



BIOABSORPTION OF COPPER BY *S.platensis* FROM INDUSTRIAL EFFLUENT

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ABSTRACT

Effluent from electroplating industry involved in copper plating and other metal polishing work contain various heavy metals which have severe adverse effect on health. The objective of the present study is to determine the efficiency of algae, namely *Spirulina platensis* to remove heavy metals from electroplating industrial effluent. Optimum temperature, concentration, contact time and pH were found to increase which indicated that *Spirulina platensis* (*S.platensis*) was able to tolerate the heavy metals. The efficiency of the algae in removing the heavy metals was checked. The samples were analyzed for copper content before and after treatment with the algae. The highest removal efficiency was noticed for copper (Cu) to be 74%. The study suggested that the algae has good potential applications in removing heavy metals from industrial effluents.

KEYWORDS: *S.plantensis*, heavy metals, copper, bioabsorption, effluent.

INTRODUCTION

Environmental pollution with heavy metals is one of the most alarming issues in the present world. Heavy metal pollution has emerged as a major concern threatening human health, natural resources and ecosystem.^[1] Disposal of wastes containing heavy metals by various industries into environment leads to this disastrous effect affecting the water, air and soil. The challenge is to properly incorporate the disposal of the wastes in a controlled management programme so that the applied industrial solid wastes do not contribute any problem of pollution into soil, soil microbes and environment.^[2] Biosorption is a method that can remove heavy metals from wastewater where transfer of ions from solution phase to the solid phase, actually describes a group of processes, which includes adsorption and precipitation reactions. Adsorption has become one of the alternative treatment techniques for wastewater. Basically, adsorption is a mass transfer process and substances bound by physical and or chemical interactions to solid surface.^[3]

These processes may contribute to environmental problems, as large amounts of sediment and sludge that contain toxic compounds are produced.^[4] *S. platensis* has been proven to treat wastewater by degrading the organic matter and heavy metals. It is a tiny blue-green algae, spiral coiled shaped, one of the oldest inhabitants of the planet, scientific name is *Arthrospira platensis*. It is a potential alternative to conventional processes for the removal of metals hence treating leachate in general.^[5]

METHODOLOGY

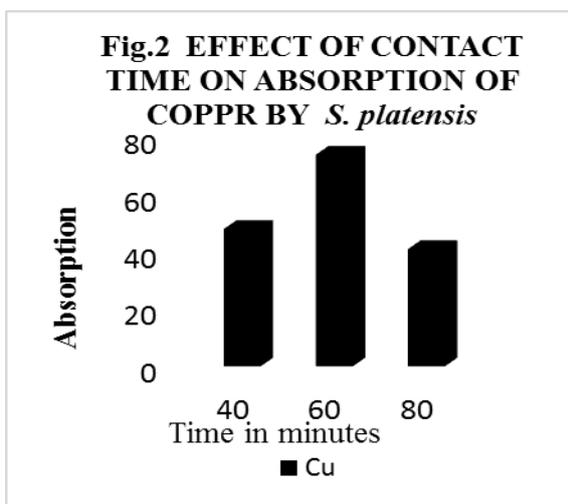
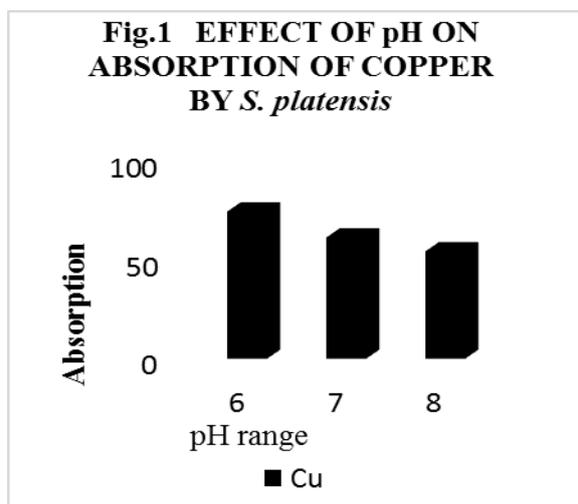
S. platensis was collected and cultivated under laboratory condition, biomass harvested, filtered through whatmann filter paper no.3. Then it was dried, "dry biomass" was prepared by rinsing the stored cells with deionised water to remove the residual alkalinity and dried firstly at room temperature for 24 h and subsequently at 80°C in an oven for 12h. It was ground, sieved through a 60–100 mesh sieve and stored in desiccators. The powder was added in Erlenmeyer flasks which contains effluent, incubated at different parameters such as pH of 6, 7 and 8, temperature 35, 45 and 55°C, contact time 40, 60 and 80 minutes, concentration of biomass at 0.1, 0.2 and 0.3 g/l of effluent. After agitation on a rotary shaker (150 rpm) at room temperature again it was filtered by the whatmann filter paper and sample was carried to estimate the copper by iodometric method.^[6]

RESULTS AND DISCUSSION: Effect of pH

One of the critical factors that influence adsorption of metal ions is pH since it directly affects the metal solubility or the dissociation degree of functional groups located on the surface of sorbent.^[7] Although optimal pH for maximal copper adsorption was found to be 7.0, further it was noted that adsorption of copper by biomass was affected by acidic pH (pH 2.0–5.0) while pH 7.0 to 9.0 supported the adsorption process. However, highly alkaline pH conditions (pH 10.0) led to a decline in adsorption efficiency. In general, the metal adsorption rate decreases to a large extent with an increase in alkalinity mainly at pH >6.0–7.0.^[8]

Thus the adsorption of copper by *S. platensis* was observed in the present study as a function of pH (Fig. 1). Results showed that in all cases, metal uptake by the biomass increased with an increase in pH from 5.0 to pH 7.0 although optimal pH for maximal copper adsorption

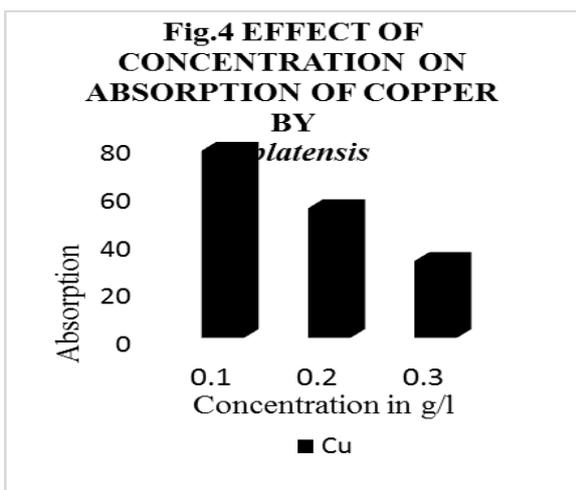
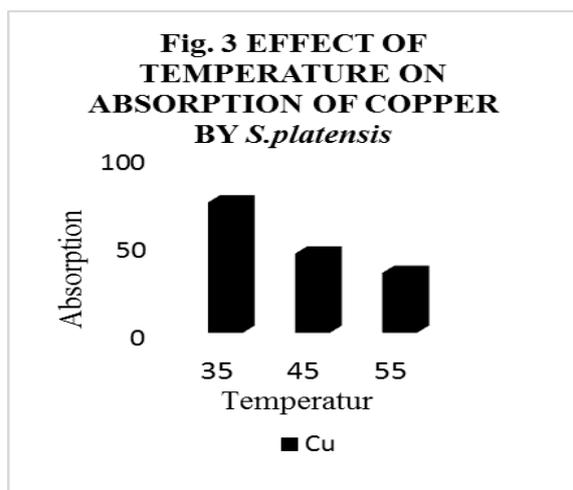
was found to be 6.0. In spite of the discrepancies recorded in the literature on the effect of pH on the biosorption it is inferred that pH would alter the process of adsorption of metal ions to cells and it varies with the type of adsorbents (cells) and adsorbates (metal ions).^[9]



Effect of contact time

It is proved in Fig. 2 that adsorption of copper by microalgal biomass increased with an increase in contact time up to 60 min and remained stable until 180 min. Maximum adsorption was recorded within the first 60 min. It was inferred that the contact time influenced the biosorption of Cu by biosorbent from aqueous solutions since it was noted that the rate of copper biosorption by the nonliving cells was very rapid, reaching almost 78% within 60 min of contact time. Earlier studies have

indicated that the process of biosorption became slow during the later stage because during the initial stage of Cu biosorption a large number of unoccupied surface sites were available for biosorption compared to that in the later stages, when the rest of the site surface vacancies were probably inaccessible or deeper in the cell membranes.^[10] Results of the present study indicated efficiency of *S. platensis* biomass for rapid metal uptake in short periods of contact time.



Effect of Temperature

Temperature is an independent variable which directly influences the rate of reaction between the biosorbent and the metal species present in the aqueous solutions during the process of adsorption. Increase in the temperature is known to increase the rate of diffusion of the adsorbate molecules across the external boundary layer and in the internal pores of the solution. In addition, changing temperature will change the

equilibrium capacity of adsorbent for particular adsorbate.^[11] Results obtained during the course of the present study demonstrated the effect of temperature (35 to 55°C) on the biosorption of Cu by the non living biomass of *S. platensis* (Fig. 3). It was found that metal uptake increased gradually with an increase in temperature and the rate of copper biosorption by the nonliving cells was rapid reaching a maximum of 74% at 35°C temperature, indicating that the removal of the

copper from aqueous to adsorbent is rapid at ambient temperatures compared to higher temperatures (45°C). It was suggested that biosorption between algal biomass and metals could involve a combination of chemical interaction and physical adsorption. With an increase in temperature above 5 to 25°C, pores in the algae enlarge resulting in an increase of the surface area available for the sorption, diffusion, and penetration of metal ions within the pores of algae causing an increase in sorption.^[12]

Effect of concentration of algal biomass

Results presented in Fig. 4 indicate that the optimum dose of biomass for maximal removal of copper ions was found to be 0.1 g/100mL with a removal efficiency of 78.14%. It was observed that the metal removal efficiency of the algal biomass was a function of biomass concentration and the percent removal of copper (adsorption) declined along with the increase in biomass concentration from 0.01g/100 ml. The biomass concentration is an important variable during metal uptake. At a given equilibrium concentration, the biomass takes up more metal ions at lower cell densities than at higher cell densities.^[13] Biosorption became slow during the later stage because during the initial stage number of unoccupied surface sites were available for biosorption compared to later stages, which probably become inaccessible or deeper in the cell membranes.^[14] As a result it becomes mandatory to determine the optimal contact time for achieving maximal adsorption of metal at the earliest possible time of incubation by the biomass toward having efficient biosorption and consequent metal removal.

CONCLUSION

Biosorption of heavy metals from aqueous solution is relatively newer technology for the treatment of waste water from various industries. Copper is studied here due to their abundance in water, in addition to their toxicity. The present study demonstrated the use of *Spirulina platensis* in the wastewater treatment and suggest that biomass could positively act on the adsorption process and maximum absorption achieved at optimum pH, temperature, contact time and concentration. It is concluded that this adsorbent has a great potential for removing copper from aqueous solutions as an eco-friendly process.

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