AN ECOTECHNOLOGICAL TOOL FOR CADMIUM SEQUESTRATION USING WASTE STABILIZATION PONDS IN INDIA

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Introduction

Wastewater generated from diverse anthropogenic sources contains a cocktail of chemicals including trace metals like Cadmium. Bio-magnification of metals in sewage-fed pond has been a global concern especially in developing countries. Cadmium as a toxic metal poses a threat to human health passing through food chain. In developing countries, conventional wastewater treatment plants are not considered as an viable option for treating sewage owing to its capital and energy-intensive nature. Waste stabilization ponds exemplify systems of low-cost, low-tech, and minimal energy demanding system and therefore, can be promoted as an appropriate ecologically-based solutions to wastewater problem. The objective of the study was to investigate sequestration of Cd in a series of waste stabilization pond ecosystems that would assist to design the sewage treatment ponds in metal removal more effectively.

Materials and Methods

The study was conducted in waste stabilization ponds integrated with fish culture system at Kalyani, West Bengal, India, comprising of eight ponds - two anaerobic, two facultative and four maturation ponds aligned along the sewage effluent gradient finally falling to an outside canal that run to the Gangas. Water, sludge, plankton, water hyacinth and fish tissue were prepared and Cd contents were measured by AAS (APHA, 1995). The physicochemical analyses (Turbidity, Total Dissolved Solids, Total Suspended Solids, pH, Total alkalinity, Dissolved Oxygen, Orthophosphate, Chemical Oxygen Demand, of water was analyzed following standard methods (APHA, 1995). Sedimentation rate, bioconcentration -, tissue concentration - and bio-magnification factor in Tilapia fish were also determined. Finally the data were subjected to appropriate statistical analyses.

Result

Cadmium was found Both the abiotic and biotic ecosystem components (water, sludge, plankton, Eichhornia and fish) although of varied concentrations (1.0 – 8.0 ppb). It implied that Cadmium mixed in sewage entered into pond water and soil media and got transferred and partitioned to biota of different trophic tiers. Considerable amount (29% - 100%) of cadmium of sewage has been deposited into sludge, 13 – 30 % of which remained bound in sludge throughout year. Facultative pond served as the best reserve (7.2 ppb) followed by anaerobic pond (3.75 ppb). Following was the overall order of metal mobility: FP > AP > SP_1 > SP_4. In anaerobic pond, metal partitioning was more in abiotic compartments than biotic ones in contrast to in other ponds. Biomagnification of Cadmium in the sewage fed pond ecosystem by 0.48 – 1.84 folds. In anaerobic pond, it was amplified only in Eichhornia by 0.52 times. Plankton community in facultative pond revealed the highest magnification (1.48 times) but stocking ponds showed the classical mode of bio-magnification with tilapia having a biomagnification factor of 1.84. In facultative pond the bio-concentration factor was highest in plankton (1.48) but stocking ponds fish exhibited 1.37-1.9.

Cd became mobilized from abiotic environment of the sewage-fed pond ecosystem into its biotic components along the food chain (Grey, 2002; Croteau et al., 2005). A great quantity of Cd was precipitated in sludge due to either adsorption of Cd^{+2} to the large organic molecule or formation of organometalic

compounds or both (Zhang et al., 2003; Igwe and Abia, 2006). Rate of biodynamics of Cd from water and sludge was caused of rapid absorption by phytoplankton and Eichhornia and high sludge consumption rate zooplankton and tilapia. Large planktonic population size coupled with macrophyte mediated Cd uptake made FP most efficient in metal removal. High concentration of Fe^{+2} accompanied with high sedimentation reduced the reclamation efficiency of Cd in AP.

Conclusion

Cd sequestration by different ecosystem components in different types of waste stabilization ponds offer a practicable and ecosystem based solution to Cadmium problem. The stocking ponds integrated with other treatment ponds became productive to convert waste nutrients into fish protein without toxic load of metal.

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