Pb and Ni contaminated water (individually and in combination) and *Brassica juncea arawali* was selected to study the metal accumulation from Pb and Ni contaminated soil with or without chelating agents.

To investigate the effect of pH on the removal of Pb and Ni, *L. minor* was treated with 1, 5, 10, 15 and 20 mg/l concentrations of Pb and Ni under different pH i.e. pH 4, 5, 6, 7, 8, 9 and 10. Metal bioaccumulation process was affected by various parameters such as exposure time, pH and concentration of metal solution. The maximum Pb uptake was achieved at pH 5 with 20 mg/l of Pb after 28 days. However, plants treated with 20 mg/l of Ni accumulated the highest level of metal at pH 6 for the same time period. In combined Pb+Ni treatments, the highest Pb accumulation in biomass (675 ± 18 mg/kg) was determined in 20 mg/l of Pb+Ni combined treatment at pH 5 and for Ni (775 ± 21 mg/kg) at pH 6 after 28 days exposure. These results suggested that pH played an important role in counteracting metal stress in *L. minor*.

In another approach, the influence of natural organic agent SA (salicylic acid) and synthetic organic agent EDTA (ethylenediaminetetraacetic acid) on metal uptake by *L. minor* in Pb and Ni contaminated water was studied. 6.0 g initial fresh weight of *L. minor* was used and treated with Pb and Ni, each at concentration of 10 mg/l. EDTA and SA were added at 2.4mM concentration. Samples were collected at an interval of 7 days for four weeks i.e. 7, 14, 21 and

28 day. Salicylic acid significantly enhanced the uptake of Pb and Ni in single Pb and Ni treatments. However, addition of EDTA could not induce Pb and Ni accumulation.

In the soil remediation study, two ways, natural phytoextraction and induced phytoextraction with the chelating agent EDTA and SA, were studied. Pot experiments were executed to assess the potential of *Brassica juncea arawali* with and without EDTA and SA in metal uptake grown in Pb and Ni contaminated soils. Metal concentrations used for the Pb and Ni (alone) treatments ranged from 100-800 ppm. High levels of combined metal concentrations (200-1600 ppm Pb+Ni) were taken to assess the feasibility of phytoextraction on a high-level metal contaminated soil. Mustard plants were analysed for morphological, biochemical parameters and metal accumulation. Results showed an overall negative effect of EDTA on plant's growth. This could have been either due to EDTA toxicity or the breaking of phytochelatin-metal bonds. The mustard plants grown without chelant EDTA achieved hyperaccumulator status (1462 ± 59 mg/kg) at the 800 ppm of soil Pb contamination level after 120 days. With EDTA addition, plants achieved hyperaccumulator status (1150 ± 50 to 3479 ± 71 mg/kg) for the applied Pb doses of 100-800 ppm after 120 days. EDTA and SA proved effective in enhancing Pb and Ni concentrations in *B. juncea* and the role of the synthetic organic agent (EDTA) was far better than that of the natural organic agent (SA).

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