Bioremediation of Cr (VI) from Tannery Effluent by *Syncephalastrum Racemosum* and Rice Husk

[*]Nupur Srivastava, Neeta Sharma

[*]*Mycology and Plant Pathology Lab, Botany Department, Lucknow University, Lucknow, UP, India.*

Mycology and Plant Pathology Lab, Botany Department, Lucknow University, Lucknow, UP, India

Abstract

The research aimed to remediate 'Cr' polluted tannery waste water using S.racemosum and rice husk. The treated sample was composed of rice husk and Cr (VI) solution along with the inoculation of the test fungal strain S.racemosum. The effect of pH and Chromium VI concentration was investigated. The biosorption was maximum (96%) at pH 7 although the fungal growth was maximum at pH 8.At lower or higher pH values (>9), Cr (VI) removal was significantly reduced. With increase in Chromium VI concentration from 25mg/L to 100mg/L the Cr (VI) removal did not show much decrease and was (98.4%).

1. Introduction

'Cr' is a naturally existing element which belongs to the category of transition metals.'Cr' occurs most frequently as Cr(III) and Cr(VI).Toxicokinetics of Cr(VI) show higher rate of penetration into biological membranes as compared to Cr(III).Since the past few decades several studies have been made regarding the Cr(VI) removal by fungi[1],yeasts, trees[2],bacteria and microalgae [3][4] and also by using low cost biosorbents[5][6] [7] in the form of fly ash ,brick kiln ash etc.(Table-1)

Recent studies have shown microbes to be capable of altering the redox state of toxic metals. Microorganisms and other environmental factors, such as pH and presence of minerals, contribute to the mobility or immobility of chromium. In an attempt to expedite the microbiological process for toxic compounds biostimulation process has been widely seeking attention.

The current research was carried out to utilize the process of biostimulation by addition of external source of C, N and P using rice husk in the sample. Rice husk is easily available and so can be used for the remediation of 'Cr' polluted water [8].

2. Materials and Methods

2.1. Preparation of rice husk as a biosorbent and biostimulant

Rice husk was collected from a local milling industry in Barabanki, UP, India.Rice husk was washed and then rinsed with distilled water. Later it was oven dried at 60°C and then preserved in aseptic conditions.

2.2. Microorganisms, medium and culture conditions

Syncephalastrum sp. a filamentous fungus was used in this study. *Syncephalastrum* sp.[9] was isolated from a tannery effluent sample of a Kanpur tannery. The fungal strain was routinely maintained and propagated on PDA of Hi Media. The culture was grown at 25°C for obtaining fungal biomass.

2.3. Sterilization of Glasswares

Culture media and other glasswares like pipette, petri plates, conical flasks and test tubes etc.were sterilized every time before use at 121°C at 15 psig for on hour in a an autoclave. Prior to sterilization all the glasswares and plastic wares were washed with chromic acid and detergent respectively and then rinsed with distilled water and then used.

2.4. Reagents

Cr (VI) stock solution was prepared by $K_2Cr_2O_7$ of Merck AR Grade in distilled water. The standard calibration curve was also plotted using this stock solution so as to use the values for references.

2.5. Preparation of PDA and PDB

Potato Dextrose Agar (PDA): Potato Dextrose Agar plates were prepared by using the extract of 200gm potato boiled in distilled water and filtered through muslin cloth. Distilled water was added to Potato broth and the volume was made to 1Litre.The culture medium contained chloramphenicol (0.15gm/L), glucose (20gm/L), and agar (20gm/L).The PDA medium was autoclaved at 121°C and 15 psi for 15 minutes.

For PDB, the broth of same medium were prepared but without agar.

2.6. Inoculation of the fungal strain

The full grown fungal colonies of S.racemosum appeared in about 5 days of incubation and then the fungal discs of (5mm) were taken from the plates with the help of sterilized cork borer, and then inoculated into the 50mL of Cr (VI) solution in Erlenmeyer flasks.

2.7. Biosorption Study

In this study, experiments were carried out for determining the percentage Cr (VI) removal by the combination of fungal strain and rice husk. Separate experimental sets were conducted for determining initial Cr (VI) removal.

2.8. Estimation of Cr (VI) by DPC method

DPC reagent combines with Cr (VI) to form a complex that gives a magenta colour in acidic medium. All the samples of experimental sets were filtered by using Whatman Filter paper no.42.After filtration pH was maintained at 2 by adding sulphuric acid and to this 1mL of DPC was mixed. After 10 minutes absorbance was measured on UV VIS Spectrophotometer.

2.9. Micropictures of the fungal strain

The micropictures of the fungal strain were taken from optical microscope. These micropictures were taken before and after biosorption so as to compare the cellular level changes in the fungus. (Fig.1 and 2)

3. Results and Discussions

3.1. Effect of rice husk

Rice husk is a source of 'C' and 'N' [10][11][12]13] and so enhanced the Cr (VI) removal process in comparison to the control. The fungal growth was more in Cr (VI) samples with rice husk and thus it increased the rate of Cr (VI) removal. (Fig.3)

3.2. Effect of pH

The maximum Cr(VI) removal of 96% was found at pH 7.pH lower than 6 decreased the Cr(VI) removal to about 74% and higher pH of 9 decreased the Cr(VI) removal to 90%.Since increase in pH from 2 to 7 shifts concentration of $HCrO_4^-$ to other forms,CrO_4^- and $Cr_2O_7^-$,it can b concluded that active form of Cr(VI) that could be absorbed by the fungal and rice husk combination was CrO_4^- and $Cr_2O_7^-$.(Fig.4,5 and 6)

3.3. Effect of initial Cr (VI) concentration

The biosorption experiments with different Cr (VI) concentration of 25mg/L and 100mg/L were carried out. Same amount of rice husk and S.racemosum was added to the 50mL of 25mg/L and 100mg/L Cr (VI) solutions separately. Almost 99% Cr(VI) removal was seen at 25mg/L and 98.4% Cr(VI) removal was seen at 100mg/L.At lower concentrations, all metal ions present in the solution would interact with the binding sites on the fungal mycelia as well as the rice husk whereas at higher concentration of 100mg/L more Cr(VI) ions should be left unabsorbed due to saturation of binding sites on the rice husk also.Thus,the increase in Cr(VI)

concentration did not change the percentage Cr(VI) significantly.(Fig.7 a and 7b)

4. Conclusions

Removal of toxic Cr (VI) from the solutions was possible using rice husk in combination with *S.racemosum*. The combination was more efficient than the controls of rice husk and the fungal strain individually. Almost 99% Cr(VI) for 25mg/L and 98.4% Cr(VI) for 100mg/L Cr(VI) concentration was possible due to the mutual effect of the fungal cell's functional group and rice husk.Also,since the rice husk stimulated the C and N ratio in the solutions, the fungal growth was expedited consequently increasing the rate of Cr(VI) removal.

Thus, it can be concluded that rice husk [14] is a good Cr (VI) biosorbent and can be used for the Cr (VI) bioremediation in combination with the test fungus *S.racemosum* which is also a good biosorbent that is non-pathogenic and so a cheap and efficient Cr (VI) bioremediant.The combination is inexpensive and can be utilized economically on a large scale for Cr (VI) bioremediation of tannery effluents [15].

Table 1.Adsorption capacity of various adsorbents

Adsorption capacity of various adsorbents as reported in literature		
Adsorbent	**Maximum adsorption capacity(mg/L)**	**References**
Saw dust	39.7	Sharma and Foster (1994)
Sugarcane bagasse	13.4	Sharma and Foster (1994)
Eucalyptus bark	45	Sarin and Pant (2006)
Coconut husk	29	Huang and Wu (1977)
Pine needles	5.36	Dakiky et al.(2002)

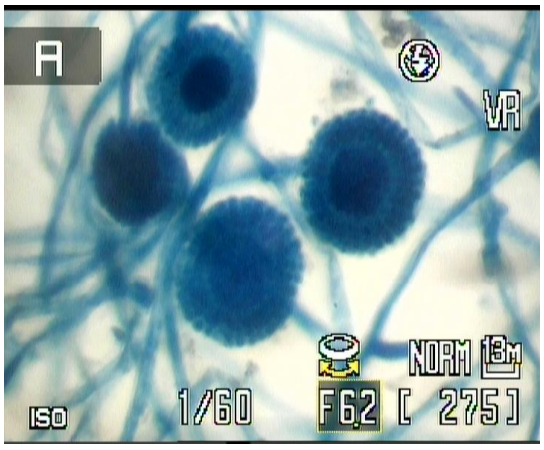

Fig.1.*S.racemosum* before Biosorption

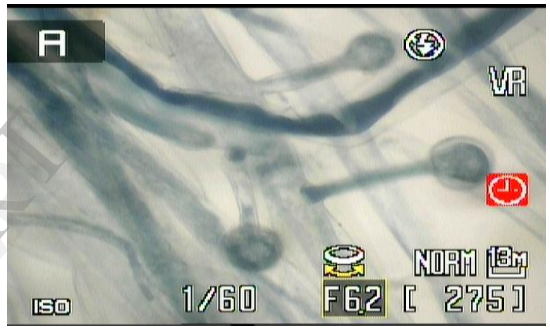

Fig.2.*S.racemosum* after Biosorption

Fig.3.Rice husk and *S.racemosum* for Cr (VI) removal

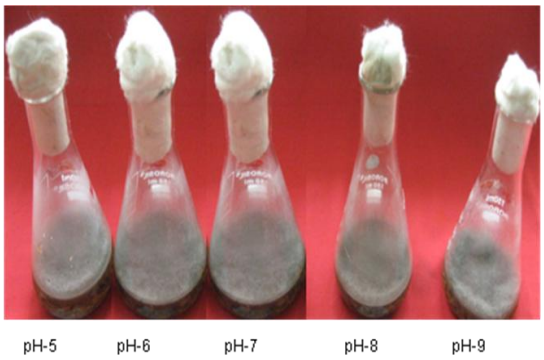

Fig.4.Effect of pH on % Cr (VI) removal

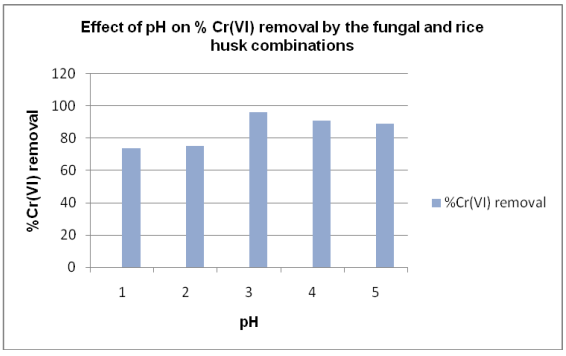

Fig.5.Effect of pH on %Cr(VI) removal

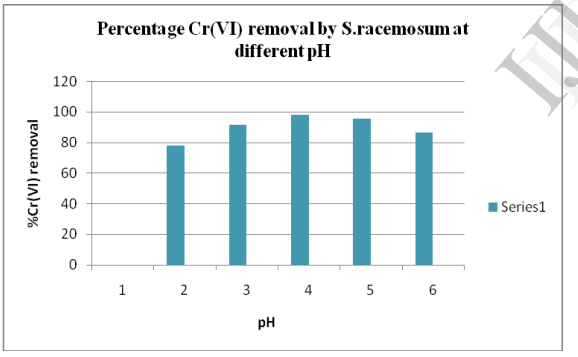

Fig.6.Effect of pH on % Cr(VI) removal

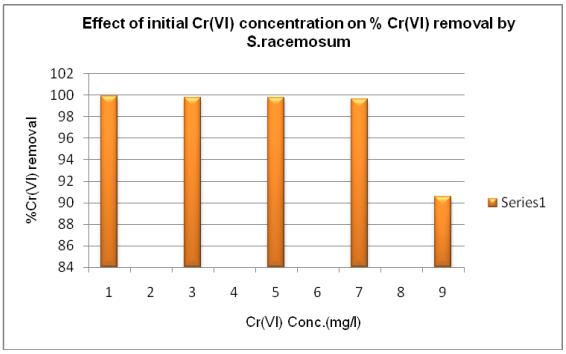

Fig.7.a.Effect of initial Cr(VI) concentration on Cr(VI) removal

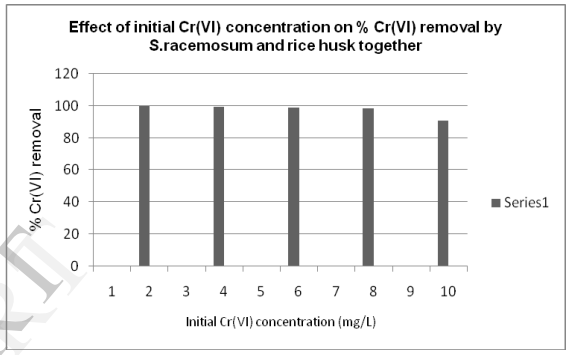

Fig.7.b.Effect of initial Cr(VI) concentration on Cr(VI) removal

References

[1] R.T.Bai and E.Abraham, Biosorption of Cr (VI) from aqueous solution by *Rhizopus nigricans*, Bioresource Technology, 79 (2001) 73-81.

[2] F.N.Acar and E.Malkoc, The removal of chromium (VI) from aqueous solutions by *Fagus orientalis* L.Biores.Technol. 94(1) (2004)13-15

[3] G.M.Gadd,Accumulation of metals by microorganisms and algae,in;H-J.Rehm(ed.),Biotechnolgy,Vol.6b,VCH Verlagsgesellschaft,Weinheim,(1988)401-433.

[4] V.K.Gupta, A.K.Srivastava and N.Jain, Biosorption of Chromium VI from aqueous solution by green algae spirogyra species, Water Res, 35(2001)4079-4085.

[5] M.Dakiky,A.Khami,A.manassara and M.Mereb.Selective adsorption of Chromium VI in industrial waste water using low-cost abundantly available adsorbents, Advance in Environmental Research,6(4)(2002)601-604.

[6] Gardea-Torresday,J.L.K.J.Tiemann,V Armendariz,L.Besse-Oberto,R.R.Chianelli,J.Rios,J.G.Parsons and G.Gamez,Characterisation of Cr(VI) binding and reduction to Cr(III) by the agricultural by product of Avena monida(oat) biomass,J.Hazard.Mater,80(2000)175-188.

[7] A.Hossein, D.Naghipour, F.Vaezi and S.Nazmara.Teawaste as an adsorbent for heavy metal removal from industrial wastewaters, American Journal of Applied Sciences, 2(1) (2005)372-375.

[8] APHA, 1992.Standard Methods for the Estimation of Water and Wastewater, 18th ed.APHA, Washington, DC.

[9] N.Srivastava and N.Sharma, A New Filamentous fungus *Syncephalastrum racemosum* for bioremediation of tannery effluents, International Journal of Recent Scientific Research, 4(8) (2013)1242-1246.

[10] S.Yan and T.Viraraghavan.heavy metal removal in a biosorption column by immobilized M.rouxii biomass.Bioresource Technology, 78(3) (2001)243-249.

[11] T.Teixeria, R.Cesar and A.Zezzi, Biosorption of heavy metals using rice milling by-products.Characterisation and application for the removal of metals from aqueous solutions.Chemosphere,54(7)(2004)905-915.

[12] W.Nakbanopte, P.Thiravetyan and C.Kalambaheti.Preconcentration of Gold by Rice Husk Ash, Mineral Engineering, 13(4) (2000)391-400.

[13] A.A.M. Daifullah, B.S. Girgis and H.M.H. Gad, Utilization of Agro-Residues (Rice Husk) in Small Waste Water Treatment Plants. Material Letters 57 (2003)1723 - 1731.

[14] E.A Oliveira, S.F Montanez, A.D.Andrade, J.A. Nobrega, and M.C. Rollemberg, Equilibrium Studies for the Sorption of Chromium and Nickel from Aqueous Solutions Using Raw Rice Bran. Process Biochemistry 40 (11) (2005)3485 - 3490.

[15] K .Selvi, S.Pattabhi, and K.Kadirvelu, Removal of Cr (VI) from aqueous solution by adsorption onto activated carbon. Bioresource Technology 80(2001) 87-89.