Short Communication

Phytoremediation of Chromium and Cobalt using *Pistia stratiotes:* A sustainable approach

Santosh Kumar Prajapati, Neelima Meravi, Shivangee Singh
Department of Botany, School of Life Sciences, Guru Ghasidas Vishwavidyalaya, C.G. 495009, India
E-mail: sntshprjpt@rediffmail.com

Received 25 November 2011; Accepted 1 January 2012; Published online 5 June 2012
IAEES

Abstract
This experimental study showed that aquatic macrophytes, *Pistia stratiotes*, may be used for phytoremediation of water bodies polluted with heavy metals, Cr and Co in a sustainable way.

Keywords phytoremediation; Chromium; Cobalt; *Pistia stratiotes*.

1 Introduction

Pollution of the biosphere with toxic metals has accelerated dramatically since the beginning of the Industrial Revolution (Nriagu, 1979; Sayyed and Sayadi, 2011). The heavy metal load from domestic wastewater and sewage alone (Nriagu and Pacyna, 1988) ensures that this will be a continuing problem for science and humankind. The release of toxic heavy metals such as Chromium (Cr) and Cobalt (Co) into the environment is a serious pollution problem affecting water quality, therefore presenting a direct hazard to human health. Ions of chromium and cadmium which are frequently present in the wastewaters can cause renal dysfunction as well as chronicle alterations in nervous system and gastrointestinal tract. These metals are released from a variety of sources such as mining, urban sewage, smelters, tanneries, textile industry and chemical industry. Technologies used for their removal from aquatic bodies include reverse-osmosis, ion-exchange, electrodialysis, adsorption, etc. Most of these technologies are quite costly, energy intensive and metal specific. Contrary to this, phytoremediation offers a promising technology for heavy metal removal from waste water (Singh et al., 1996; Miretzky et al., 2004).

Phytoremediation involves phytoextraction (Kumar et al., 1995), rhizofiltration (Dushenkov et al., 1995), phytostablization (Salt et al., 1995) and phytotransformation/phytodegradation (Susarla et al., 2002). Aquatic macrophytes *Pistia stratiotes* L. has been extensively used for phytoremediation (Quian et al., 1999; Skinner et al., 2007). *Pistia stratiotes was* used in laboratory experiments for the removal of several heavy metals (Fe, Cu, Zn, Mn, Cr, and Pb) resulting from anthropogenic activity (Miretzky et al., 2004).

2 Material and Methods

Aquatic macrophytes *Pistia stratiotes* L. (water lettuce) was selected to assess its heavy metal removal capacities for Cr and Co from water under laboratory conditions. *Pistia stratiotes* L. is a perennial freshwater weed spread across the world and carries its entire life cycle as free-floating plant, only the root system is completely submerged. This species takes up metals from water, produces an internal concentration several folds greater than their surroundings and shows much higher metal-accumulating capacity than non-hyper

accumulating terrestrial plants. Therefore this species was selected for present phytoremediation experiment. The metal concentration was measured with the help of atomic absorption spectrophotometer (AAS) model: AA 7000, SHIMADZU and the standard was prepared using standard metal solution of Inorganic Ventures.

3 Results and Discussion

Cr and Co from the water were very efficiently removed by *Pistia stratiotes* (Fig. 1). It is clear from the figure that Cr was almost completely removed in 48 hours and non detectible level was present after 72 hours. Similar results were observed with the removal of Co from water. The present finding is in consonant with other findings and is supported by literature.

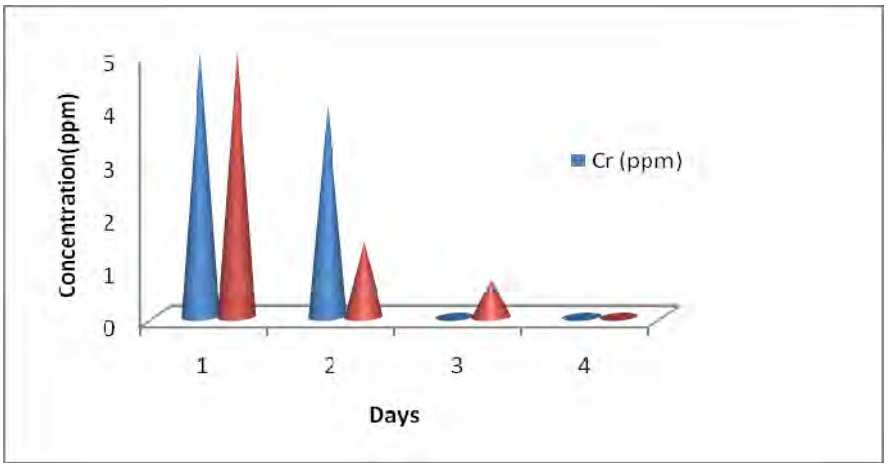

Fig. 1 Concurrent removal of Cr and Co by *Pistia stratiotes*

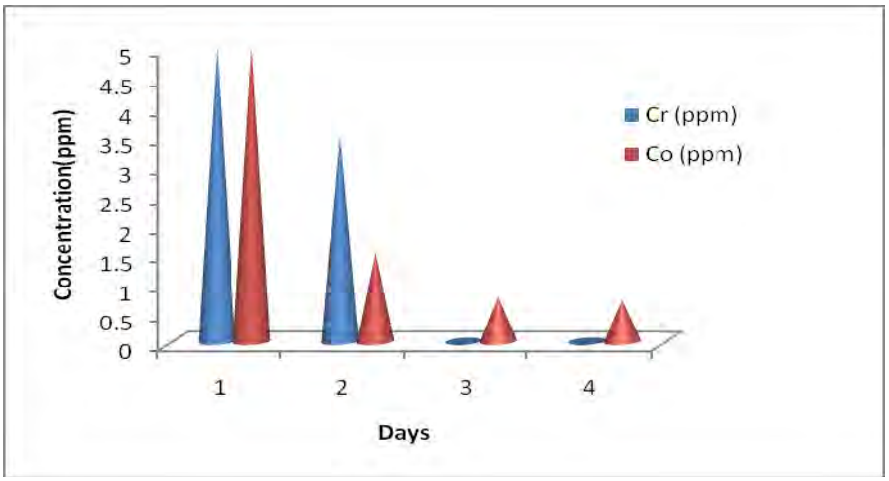

Fig. 2 Removal of Cr and Co by *Pistia stratiotes*

When the removal of heavy metals Cr and Co from water was done separately by *Pistia stratiotes* then different results were observed (Fig. 2). It can be seen clearly that almost all Cr is removed by *Pistia stratiotes* in 48 hours and there was negligible amount of Cr in water after 48 hours which cannot be detected. However, Co was not completely removed in 4 days. The main reason for this may be the toxicity of Co to *Pistia stratiotes.*

Table 1 Percent age removal of heavy metals by *Pistia stratiotes*

Days	% age removal of heavy metals by *Pistia stratiotes*	
	Cr	Co
1	0	0
2	30	70
3	100	85
4	100	86

It can observe from the Table 1 that percentage removal efficiency of *Pistia stratiotes* for the two toxic heavy metals differs. The capacity of *Pistia stratiotes* for Cr removal is high as compared to Co from water. Other researches also have similar findings and the reasons are also similar i.e. high toxicity of Co as compared to Cr for *Pistia stratiotes.*

It can be concluded from the present study that aquatic macrophytes *Pistia stratiotes* can be used for phytoremediation of water bodies polluted with toxic metals Cr and Co in a sustainable way.

Acknowledgments

Authors are thankful to the Department of Botany, School of Life Sciences, Guru Ghasidas Vishwavidyalaya, C.G. for providing the various facilities.

References

Dushenkov V, Kumar PBAN, Motto H, et al. 1995. Rhizofiltration- the use of plants to remove heavy metals from aqueous streams. Environmental Science and Technology, 29(5): 1239-1245

Kumar PBAN, Dushenkov V, Motto H, et al. 1995. Phytoextraction- the use of plants to remove heavy metals from soils. Environmental Science and Technology, 29: 1232-1238

Miretzky P, Saralegui A, Fernandez Cirelli A. 2004. Aquatic macrophytes potential for the simultaneous removal of heavy metals (Buenos Aires, Argentina). Chemosphere, 57/8: 997-1005

Nriagu JO. 1979. Global inventory of natural and anthropogenic emission of trace metals to the atmosphere. Nature, 279: 409-411

Nriagu JO, Pacyna JM. 1988. Quantitative assessment of worldwide contamination of air, water and soils by trace metals. Nature, 333: 134-139

Quian JH, Zayed A, Zhu YL, et al. 1999. Phytoaccumulation of tace elements by wetland plants, III: Uptake and accumulation of ten trace elements by twelve plant species. Journal of Environmental Quality, 28: 1448–1455

Salt DE, Blaylock M, Kumar PBAN, et al. 1995. Phytoremediation: A novel strategy for the removal of toxic elements from the environment using plants. Bio/Technology, 13: 468-474

Sayyed MRG, Sayadi MH. 2011. Variations in the heavy metal accumulations within the surface soils from the Chitgar industrial area of Tehran. Proceedings of the International Academy of Ecology and Environmental Sciences, 1(1): 36-46

Singh DB, Prasad G, Rupainwar DC. 1996. Adsorption technique for the treatment of As (V) rich effluents. Colloids Surf, 111: 49-56

Skinner K, Wright N, Goff EP. 2007. Mercury uptake and accumulation by four species of aquatic plants. Environmental Pollution, 145: 234–237

Susarla S, Medina VF, McCutcheon SC. 2002. Phytoremediation: An ecological solution to organic chemical contamination. Ecological Engineering, 18: 647–658