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BIOADSORPTION OF HEAVY METAL BY A TROPICAL FUNGI

A.KARTHIKEYAN* AND K.JAYAPRAKASH#

*Department of Microbiology, # Department of Environmental Science, J. J. College of Arts and Science (Bharathidasan University,Tiruchirappalli) Pudukkottai 622 404, T. N., India

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ABSTRACT

The soil *Myrothecium verrucaria* has been known for adsorbing metals present in effluent. The results of the present study demonstrate that *M.verrucaria* adsorb lead at neutral pH for 18 hrs exposure .The efficiency of the lead adsorption potential was estimated by Atomic absorption spectrophotometer. The non-viable biomass was utilized. The data was statistically significant. This would suggest that this fungal microbe under study may be an ideal microbe for the recovery of lead from industrial effluents.

INTRODUCTION

Heavy metal pollution poses a significant environmental health threat. These substances are discharged in to various environmental media due to increase in industrial processing. It has been established that ecotoxic effect of these heavy metal pollutants may be greater, if it is in industrial origin than natural fluxes. It is known that metal pollutants such as Cd, Hg, Cr ,As ,Pb induce carcinogeneis and teratogenesis. Certain species of microorganisms have the potential to adsorp, metabolize or accumulate heavy metals like Silver(Ag), Cadmium(Cd), Cobalt(Co), Copper(Cu), Nickel(Ni), Chromium(Cr), Zinc (Zn) and Iron (Fe) etc., (Sag and Kutsal, 1997).

These microorganisms have been employed in bioremedial processes for the recovery or degradation of metal pollutants in environmental restoration. In these days treating the Industrial effluents which are known for metal pollutants by microbes is encouraged to reduce the risks. Such bioremediation process for the restoration of environmental metal toxic substance is highly safe and ecofriendly. It may also be helpful for immediate permanent remediation of industrial effluent hazards. The fungal organisms are characterized for the presence of sequestered metal ions intracellulerly. This may be responsible for the mobilization of the metal ions from extracellular medium and uptake of metal ions by transcellular membrane. This property is exploited for the bioadsorption of the metal discharged in to the industrial effluent (Gadd *et al.* 1998).

Pumpal *et al.* (1995) have demonstrated the bioadsorptive potentials of the fungal organism like *Aureobasidium pullulans* for the removal of Nickel, Chromium, Cadmium, Zinc, Aluminium, Silver and Lead. The present study was an attempt to prove the efficiency of heavy metal adsorption potential of *Myrothecium verrucaria.*

MATERIALS AND METHODS

The soil inhabitat rhizophere fungi *M.verrucaria* and the inorganic lead nitrate were used as study materials in the present investigation. The laboratory strain of *M.verrucaria* was raised and the biomass was

kept as a stock for the experiments. The technique for the culture was as per the method outlined by Fisher *et al*. (1995).

The medium was soyatone liquid medium. The biomass was estimated as per the procedure given below. The fungus was allowed to grow in liquid media with a pH of 3.0 at 25º C. The grown fungi were harvested after 3 days by filtering the media through whatman filter paper (No.41). The harvested biomass was powdered in a mortar and pestle after drying at 100ºC for 18 hrs in a hot air oven. Bioadsorption experiments were conducted in separate conical flasks in the presence of 50mg / L of Pb2+ metal solution in 100 ml distilled water with a pH of 3.0. Non-viable biomass was added to each conical flask in concentration of 1000 mg/L and was agitated at 125 rpm min-1 on a rotary shaker.

The observed data was grouped and analysed. The maximum concentration of lead uptaken by the biomass was tried with trials (25,50,100,250,500). In the same way the duration of exposure of the lead was also attempted in a series as given in the Table 3. The ideal concentration at which the maximum adsorption of the lead by the biomass of *M. verrucaria* was also used for the analysis to find out the pH. The quantity of the lead was analysed by using a Varian AA 220 Atomic Absorption Spectrophotometer. As per the formula suggested by the earlier workers Rama *et al*. (2000).The formula is

$$Q = \{ Ci - Cf / m \}V$$

Where
Q = mg of metal ion adsorbed / gm of biomass
Ci = Initial metal ion concentration in mg L^{-1}
Cf = Final metal ion concentration mg L^{-1}
M = Biomass in gm.
V = Volume of the reaction mixture in L

RESULTS

The results of present study on the efficiency of *invitro* bioadsorption of heavy metal lead by the fungi *M. verrucaria* is documented in the Tables1 to 3. Table 1 exhibits the data on bioadsorption of lead at various concentrations. From the table it is evident that the fungi in question adsorb maximum concentration of lead at 50 ppm. In the next phase of studies the optimum pH at which maximum adsorption of lead was found as pH 7.0 (Table 2). In other categories of pH concentration the adsorption is very low. This would suggest that pH 7.0 is the ideal concentration for the maximum adsorption of lead by the fungi under

Table 1. Determination of maximum lead adsorption by *Myrothecium verrucaria* at various concentration after 24 hr exposure.

S.No	Concentration of lead added in medium (in ppm)	Concentration of lead in experimental (in ppm)	Adsorbed quantity of lead by the fungi	% of reduction
1.	25	18.0	6.5	36.11
2.	50	29.9	20.05	67.05
3.	100	77.86	22.14	28.43
4.	250	210.20	39.75	18.91
5.	500	428.25	21.75	4.54

Table 2. Determination of pH at which maximum lead adsorption by *Myrothecium verrucaria* when exposed with 50 ppm Pb after 18 hrs.

S.No	pH	Concentration of lead in experimental(in ppm)	Adsorbed quantity of lead by the fungi	% of reduction
1.	3	37.56	12.44	33.12
2.	5	32.19	17.81	55.32
3.	6	30.75	19.25	62.60
4.	7	26.00	24.00	92.30
5.	8	34.48	15.52	45.00
		Mean : 32.19	Mean:17.80	
		S.D : 4.315	S.D : 4.315	
		S.E : 1.930	S.E : 1.930	

The values are statistically highly significant after 't' test($P<0.05$).

Table 3. Determination of ideal exposure time at which maximum adsorption of lead by *Myrothecium verrucaria* when exposed with 50 ppm at pH 7.0.

S.No	Exposure time (in hr)	Concentration of lead in experimental(in ppm)	Adsorbed quantity of lead by the fungi	% of reduction
1.	4	43.79	6.21	14.18
2.	8	41.75	8.25	19.76
3.	10	39.95	10.05	25.15
4.	12	39.80	10.20	25.62
5.	14	37.60	12.40	32.97
6.	18	36.00	18.00	50.00
7.	24	35.95	14.05	39.8
		Mean : 39.263	Mean:11.309	
		S.D : 2.939	S.D : 3.908	
		S.E : 1.111	S.E : 1.477	

The values are statistically highly significant after 't' test($P<0.05$).

study. These values are highly significant ($p<0.05$).

To substantiate the bioadsorption efficiency of the fungi under investigation a constant concentration of 50 ppm at pH 7.0 for various exposure times was also carried out and the results were analysed.Table-3 provides the very data for the above experiment. The result indicates that the 18 hr exposure of the lead at pH 7.0 , resulted in the maximum adsorption of lead, which was recorded as 18 ppm . The Value is statistically significant. On the other hand when the exposure time (24hr) was increased the adsorption efficiency was also reduced. From the above foregoing results it may be reasonable to suggest that fungi *M. verrucaria* has the potency to adsorb heavy metal at neutral pH. It is also to be presumed that the lowest duration of the exposure (18 hr) may be ideal for the degradation of lead by the fungi *M. verrucaria.*

DISCUSSION

In recent years bioremediation has been practiced for the removal of metal toxicants from industrial discharges. Several microbes have been tried for the efficiency of degradative potential to remove toxic pollutant substances in industrial effluent. Among microbes fungi are described as best microbes for biodegradatative processes. The fungi *M. verrucaria* habitat in soil is shown to be adsorb heavy metal and pollutant by earlier workers (Itoh *et al.* 1975). But the knowledge on this property at various physico chemical conditions is lacking to substantiate this concept. The results of present study reveal that *M. verrucaria* adsorbs lead significantly even in lowest concentration at neutral pH(18ppm lead nitrate out of 36 ppm). In the light of present observation *M.verrucaria* may be employed to biologically degrade heavy metal pollutant like lead present in industrial effluents. The application of fungal organisms for the bioremediation of metals from industrial effluent in the present investigation is encouraging. However much more laboratory studies may be needed to ascertain this efficiency in field trials. So *M. verrucaria* may be a suitable organism for the abatement of metal pollutant in industrial waste discharge.

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