Biosorption of Cr(VI) by *Parthenium hysterophorus* biomass

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Abstract- Biosorption of heavy metals is a promising technology that involves the removal of toxic metals from waste water. The present study aims to screen the *Parthenium hysterophorus* for its potential biosorption of Chromuim (VI). The biosorption equilibrium data were well fitted by the Langmuir adsorption isotherm. The biosorption kinetics showed that the equilibrium was reached within 10 min. The maximum removal of Cr (VI) by *Parthenium hysterophorus* was estimated to be 71% in 50 mg/l of Cr(VI). In conclusion, *Parthenium hysterophorus* is proposed as an excellent biosorbent with potentially important applications in removal of heavy metals pollutants from wastewaters.

Key words: *Parthenium hysterophorus; Biosorption; Cr (VI), Biomass*

I. Introduction

Heavy metals are widely used in the industries and believed to be toxic and carcinogenic. Due to the environmental pollution of heavy metals used in the industry, there is a need for suitable and cost effective removal technology (Oliveira et al., 2008). Chromium(Cr), arising from various industrial sources such as electroplating, plastic, mineral processing and battery manufacturing, is one of the most toxic heavy metals in industrialized nations. Chromium exposure may cause adverse effects such as cancer, lung insufficiency, bone degradation, and liver and kidney damage (Oliveira et al., 2008; Costa, 2003). Therefore, the US Environmental Protection Agency has established a permissible limit of 0.1 mg/L for total chromium species in drinking water (ATSDR, 1998).

Various techniques such as precipitation, coagulation,ion exchange, adsorption, oxidation, reduction, and reverse osmosis have been used to remove chromium pollutants from wastewater streams. However, many of these approaches are ineffective or extremely expensive for practical use (Aryal and Liakopoulo, 2011).

Biosorption is a promising technology to remove and/or recover of the pollutants such as heavy metals, and precious metals. Numerous biomaterials such as algae, fungi, yeast, bacteria, sludge, agricultural and industrial byproducts have been studied as biosorbents for the removal of heavy metals and dyes in recent periods. The biosorption of the ionic pollutants Using the biomass generally takes place on the functional groups of the biomass surface (Levankumar et al., 2009). As the most potent sorbent, *Parthenium hysterophorus* was finally selected for further studies on equilibrium, kinetics and the effects of various parameters such as contact time, pH and initial Cr(VI) concentration on biosorption efficiency.

MATERIALS AND METHODS

Biomass preparation

The biosorbents used in this studywere the *Parthenium hysterophorus* biomass was obtained from Kathmandu. Nepal and indentified by Botany, deapartment, TU. After being powdered, treated with 1 M HCl, washed twice by distilled water and freeze-dried.

Biosprtiom experiments:

Reference Cr(VI) solutions at 1000 mg L−1 were prepared from $K_2Cr_2O_7$ (Merck, Darmstadt, Germany). In order to determine the optimum pH, contact time and biomass concentration, initial Cr(VI) concentration of 50 mg/L was used. Biosorption experiments were carried out in 50 mL conical flask . The pH experiments were conducted betwween 1 to 7 with 50 mg/L of the initial metal concentration and 1 g/L of the biomass. The pH was intentionally altered by the addition of either 0.1 M NaOH or 0.1 M HNO3 to the working solution. Isotherm experiments were carried out by placing various metal concentrations, ranging from 10 to 500 mg/L, in contact 0f 30 min with 1g/L of the biomass.

Estimation of chromium concentration:

The Cr(VI) concentration was determined at 540 nm followed by complex formation with 1,5-diphenylcarbazide using a spectrophotometer (Snell and Snell, 1959). The values reported in this study were obtained from the average of triplicate analyses for each sample.

RESULTS AND DISCUSSION

Effect of pH, biomass concentration and metal initial concentration

The effect of pH on Cr(VI) biosorption is shown in Fig.1. Effect of pH was studied between 1 to 7 respectively. It was found that 67 % of Cr(VI) was removed in pH 3. The results further show that removal efficiency increase from 1 to 3 and again decreases to PH 7. The maximum Cr(VI) removal was achieved at pH 3.0. This may be due to the interaction between $HCrO_4^-$ ions and positively charged biomass surface groups. A decrease in percentage Cr(VI) removal was observed upon further increase of pH from 2.0 to 7.0, possibly due to the gradual increase in negatively charged biomass surface groups and shifting of monovalent $HCrO_4^-$ to divalent $Cr_2O_7^{-2}$ and CrO_4^{-2} ions in aqueous solutions (Aryal et al., 2011).

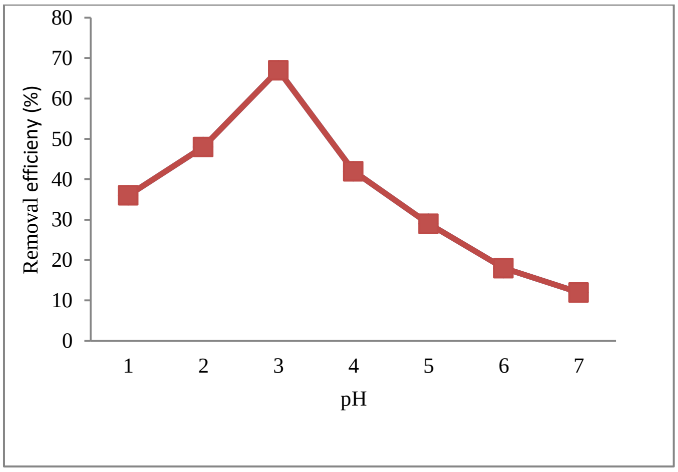

Fig 1. Effect of pH on removal of Cr (VI) by *Parthenium hysterophorus* biomass

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The effect of biomass concentrations on Cr (VI) biosorption is presented in Fig. 2. Biomass concentration was examined between 1 to 5 g/L. The results show that maximum removal of chromium was observed in 1 g/L around 66.13 %. . This increase in sorption efficiency with increase in biomass concentration is indicative of the higher number of binding sites at increased biomass concentration. The lower increment in percentage removal of chromium species observed above biomass concentration of 1.0 g/L may be attributed to the strong limitations of chromium ions mobility in the biosorption medium (Zubair et al., 2009).

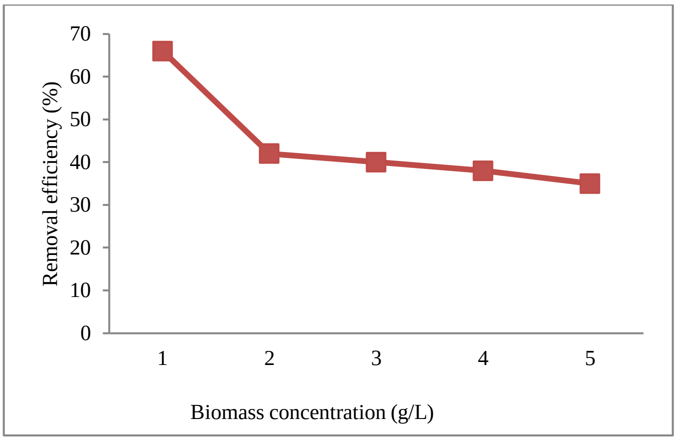

Fig 2. Effect of biomass contration on removal of Cr(VI)

The effect of contact time for Cr(VI) biosorption is depicted in Fig. 3. Contact time of biosorption of chromium was studied between 5 to 60 min. Maximum removal of chromium was observed at 30 min and this time was taken as optimum time for further biosorption experiments. The results indicate that biosorption efficiency initially increased with increase in contact time rapidly and thereafter proceeded at a lower rate and attained equilibrium at 30 min for Cr(VI) ions (Levankumar et al., 2009).

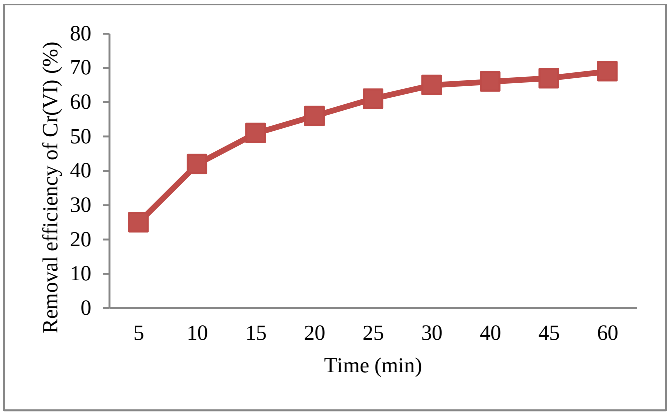

Fig 2. Effect of contact time for biosorption Cr(VI) on *Parthenium hysterophorus* biomass

The effect of initial concentration of Cr(VI) indicates that maximum removal efficiency was 71% in the optimum conditions of plant biomass. The removal efficiency of *Parthenium hysterophorus* biomass decreases with increasing the initial concentration of chromium. As can be seen, the amount of sorption capacity decreases upon increasing initial Cr(VI) concentrations, which can be explained from the fact that initial chromium concentration provides the necessary driving force to overcome the resistance to the mass transfer of chromium species between aqueous and solid phases. High concentrations may enhance the interaction between chromium species and biomass surface and thus increase biosorption capacity (Elangovan et al., 2008).

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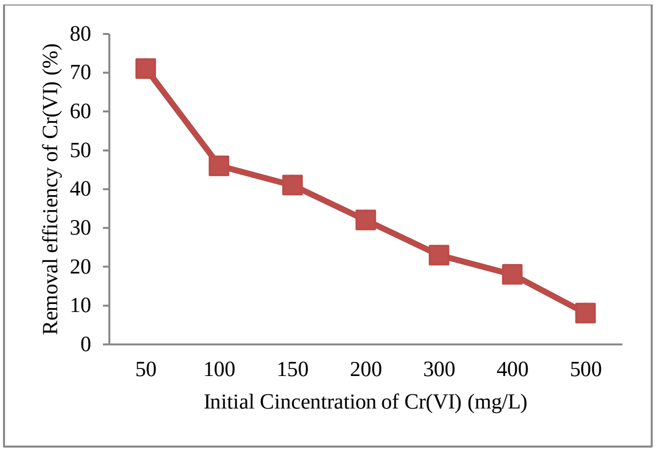

Fig 3. Effect of initial concentration of Cr(VI) on *Parthenium hysterophorus* biomass

CONCLUSION

In the present work, *Parthenium hysterophorus* biomass showed the high removal effiiency for reoval of Cr(VI). The optimum pH and biomass concentration were estimated at 3 and 1g/L respectively. The maximum removal efciency was determined at 50 g/L initioal concetration of chromium. Ot can be concluded that *Parthenium hysterophorus* biomass is promising biosorbent for removal of heavy metals for contaminant sites.

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