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Biosorption of Nickel By the Aquatic Plant Eichhornia Crassipes At Varying Temperature

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Abstract

Heavy metals create Environmental contamination, which is a critical problem in environment and public health as they tend to accumulate in food chain and are not biodegradable creating everlasting burden on ecosystems. Aquatic ecosystems are more prone to the heavy metal contamination and are predominantly susceptible and becoming final receptor of heavy metals. These ecosystems supposed to be more sensitive to contaminants because of small biomass in different trophic levels. Therefore, many aquatic plants are considered as first link with respect to the heavy metal content in an aquatic ecosystem. Present study planned to suggest role of aquatic plant *Eichhornia crassipes* in Ni (II) ions removal by biosorption process. The biosorption characteristics of Ni (II) ions from aqueous solution using *Eichhornia crassipes* dead biomass were investigated as function of temperature. The optimize values for these parameters were found to be 30°C.

Keywords: Heavy metals, Nickel (II) ion; Eichhornia crassipes; Biosorption; Temperature

Introduction:

Elevated levels of heavy metals can cause environmental contamination which is a critical problem in environmental and public health (Kanoun-Boule et al.2009) as they tend to accumulate in food chain and are not biodegradable thus becoming an everlasting burden on ecosystems (Bailey et al. 1999). Aquatic ecosystems are more prone to the heavy metal contamination and are predominantly susceptible and becoming final receptor of heavy metals. These ecosystems supposed to be more sensitive to contaminants because of small biomass in different trophic levels. Therefore, many aquatic plants are considered as first link with respect to the heavy metal content in an aquatic ecosystem. Ni is an essential trace element required by plant in low concentration (Alyuz and Veli, 2009). Its elevated levels might resulted in to serious health hazards like lung and kidney problems, skin dermatitis, pulmonary fibrosis and gastrointestinal distress (Borba et al.2006; Fu and Wang 2011)

Several conventional technologies in use for heavy metal removal from aquatic medium include chemical precipitation (Miranda et al.2000) and filtration, chemical oxidation or reduction, electrochemical treatment, reverse osmosis (Mohsen-Nia et al.2007), ion exchange (Alyuz and Veli, 2009), adsorption and evaporation (Samra et al.2007). These treatment technologies currently available are either not effective enough or are prohibitively expensive and inadequate in case of low metal ion concentrations (1-100 mgm/l) or the volume of waste water to be treated is large (Volesky, 2001).

Biosorption is a process that utilizes inexpensive dead biomass, to sequester toxic heavy metals; Bioabsorbents are prepared from naturally abundant or waste biomass of algae, fungi, moss and aquatic plants or dead bacteria. The process has been found to be quite convenient than conventional methods for metal extraction with advantages which include low cost, high efficiency, minimization of sludge production, and regeneration of biosorbent and possibility of metals recovery (Kratochvil and Volesky, 1998; Ahalya et al. 2003). Biological materials have ability to accumulate heavy metals, radionuclide and organometalloid compounds by physicochemical and biological processes. Aquatic plants are the good accumulators of heavy metals and can be a promising eco-friendly option in heavy metal removal technologies. Many aquatic plants have been used for the heavy metal removal like *Ceratophyllum* (Chorom et al.2012) , *Nymphea lotus* (Galadima et al.2015) , *Salvinia molesta* and *Azolla pinnata* (Motankar et al.2016), *Hydrilla verticillata* , *Elodea canadensis* and *Salvinia sp.*(Abida and HariKrishna , 2010). Therefore in present investigation *Eichhornia crassipes* an aquatic plant found in muddy stream banks, freshwater ponds, riverside and marshes is used for the removal of Ni(II) by checking its biosorptive capacity on the basis of different, temperature.

Materials and Methods:

Collection of plant material

Plant material *Eichhornia crassipes* selected for present study was collected from the river Chandrabhaga near village Mahuli (Dhande) Ta-Daryapur, Dist- Amravati (M.S.).

Preparation of biosorbent and synthetic solution

The harvested plant biomass (stem) of *Eichhornia crassipes* from river water was thoroughly washed with distilled water to remove all the extraneous material and placed on a filter paper to reduce the water content prior to treating the biomass with 0.02 M HNO_3. It was then dried overnight at 50°C until a constant weight was achieved and the final weight of the biosorbent was recorded. The biosorbent were then crushed and passed through a 300 nm sieve to obtain uniform particle size of biosorbent used for further studies.Synthetic stock solution of Nickel was prepared by dissolving 4.47 grams of $NiSO_4$ $6H_2O$ (Analytical grade) in 100 ml of double distilled water to make a concentration of 1000 mg/l, and serial dilutions from of this stock solution were prepared to obtain10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 mg/l concentration of Ni (II) ion solution.

Batch mode studies

The experiments were carried out in 250 ml Erlenmeyer flasks with dry plant biomass of 0.5 g /100ml aqueous solution. The flasks were kept at 25 °C on a rotary shaker at 200rpm with initial Ni (II) ion concentration ranging from 10 to 100mg/l. In order to check the maximum metal biosorption capacity by the plant biomass optimization of, temperature (25-50 °C), was done using 100ml of 20mg/l of Ni(II) metal ion concentration with dose of 0.5g dead biomass(dry weight) per flask except for optimization of biosorbent quantity and initial metal ion concentration the range of plant biomass dose (0.5-3 g) and initial metal ion concentration (10-100mg/l) were used.

Metal Analysis

All the samples were tested for metal ion concentration by using Atomic Absorption Spectrometer at Department of Biotechnology, North Maharashtra University, Jalgaon (M.S.)

Results and discussion

Biosorption of Ni (II) was studied as a function of, temperature.

Effect of Temperature

The temperature has been found to affect the biosorption. In present investigation extent of Ni (II) ion biosorption by *Eichhornia crassipes,* has been recorded maximum 13.6 mg/g at 30^{o}C (Fig.2) and lower at 25, 40 and 50^{o}C. The decreased adsorption at lower temperature can be due to shrinking of the surface whereas elevated temperatures can be attributed to exothermic characteristics of the biosorbent. Alteration in adsorption equilibrium in a specific way due to the temperature change determined by the exothermic or endothermic nature of a process

Conclusion:

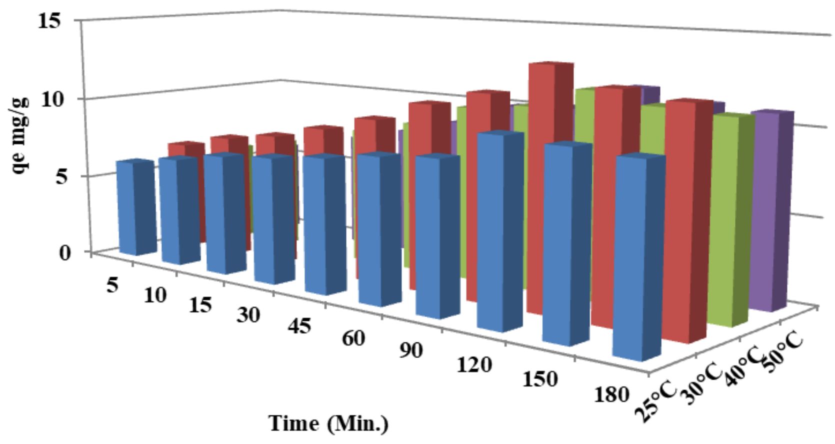
The biosorption capacity of aquatic plant *Eichhornia crassipes* for the removal of Ni (II) ions based on batch mode studies, revealed that, temperature 30°C, were optimum for biosorption of Ni(II) ions (Table1 and fig1). Thus, the present study concludes that *Eichhornia crassipes* may employ as an economic and environment friendly biosorbents and can be a good option to the expensive methods currently used in removing Ni (II) from polluted water.

Table 1 : Biosorption of Ni (II) Eichhornia crassipes (Mart) Solms at varying temperatures.

Time (min.)	Temperature			
	25°C	30°C	40°C	50°C
5	6	6.7	6.1	5.7
10	6.6	7.5	6.8	6.6
15	7.2	8	7.3	7
30	7.5	8.8	8.2	7.8
45	7.9	9.7	9	8.7
60	8.4	10.9	10.3	10
90	8.7	11.8	10.7	10.2
120	10.3	13.6	11.9	11.7
150	10.1	12.6	11.3	11.1
180	9.9	12.2	11.1	10.9

$C'_0 = 20$ mgm/l; initial estimated Ni concentration, $C_0 = 19.2$ mgm/l.

Fig.1: Biosorption of Ni (II) by *Eichhornia crassipes* (Mart) Solms at varying temperatures



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