

# Equilibrium Adsorption Quantities and % Removal of Different Metal Ions at Different Metal Ion Concentration by *Hydrilla Verticillata* (Lf) Royle

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## Abstract

Heavy metal pollution in an aquatic environment has become major problem globally and there is need to utilize the diverse group of aquatic macrophytes by means of phytoremediation as these groups of plants can hyperaccumulate many heavy metals pointing their potential and an alternative way to deal with remediation of heavy metal from aquatic environment . Aquatic macrophytes posses ability to remove and recover the nutrient anions and metal cations present in water and waste waters . Aquatic plants has been used in water quality assessment as *in-situ* biomonitors and bioremediators. There were several factors like pH, temperature, biomass loading and presence of other metal ions that influence the biosorption process. Biosorption of metal ions onto biosorbents involve a combination of the following metal-binding mechanisms including physical adsorption, ion exchange, complexation and precipitation The initial metal concentration plays an important role in the process of biosorption. In order to study the effect of initial metal ion concentration sorbate concentrations in the range of 10 mg/l to 100 mg/l were taken for all the metal ions (sorbent 1.5, 2.0, 2.5 gm/l, pH 5.0 and pH 6.0; time 120 min. and temperature 30°C and 40°C). . *Hydrilla verticillata* (Lf) Royle reported with maximum biosorption at 50 mg/l initial metal ion concentration (Table 4.5.3) for Zn (II) ion (33.25 mg/g) followed by Pb (II) ion (31.89 mg/g), Ni (II) ion (28.41 mg/g), Al (III) ion (26.98 mg/g) and Cu (II) ion (24.11 mg/g). Highest percent removal for Zn (II) ions (65.97%) and lowest for Cu (II) ions (47.83%) was observed (Fig. 4.5.3) in *Hydrilla verticillata* (Lf) Royle.

**Keywords:** Heavy metals; *Hydrilla verticillata*; Biosorption; biomonitors; bioremediators

## 1. Introduction

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 or dead bacteria, agricultural waste and plant materials. The biosorption process has been recently evaluated, since conventional methods like ion exchange, precipitation, filtration, oxidation/ reduction, membranes and evaporation are very expensive, or not found suitable for metal extraction. Even though biosorption shows potential, its mechanism is not well elucidated. Biological materials can accumulate heavy metals,

radionuclide and organometalloid compounds by a range of both, physicochemical and biological processes. Metabolism independent binding or adsorption to living or dead cells, extracellular polysaccharides, capsules and slime layers in frequently rapid, bacterial cell walls and envelopes, and walls of algae, fungi and yeast are capable metal biosorbents, with binding to charged groups, frequently being followed by an increased amount of inorganic metal deposit.

The major advantages of biosorption process over conventional technologies comprise (Kratochvil and Volesky, 1998; Ahalya et al. 2003) the followings:-

- Low cost
- High efficiency
- Minimization of sludge production
- Biosorbent can be regenerated and
- Possibility of metals recovery

Biosorption of metal ions onto biosorbents involve a combination of the following metal-binding mechanisms including physical adsorption, ion exchange, complexation and precipitation (Wang and Chen, 2006; Ahalya et al. 2003). Each mechanism is described by Aha Metal ion binding sites like cellulose and peptidoglycans on the cell wall of various biosorbents, such as algae (microalgae, green algae, red algae, brown algae, etc.), fungi and bacteria play an important role in the adsorption of heavy metal ions. Macroalgae like seaweeds *Sargassum natans* and *Ascophyllum nodosum* have shown excellent biosorptive capacities for various metals. Iya et al. (2003)

Mechanisms such as entrapment of metal both in the form of insoluble micro deposits in the inter and intra-fibrillar capillaries and paracrystalline regions of polysaccharides and the binding to other biopolymers (RNA, Polyphosphates) can contribute to the metal binding. The photoautotrophs, eukaryotic algal cell wall are mainly cellulosic, and potential metal binding groups are amine, carboxylate, phosphate sulfhydryl, imidazole, sulfate and hydroxyl.

Therefore physical and chemical characteristics of biosorbents can help in understanding the metal binding mechanism on the biomass surface. Different techniques have been used for this reason like Scanning Electron Microscopy (SEM), Fourier Transform Infra-Red (FTIR) spectroscopy, X-ray Diffraction (XRD), X-ray Photo Electron Spectroscopy (XPS), Energy Dispersive X-ray (EDX) fluorescence spectrophotometry, nitrogen sorption, etc. which are very useful in understanding the morphology, structure and composition of the biosorbent.

## **2. Materials and Methods**

### *2.1. Collection of plant material*

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

### *2.2. Preparation of biosorbent and synthetic solution*

The harvested plant biomass (stem) of *Ipomea aquatica* 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<sub>3</sub>. 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<sub>4</sub> 6H<sub>2</sub>O (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 obtain 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 mg/l concentration of Ni (II) ion solution. All the experiments were conducted at desired pH using buffer solutions (KCl-HCl buffer for pH 2, citric acid- sodium citrate buffer for pH 3-5, Na<sub>2</sub>HPO<sub>4</sub>-NaH<sub>2</sub>PO<sub>4</sub> buffer for pH- 6-8 and glycine-NaOH buffer for pH 9-10).

### 2.3. 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 pH (2-10), temperature (25-50 °C ), contact time ( 5-180 min.) 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.

### 2.4. 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.)

## 3. Results and discussion

The initial metal concentration plays an important role in the process of biosorption. In order to study the effect of initial metal ion concentration sorbate concentrations in the range of 10 mg/l to 100 mg/l were taken for all the metal ions (sorbent 1.5, 2.0, 2.5 gm/l, pH 5.0 and pH 6.0; time 120 min. and temperature 30°C and 40°C).

. *Hydrilla verticillata* (Lf) Royle reported with maximum biosorption at 50 mg/l initial metal ion concentration (Table 4.5.3) for Zn (II) ion (33.25 mg/g) followed by Pb (II) ion (31.89 mg/g), Ni (II) ion (28.41 mg/g), Al (III) ion (26.98 mg/g) and Cu (II) ion (24.11 mg/g). Highest percent removal for Zn (II) ions (65.97%) and lowest for Cu (II) ions (47.83%) was observed (Fig. 4.5.3) in *Hydrilla verticillata* (Lf) Royle.

## 4. Conclusion

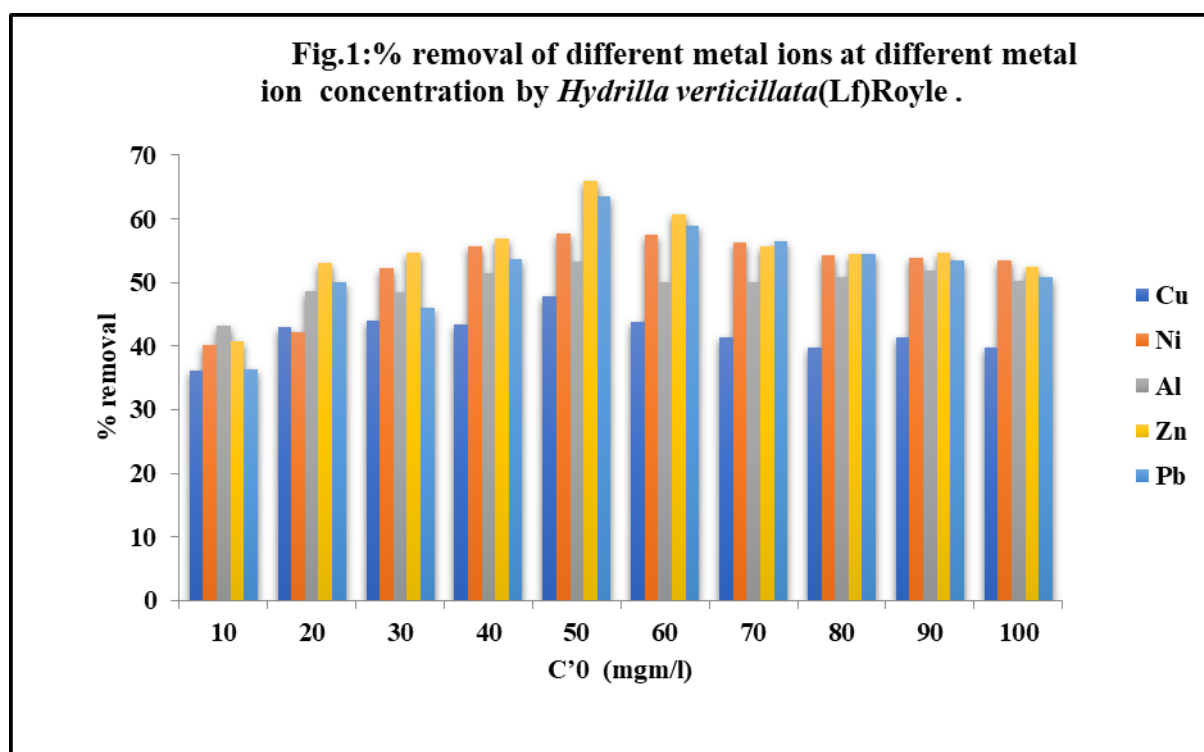
Overall results obtained shows that the aquatic macrophyte plant species can be used for removal of metal ions studied as a part of phytoremediation. *Hydrilla verticillata* (Lf) Royle, reported with maximum percent removal for Zn (II) Ni (II), Zn (II) Ni (II) and Zn (II) Ni (II) Pb (II) metal ions respectively.

Thus, the present study concludes that *Ipomea aquatica* may employ as an economic and environment friendly biosorbents and can be a good option to the expensive methods currently used in removing Zn (II) Ni (II), Zn (II) Ni (II) and Zn (II) Ni (II) Pb (II) metal ions respectively from polluted water( Table 1 and fig 1).

**Table :1. Equilibrium adsorption quantities and % removal of different metal ions at different metal ion concentration by *Hydrilla verticillata* (Lf)Royle**

	<i>Cu</i>			<i>Ni</i>			<i>Al</i>			<i>Zn</i>			<i>Pb</i>		
$C'_0$ (mgm/l)	$C_0$ (mgm/l)	qe (mg/g)	% removal	$C_0$ (mgm/l)	qe (mg/g)	% removal	$C_0$ (mgm/l)	qe (mg/g)	% removal	$C_0$ (mgm/l)	qe (mg/g)	% removal	$C_0$ (mgm/l)	qe (mg/g)	% removal
10	9.12	3.3	36.18	9.7	3.9	40.2	9.5	4.1	43.15	9.3	3.8	40.86	8.9	3.23	36.29
20	19.4	8.34	42.98	19.2	8.1	42.18	19.3	9.4	48.7	19.2	10.2	53.12	19.4	9.7	50
30	29.2	12.87	44.07	28.9	15.11	52.28	28.5	13.78	48.35	29.1	15.89	54.6	30.1	13.83	45.94
40	39.5	17.1	43.29	40.1	22.32	55.66	40.2	20.66	51.39	39.6	22.54	56.91	39.4	21.11	53.57
50	50.4	24.11	47.83	49.2	28.41	57.74	50.6	26.98	53.32	50.4	33.25	65.97	50.2	31.89	63.52
60	60.5	26.45	43.71	59.3	34.1	57.5	60.1	30.11	50.09	59.3	35.97	60.65	59.3	34.88	58.81
70	69.3	28.61	41.28	70.2	39.45	56.19	69.1	34.55	50	70.5	39.32	55.77	71.1	40.12	56.42
80	78.4	31.22	39.82	78.9	42.86	54.32	79.3	40.26	50.76	79	43.11	54.56	78.9	42.95	54.43
90	89.4	36.98	41.36	90.2	48.63	53.91	89.1	46.12	51.76	90.2	49.26	54.61	89.1	47.67	53.5
100	101	40.12	39.72	98.55	52.77	53.54	99.2	49.8	50.2	99.6	52.28	52.48	104	52.89	50.85

$C'_0$  = Initial calculated Metal ion concentration ,  $C_0$  = Initial estimated Metal ion concentration



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