The effectiveness of Typha Latifolia for phytoremediation of hazardous heavy metals in wastewater

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The effectiveness of *Typha Latifolia* for phytoremediation of hazardous heavy metals in wastewater

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Abstract

The objective of this study was to evaluate the effectiveness of *Typha Latifolia* for the phytoremediation of heavy metals from waste water using phytoremediation indices: bioconcentration factors (BCF), translocation factors (TF) and enrichment factors (EF). The result indicated that the plant species is both an accumulator (Al and Fe) and an excluder (Pb, Co, Ca, Cr) of heavy metals. The TF values are <1 for all the tested metals (except Fe), greatest accumulation was found in the roots of the plant and these parameters were not successfully translocated to the shoots and leaves of the plant. Similarly, the EC values are found to be <1 for all the heavy metals considered, indicating there was a greater concentration at the selected site than in the roots and shoots of the plants. In general, the considered plant species is effective in the phytoremediation of the heavy metals from wastewater. The percent removal rate is in the range of 70 – 80 % for some parameters (Fe, Cu and Cr) and more than 99% for other parameters (Pb, Al, and Cd).

Introduction

The deposition of heavy metals from different activities (industrial processes, mining activities, etc) into water bodies and soil is a major concern to human health and ecosystem (Monisha, *et al.,* 2015). Once deposited in water bodies, the heavy metals can have adverse effects on human health, biodiversity and aquatic life (Mojri, 2011). In order to eliminate the impacts of heavy metals and improve the quality of life, it is, therefore, important to treat wastewater and completely remove or minimise the concentration of the hazardous and heavy metals in wastewater. Phytoremediation is one of many technologies that have been employed in aid to remediate and mitigate these environmental and health concerns. Phytoremediation technology makes use of plants and their rhizosphere micro-organisms to extract the pollutants from the contaminated wastewater bodies or soil. The objective of this study was to evaluate the effectiveness of a Broadleaf Cattail (*Typha Latifolia*) for the phytoremediation and the metal extraction.

Methodology

The wastewater sampling took place at the Auckland Park industrial area, Johannesburg. The wastewater samples were placed in an appropriate container. Then, *Typha Latifolia* (Broadleaf Cattail) plant species are placed in each of the samples. The samples are left for 18 days before removal of the plants for analysis. The plants were rinsed with distilled water to wash off any soil particles. Broadleaf Cattail was selected for the phytoremediation because of its various advantages (Rodriguez-Hernandez, *et al.,* 2017): the plant specie can be grown under different climatic conditions, it can grow very fast, and easily harvested. *Typha Latifolia* has been used by different researchers in the world for the phytoremedation of water and soils from metals (Hazra, *et al.,* 2015). The contaminant concentrations for each sample were measured and the removal percentage (RP =$(C_i - C_f)/C_i$) calculated. The effectiveness of the plant species for the phytoremediation was calculated based on the phytoremediation indices (Farraji, 2016): Bioconcentration factor (BCF = P/E),

Translocation (Mobilisation) Factor (TF = C_{sp}/C_r) and enrichment coefficient (EC =C_r/C_s). Where, Ci and Cf = initial and final concentration (kg); P = element concentration in plant tissues (mg/kg); E = the element concentration in the water (mg/L) or in the sediment (mg/kg); Ci = Initial concentration; Csp, Cr and Cs = concentration of metallic element in the plant shoot, root and soil, respectively.

Results and discussion

Table 1 shows the experimental results obtained from this study. The result shows the effectiveness of the selected plant species for the removal of heavy metals. The highest removal (99.8%) was obtained for Al and the lowest removal (71.4%) was obtained for Cd. The plant removal order is Al>Cd>Pb>Cr>Fe>Co.

Table 1. Concentration of heavy metals, removal % and their phytoremediation indices

		Sample number				Removal %	Phytoremediation indices		
Metal	Initial conc.	101	102	103	104		BCF	TF	EC
Pb	0.99	<0.01	<0.01	<0.01	<0.01	99.0	0.54*	0.81	0.68
Fe	12.46	1.72	10.6	0.31	0.028	73.8	1.05**	1.32	0.83
Cu	0.35	<0.10	<0.10	<0.10	<0.10	71.4	0.24**	0.03	0.12
Al	6.56	<0.01	<0.01	<0.01	<0.01	99.8	2.56*	0.16	0.18
Cr	0.13	<0.03	<0.03	<0.03	<0.03	76.9	0.04*	0.41	0.06
Cd	3.87	<0.01	<0.01	<0.01	<0.01	99.7	0.57*	0.17	0.04

BCF: * indicates the plant is excluder; ** indicates the plant is accumulator

The result, based on BCF, indicated that the plant species is both an accumulator (Al and Fe) and an excluder (Pb, Co, Ca, Cr) of heavy metals. The TF values are <1 for all the tested metals (except Fe), greatest accumulation was found in the roots of the plant and these parameters were not successfully translocated to the shoots and leaves of the plant. Similarly, the EC values are found to be <1 for all the heavy metals considered, indicating there was a greater concentration at the selected site than in the roots and shoots of the plants. The TF value for Al (0.15) indicates that the greatest accumulation was found in the roots of the plant and the Al was not successfully translocated to the shoots of the plant. The EC value for Al (0.169) indicates a greater aluminium concentration at the site than in the roots and shoots of the plant. The BCF value of Cd (0.537) indicates that *Typha latifolia* is an excluder of the heavy metal. However, the specie was able to reduce the metal concentration from 3.87mg/L to a value that is less than 0.001 mg/L. In general, the considered plant species is effective in the phytoremediation of the heavy metals from wastewater. The percent removal rate is in the range of 70 – 80 % for some parameters (Fe, Cu and Cr) and more than 99% for some parameters (Pb, Al, and Cd). Therefore, other plant species (Brassica juncea L., Oryza sativa L., Pistia stratoites (water lettuce), P. stratiotes, Eichhornia crassipes and Duckweed) might also be considered for the remediation of the heavy metal from the waste water.

Keywords

Contamination, heavy metals, phytoremediation, wastewater.

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