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Biosorption of Cu (II) ions by using dead biomass of Marsilea Quadrifolia at varing pH

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Abstract

Present study planned to suggest role of aquatic plant *Marsilea quadrifolia* in Cu (II) ions removal by biosorption process from the water resources heavily polluted with the concentrations of the heavy metals due to industrial, agricultural and anthropogenic activities. However copper is considered to be a essential heavy metal like other metals but its increased concentration can cause lethal effect on the aquatic flora and fauna which creates disturbance in ecological systems. The biosorption characteristics of Cu (II) ions from aqueous solution using *Marsilea quadrifolia* dead biomass were investigated as function of pH. The optimize values for these parameters were found to be pH 6, *Marsilea quadrifolia* promises its potential use in removal of Cu (II) ions from polluted water.

Keywords: Heavy metals, Copper (II) ion ; Marsilea quadrifolia ; Biosorption

Introduction

Water is one of the most indispensable resource and is the elixir of life. Water constitutes about 70% of the body weight of almost all living organisms. Without water life is not possible on this planet. It exists in three states namely solid, liquid and gaseous state.About 97.2% of water on earth is salty and only 2.8% is present as fresh water from which about 20% constitutes groundwater which is highly valued because of certain properties not possessed by surface water (Goel 2000). According to Leonard (1971); Rognemd and Fjeld (2001) the unequal distribution of water on the surface of earth and the fast declining availability of fresh usable water are the major concerns in terms of water quality and quantity.

Almost all of earth's organisms need certain metals in order to maintain health and biological functions, with around 15 of these elements found naturally in rocks and soils, in general in very small amounts some of these required by humans for nutrition are copper (Cu), zinc (Zn), iron (Fe), cobalt (Co), manganese (Mn), molybdenum (Mo). However, in large amounts these are carcinogenic or toxic, affecting

Environmental contamination due to heavy metals is a severe problem because of their increased accumulation in food chain. Since these contaminants are not biodegradable this tends to accumulate in living organisms, disturbing ecosystems (Bailey et al. 1999).

Aquatic macrophytes posses ability to remove and recover the nutrient anions and metal cations pBiosorption 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 Ahalya et al. (2003) as followsresent in water and waste waters (Kadlec, 2000).

Materials and Methods

Collection of plant material material

Plant material *Marsilea quadrifolia* 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 of *Marsilea quadrifolia* 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 Copper was prepared by dissolving 3.93 grams of $CuSO_4$ $7H_2O$ (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 Cu(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, Na2HPO4-NaH2PO4 buffer for pH- 6-8 and glycine-NaOH buffer for pH 9-10).

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 Cu (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), 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.

Results and discussion

Biosorption of Cu (II) was studied as a function of pH,

Effect of pH on Cu(II) biosorption

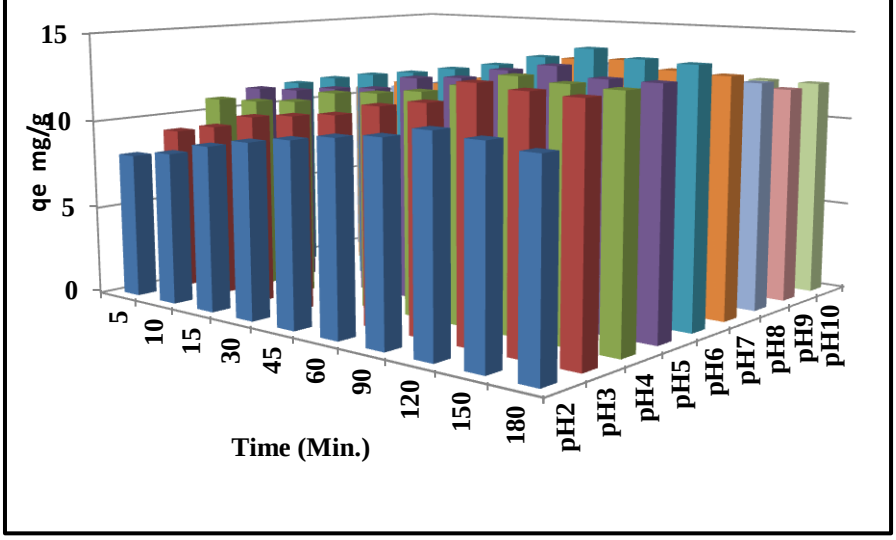
Cu (II) ions removal by plant biomass of *Marsilea quadrifolia* at an initial calculated metal ion concentration of 20mg/l was found to be pH dependent. Acidic pH range (4-6) was favored by plant for equilibrium Cu(II) sorption and maximum biosorption 14.5 mg/g was observed at pH 6.0 (Table 1 and Fig.1). Increase in pH decreased the biosorption of Cu(II) ions by the plant biomass. However, no significant variations in Cu (II) concentration were observed due to varying pH based on blank readings as a control (without plant biomass).

Table:1. Effect of pH on equilibrium Cu (II) sorption capacity Marsilea quadrifolia Linn.

Time (min.)	pH								
	2	3	4	5	6	7	8	9	10
	qe mg/g	qe mg/g	qe mg/g	qe mg/g	qe mg/g	qe mg/g	qe mg/g	qe mg/g	qe mg/g
5	8.1	9.2	10.8	11.2	11.3	10.9	10.5	9.7	9.5
10	8.5	9.7	10.9	11.3	11.8	11	10.8	10.6	10.1
15	9.2	10.5	11.1	11.6	12.2	11.5	11.2	11	10.2
30	9.7	10.8	11.8	11.8	12.5	11.6	11.4	11.1	10.8
45	10.1	11.1	12	12.6	12.9	12.1	11.9	11.4	11.2
60	10.5	11.8	12.3	12.8	13.3	12.5	12.2	11.8	11.6
90	10.8	12.2	12.8	13.4	13.9	13.6	13.1	12.1	11.9
120	11.4	13.4	13.5	13.8	14.5	13.7	12.7	12.3	12
150	11.2	13.2	13.3	13.3	14.1	13.3	12.5	12.1	12.1
180	10.9	13.1	13.2	13.3	14	13.2	12.6	12	12.1

C'_0 = 20 mgm/l; initial estimated Cu concentration, C_0 = 19.4 mgm/l.

Fig.1: Biosorption of Cu (II) ions by *Marsilea quadrifolia* Linn. at varying pH



Conclusion:

The purpose of the present study was to find out the adsorption capacity of *Marsilea quadrifolia* collected from river water. The plant material (dead biomass) was taken under investigation for the removal of Cu (II) ions for low cost eco-friendly biosorbents. The findings were based on biosorption capacity, Experiments were performed as a function of initial solution pH. The values of the above parameter obtained on performing batch mode studies revealed that pH 6, were optimum for biosorption of Cu (II) ions.

Thus, the present study concludes that *Marsilea quadrifolia* may employ as a low-cost and eco-friendly biosorbents as an alternative to the currently used expensive methods of removing Cu (II) from polluted water. This may also help in the development of subsequent eco-friendly water treatment technologies in the application of biosorption at industrial scale.

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