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THE EFFICACY OF MODIFIED CYANOBACTERIAL BIOMASS TO REMOVE Cr(VI) IONS FROM AQUEOUS SOLUTION

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ABSTRACT

The efficacy of cyanobacterium*Aulosira fertilissima* was studied for the removal of Cr (VI) from aqueous solution under modified and unmodified conditions. The pretreatedcyanobacterialbiomass (chemically modified) were found more effective than living and dried biomass. The sorption capacity (mg.g^{-1} biomass) increased with increasing initial concentration while a decrease in percent removal was found with increasing Cr(VI) concentration. The order of biosorption efficacy of the cyanobacterial biomass is as modified cells > living cell > dried biomass with 82-66%, 80.04% and 76.80% respectively. A greater biosorption by pretreatedcyanobacterial biomass (modified) might be due to more availability functional group associated with pectin, hemicelluloses and cellulose of the cell wall.

KEY WORDS: Efficacy, modified cyanobacterial biomass Cr (VI) aqueous solution

Cyanobacteria, a group of prokaryote, are present in every and adverse condition ecological niche and exposed to the toxic effects of metals and encounter them. The use of living and dead biomass and dead biological materials for heavy metals has gained importance in recent years due to their natural occurrence, low cost, abundance and good performance for metal biosorption (Rai*et al*. 1998; Benarjee *et al*. 2004; Wild *et al*. 2006; Anjana*et al*. 2007; Parmeswari*et al*. 2009; Singh and Pandey 2011; Mane and Bhosle 2012). The metal accumulation by microbes is possible by a rapid binding at cations to negatively charged group on the cell surface and the subsequent metabolism is dependent on interacellularcation uptake (Banarjee et al. 2008). The biosorption capacity for metal ions by cyanobacterial biomass under modified conditions viz. dried, modified after pretreatmentetc have also proved a better condition (Parmeshwari*et al*. 2009; Mane and Bhosle 2012) but the loss of biomass after pretreatment should be taken into consideration during assessment. Therefore, the aim of the present study is to assess the efficacy cyanobacterium *Aulosira fertilissima*, under unmodified and modified conditions, to remove the Cr(VI) from aquatic environment.

MATERIALS AND METHODS

Mass Cultivation of Cyanobacteria

Cyanobacterium,*Aulosira fertilissima* was cultured in BG11 medium at pH 7.5 in a culture room at temperature 28±2ºC with 2500-3000 lux fluorescent light illumination for 14 hrs photoperiod. After 15 days, biomass was harvested by filtration and washed repeatedly with triple glass distilled water.

Cyanobacterial Biomass Treatment

Exponentially grown 10 days old cyanobacterial culture were harvested by repeated filtration and washed with triple glass distilled water. The treatment experiments were divided into three groups (a) B_1 – living biomass (b) B_2 – chemically modified biomass and (c) B_3 – dried biomass.

For chemical modification, the cyanobacterial biomass was treated with 10% (v/v) acetic acid for 30 minutes and washed with double distilled water and air dried for a constant weight.

For dry biomass, the living biomass was dried at 70ºC in a hot air oven till a constant weight.

Preparation of Stock Solution

A stock solution of Cr(VI) was prepared by dissolving analytical grade of potassium dichromate (Loba chemicals) in glass distilled water and dilutedto 10, 20, 30 and 40 mgl^{-1}. 100 ml of each chromium solution was taken in 250 ml flask and pH was adjusted to 7.5 by using 0.1N NaOH or 0.1 N HCl.

A known amount of living, modified and dried biomass were added to each flask containing 10, 20, 30 and 40 mgl^{-1} chromium solution (as mentioned above) and reaction mixtures were agitated at 30 rpm on rotary shaker

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at 25±1ºC. After 2 hrs of contact time the biomass was separated by filtration and reaction mixture and filtrates were analyzed for metal concentration chromium biosorbedpre gram of biomass was calculated by using the following equation (Parmeswari *et al*. 2009).

$$Q = \frac{(Co - Ci)}{M} \times V$$

Where:

Q = Metal ion bisorbed per gram biomass ($mg.l^{-1}$)

Co = Initial metal ion conc. ($mg.l^{-1}$)

Ci = Final metal ion conc. ($mg.l^{-1}$)

M = Weight of biomass

V = Volume of the reaction mixture

Control experiments were also came out using culture vessels containing solution only and examined throughout the experimental observation to check the sorption of metal by glassware, if any. All the experiments were carried out in triplicate.

RESULTS AND DISCUSSIONS

The removal efficacy of the cyanobacterium*Aulosira fertilissima* under unmodified and modified was examined with regard to as Cr (VI) from aqueous solution. Pretreated biomass (chemically modified and dried) showed a promising result (Fig.1). Chemically modifiedcyanobacterial showed a higher affinity for metal ions than living and dried biomass (Fig.1). The sorption capacity (mg metal sorbed g^{-1} biomass) increased with increasing initial metal concentration though a decrease in percent removal was observed with increasing concentration of Cr (VI) (Fig. 2). The order of biosorption was chemically modified > living cell > dried biomass at all the concentration and percent sorption with 82.66%, 80.04% and 76.80% respectively at 10 mgl^{-1} chromium concentration. Thus, for application purposes the metal sorption efficacy (% removal) of biomass has special significance. A lower concentration more binding sites are available which facilitate higher sorption and at higher concentration more metal ions are left unabsorbed in the solution due to saturation of binding site. Higher sorption rate of Cr(VI) ions by chemically treated biomass might be due to presence of more carboxyl groups (RCOO) which associated with pectins, hemicelluloses and cellulose of the cell wall which provides an increased binding sites for metals (Singh *et al*. 2000) and removal of surface impurities.

$$R.COOH \rightarrow RCOO^- + H^+$$

Fig.1:Biosorption of Cr(VI) by cyanobacterial biomass under unmodified and modified condition, after 2 hr of incubaction at different metal concentration

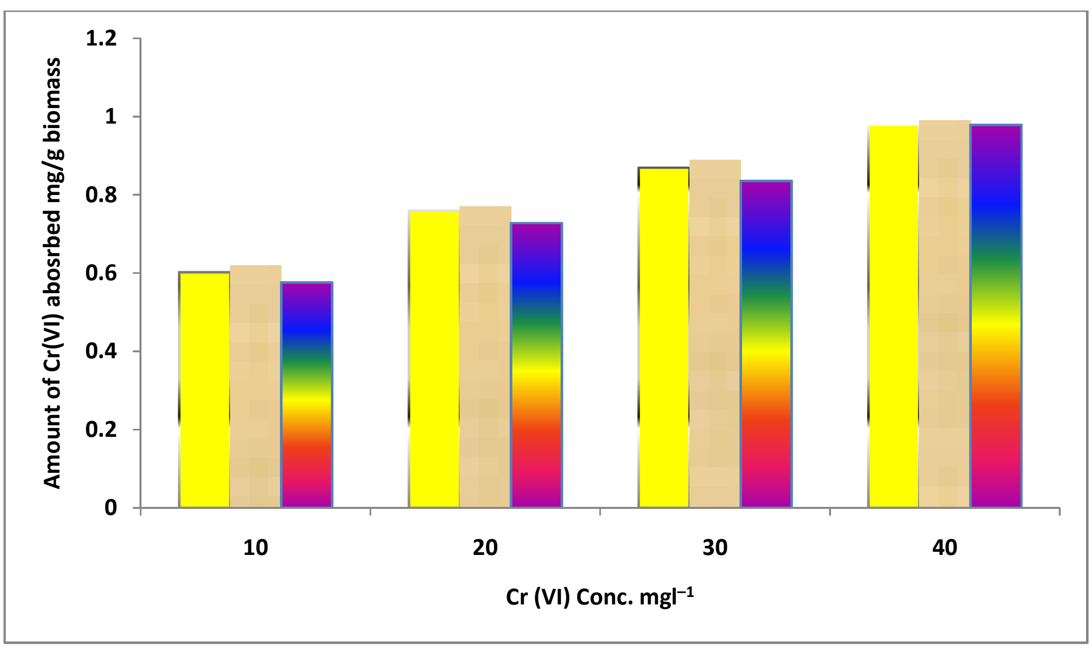
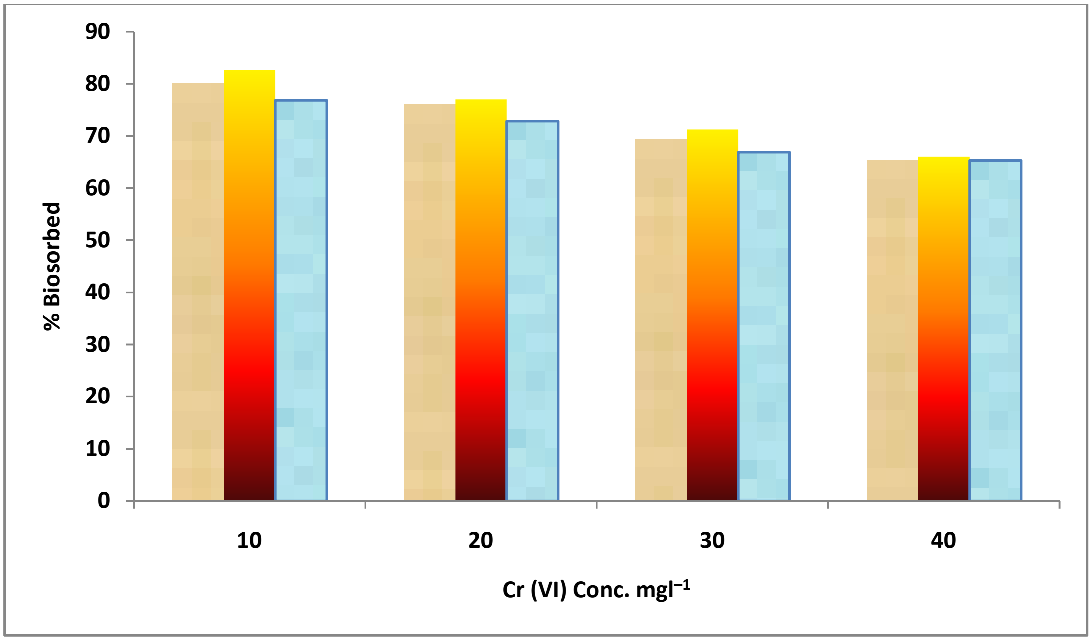


Fig.2 :Percentbiosorption potential of unmodified and modified cyanobacterial biomass at different concentrations of chromium in aqueous solution



Oven dried cyanobacterial biomass absorbed less amount of Cr(VI) ions might be due to deactivation of cell surface amino functional groups which contribute for binding the metal ions (Loace*et al*. 1997).

CONCLUSION

The present observation showed that sorption capacity of *A.fertilissima*is dependent on Cr(VI) concentration in aqueous solution. The difference sorption capacity was as a result of modification of biomass. Therefore, a detailed experiment should be conducted to know the cause of increase/decrease in biomass sorption capacity as a result of modification.

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