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Effect of pH on Chromium Biosorption

*D.Seshikala**& M.A.Singara Charya*

Department of Microbiology, Kakatiya University,
Warangal – 506 009, A.P. India
***Corresponding Author Email: dr.shashidsk@yahoo.com**

ABSTRACT

Twelve soil fungi were isolated from tannery effluent amended soils and studied for chromium absorption at different concentrations. Among them, seven commonly occurred organisms were selected and studied. The chromium absorption decreased with increase in the initial Cr concentration and at higher Cr concentration the fungi failed to grow. To improve the chromium absorption capacity organisms were exposed to different pH ranges. A ochraceous, A.terreus, Fusarium sp. Penicillium sp. And Rhizoctonia solani showed (100%) improvement in chromium absorption at differentpH ranges.

KEYWORDS

Soil fungi, Hexavalent chromium, Absorption and pH

INTRODUCTION

Hexavalent chromium compounds are being used in wide variety of commercial processes and unregulated disposal of chromium containing effluents in both developing and developed Countries has led to the contamination of the soil, sediments, surface and ground water[1, 2]. In trace amounts, chromium is considered as an essential nutrient for numerous microorganisms, but at elevated levels, it is toxic, mutagenic, carcinogenic, tartogenic [3]. Nearly 80% of the tannery effluents in India are discharged in untreated form into the environment [4, 5]. The methods available for treatment of these effluents are oxidation, reduction, precipitation, ion exchange, reaction with silica, electro chemical reduction, evaporation, reverse osmosis and direct precipitation etc. [6, 7]. All these processes are expensive non-renewable and ecologically non viable. Once in the environment these toxic heavy metals enter, they undergo transformation in to different mobile forms [8].

Microorganisms which are ubiquitous and may even be dominant in adverse environment, exhibit a variety of responses towards heavy metals [9]. Bioremediation is the approach to the abatement of toxic metal pollutants, selecting appropriate microorganisms. Among the microbes the highly exploited are the bacteria for absorption of chromium from industrial effluents [10, 11, 12, 13]. However fungal organisms offer an advantage of having high percentage of cell wall material for excellent metal binding properties [14, 15, 16].

In view of the above facts, due to high occurrence of fungi in tannery effluent amended soils, the fungi were selected as a tool for the treatment of chromium effluents. It was felt that the organisms mutated to absorb more chromium as they are continuously exposed to chromium concentrations. In this study thirteen fungal organisms were isolated and screened for better absorption of chromium. As different organisms have different optional conditions like pH which plays an important role in Cr absorption. Among them, six better organisms were selected and studied.

MATERIALS AND METHODS

Isolation:

The fungal organisms were isolated through serial dilution technique in the soil samples, amended with the tannery effluents. These isolated organisms were maintained on Asthana and Hawker's (A and H) slants 5 gm. Glucose; 3.5 gm. KNO_3; 1.75 gm. KH_2PO_4; 0.75 gm. $MgSO_4$; 20 gm Agar and 1L Distilled water. (All chemical were supplied by Sd fine). $K_2Cr_2O_7$ (Sd. Fine) was used as chromium source. Diphenyl Carbazide (Merck Company) is used as a reagent for the qualitative analysis of chromium (Spectrophotometer, Elico SL 171 Mini Spec). Isolated fungal organisms were screened for better absorption capacity. A and H broth has prepared with different concentrations of chromium starting from 0 to 100 ppm. But all the organisms showed 100% absorption up to 15 ppm, except *Mucor mucedo* and *Dactylosporium* species. Each organism was inoculated at increased concentrations from 0 to 100 ppm in triplicates and average results were shown in the table. But after 40 ppm the organisms failed to grow. That's why results were shown between 20 to 40 ppm only. At every concentration blanks were maintained. At the time of harvest (after 10 days) blanks were considered as initial concentrations, and test values were deducted from the initial concentrations and results were presented in the **Table 1**.

TABLE 1: SCREENING OF ORGANISM FOR CHROMIUM BIOSORPTION

Initial Conc.ppm	20		25		30		35		40	
Name of the organism	G	C%	G	C%	G	C%	G	C%	G	C%
Alternaria alternate	241	70.5	114	40	-	-	-	-	-	-
Ascohyta betae	209	85	140	60	-	-	-	-	-	-
Aspergillus ochra ceous	241	94.1	115	85	114	84	11.1	40	-	-
Aspergillus terreus	251	94.3	127	94	117	71	11.7	39	-	-
Curvularia lunata	249	58	129	36	119	27	-	-	-	-
Dactylosporium sp	114	74	110	37	-	-	-	-	-	-
Drechslara rostata	309	92	124	66	221	64	-	-	-	-
Fusarium oxysporum	204	95	117	73	110	60	-	-	-	-
Pencillium Notatum	341	93.7	349	94.1	114	67.7	11.9	42.6	-	-
Pyrenochaeta cajani	248	71.5	110	56.4	111	33.3	-	-	-	-
Trichoderma viride	151	67	144	40.8	112	173	-	-	-	-
Rhizoctonia solani	312	939	249	94.1	229	90	11.7	60	53	35

G= Dry weight of mycelial mat in "mg"
C% = Chromium absorption in %
" – ' No growth and no absorption.

pH Studies:

Fungi failed to grow up to 3pH and added chromium was precipitated after 8pH. Hence experiments were conducted in between 3pH to 7pH. 25 ppm of A and H broth was prepared and pH was adjusted with Elico pH meter. Different blanks were prepared at each pH stage, and the values were evaluated and presented in the table 2. After 10 days of incubation cultures were harvested and fungal mat was oven dried and weighed. The culture filtrate was studied for chromium absorption.

Chromium estimation:

0.5 ml of D.P.C. reagent (250mg/50ml Acetone) was added to 1 ml (0.02M H_2SO_4) sample (0.1 ml Cr source + 0.4 ml Distilled water) pink colour was developed which was read at 540mm.

These readings were also cross checked with AAS (Atomic Absorption Spectra).

RESULTS AND DISCUSSION

From the **Table 1**, it was observed that absorption capacity of the Cr by the organism was decreased with increased initial Cr concentration. At higher Cr concentrations most of the fungi failed to grow except Mucor mucedo (at 10 and 15 ppm) and *Dactylosporium* (at 15 and 20 ppm). The remaining fungi showed 100% absorption up to 15 ppm. However *Rhizoctonia solani* recorded better absorption capacity up to 40 ppm with 53 mg of dry weight. It showed 100% absorption up to 15 ppm and 94% up to 20 and 25 ppm with 312 and 244 mg of dry weights. Second best organism was *Pencillium notatum* with better dry weights and good absorption in high chromium concentrations (341 mg, 94% absorption at 20 ppm of Cr and 394 mg, 94% of absorption at 25 ppm of Cr). *Aspergillus* species*, A. ochraceous, A. terreus* absorbed Cr for about 94% with 241 and 251 dry weights respectively. *Drechslera rostata* showed 64% absorption of chromium at 30 ppm with dry weight 221mg. *Alternaria alternate* showed less absorption (40%) with 114 mg dry weight at 25 ppm chromium concentration the remaining fungi showed moderated absorption rates. From the **Table 2** it was observed that six different organism responded differently in varied pH ranges *A.orhraceous* and *A.terreus* showed maximum absorption (100%) at 3 and 4 pH with relatively good growth. *A.Terreus* showed its maximum Cr absorption while its growth was 310 and 299 mg in 3 and 4pH respectively. The absorption of these fungi were subsequently declined in neutral pH. *Rhizoctonia solani* improved its absorption rate atpH 5 and 6 (97.2% and 99.1%) with dry weights 341 mg and 220 mg respectively. *Alternaria alternata* improved the absorption of chromium at 5pH (96%) with 271 mg of dry weight and neutral pH showed only 37% of absorption. *Drechslera rostata* recorded 79% at 3 pH and was increased to 96% with 201 mg dry weight at pH 5. *Fusarium oxysporum* recorded 100% absorption at pH 4 and 74% at neutral pH. *Pencillium notatum* showed 100% cr absorption at 6 pH.

Table 2:

Name/pH	3		4		5		6		7	
	G	C%	G	C%	G	C%	G	C%	G	C%
Aspergillus ochraceous	300	100	291	95	297	60.5	220	32	210	10.6
Aspergillus terreus	310	100	299	100	298	72.6	270	60	120	14.8
Alternaria alternate	115	69	251	68	271	96	268	70.5	310	37
Drechslara rostata	171	79	101	60	145	85	201	96	210	15
Fusarium oxysporum	241	47.32	201	100	276	67.6	278	60	171	74
Pencillium Notatum	309	69.3	201	68	258	78.16	301	100	170	06
Rhizoctonia solani	209	75.6	240	80	341	97.2	220	99.1	140	24.5

G= Dry weight of mycelial mat in "mg"
C% = Chromium absorption in %
" _ " No growth and no absorption.

The pH influences the formation of metal biosorbent complexes, pH variation can affect the availability of metallic elements in solution and also the chemical state of the functional groups responsible for the metal binding in the biomass [17]. In the similar study, pH played vital role in uptake of chromium ions in to yeast cells [18].When pretreated microbial biomass was taken and studied hexavalent chromium reduction was studied.Maximum biosorption efficiency was evident at neutral pH with a metal remover efficiency of 99%. *S. cerevisiae* was then pretreated with NaOH and Acetic acid to study the role of proteins and amino acids, respectively in biosorption. At pH 7, 9 and 11, biomass pretreated with NaOH exhibited significant biosorption as compared to raw biomass and then treated with Acetic acid [19]. Similar to our present work, the effect of pH on Cr (VI) reduction and removal from aqueous solution was studies in the range of 1 – 4. The removal rate was enhanced in acidic conditions [20].

CONCLUSIONS

Microorganisms play a vital role in the food chain ,in medecine preaparations ,and in industrial effluent treatment also. Present study aims at exploitation of microbial capacities for the betterment of the society. Because industries are polluting the environment by letting out their poisonous gases,effluents and solid waste. In this study author took pH as tool to increase the absorption efficiencies soil microbes in hexavalent. Chromium absorption from industrial effluent containing chromium. Seven most frequently occurred fungi were taken and allowed to grow in different pH, and Chromium concentrations and found that every individual organism is better in particular pH level.

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***Corresponding Author:**
Dr.D.Seshi kala
Lecturer in Environmental Sciences,
Kakatiya University Engineering college,
Warangal.