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Selection of Suitable Fungus, Development of Arsenic Resistant Strain and Kinetic Analysis for as (Iii) Biosorption

KEYWORDS: As (III), Aspergillus niger, Zeta potential, pH, pseudo-first order, kinetics

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ABSTRACT *An experimental study was carried out to select suitable suitable fungal biosorption of As (III) from ground water.For this purpose , sample of soil was collected from As (III) contaminated area at Jadavpur, Kolkata, West Bengal ,India and fungal strains were initially collected from this sample.. This strain was then subjected to subsequent trials to develop As (III) resistant strain. Aspergillus niger X300 was selected as the best strain which can grew even in a As (III) contaminated medium as 1500 mg/L. Its maintenance medium, Zeta potential at different pH , pI and pseudo-first order linear kinetics for As (III) biosorption was studied.*

INTRODUCTION

Arsenic is a potentially toxic metalloid in the environment. It exists in ground water in mainly two forms: As (III) and As (V) , among which As (III) is potentially more toxic 1. Its mobility from ground water is not only affected by abiotic factors, but also by microbs especially fungus and bacteria by biosorption [2-6]. Biosorption is a Physico-Chemical interaction which may occur between metals and metalloids with cellular compounds [7]. The research for biosorption is expected to improve the potential for the removal of As (III) from ground water. The main objective of my present study was to select suitable fungal strain, develop of As (III) resistant strain and studies on Kinetic aspects of As (III) biosorption by the selected strain.

MARERIALS AND METHODS

Screening of microorganism: Soil sample was collected from the As (III) contaminated area of Jadavpur, Kolkata, and West Bengal, India in 2009. The sample was stored in sterile polyethane bag. The sodium salt of As (III) was used throughout the study.1 gm of sample was mixed with 10 ml of sterile distilled water and left for sedimentation. After that 0.1 ml of the supernatant was spread on PDAC plate containing 100 mg / L As(III). This was repeated for several times using graded concentrations of As (III) upto 1500 mg/L in PDAC plates using fungal colonies from just previous concentration as inoculum. For the removal of As(III) from aqueos solution it was further tested . There were six replicates for each experiment. The entire incubation was carried out for seven days at 28^{0}C.Selected fungus was identified by wet mounting with lacto-fuchsin and examined by viewing at 1000X magnification using a compound microscope [7].

Estimation of As(III) : The total concentration of As(III) in the culture medium was analysed using hydride generation atomic absorption Spectrometry (HG ASS) , using the Perkin- Elmer Atomic Absorption spectrometer model 1164 (USA) equipped with a hydride generator Labtech HG (Czech Republic) [9].

Estimation of Zeta-Potential : The fungal mat was harvested so that the iron precipitate in the flasks would not affected Zeta Potrential.The Zeta Potential was measured using a Zeta- Meter system 3.0 by Zeta-Meter Incorporated.

Biosorption isotherm: Biosorption isotherm experiments were carried out in a single component system. The initial concentration was 1500 mg/L. The kinetics of As (III) biosorption was studied using pseudo-first order (Langergren) equation as mentioned below:

Ln= $(q_e-q_t)/q_e$=-k1t where qe and qt are the amount of metalloid sorbed (mmol/gm) at equilibrium at given time respectively. K1 is the pseudo-first order constant of adsorption (1/min)[10].

RESULTS AND DISCUSSION

Among 386 isolates studied, the fungal isolate which showed maximum As (III) tolerance i.e. Aspergillus niger X_{300} (tolerated 1500 mg/L) was selected the best one for the removal of As (III) from aqueous medium. The isolate had separate hyphae and grew fast at 28^{0}C, formed a mat within 7 days of inoculum. The colony was initially green and then progressively to black as incubation continued. The colour change begins at the centre of the colony and then spreadoutward. For maintenance of subcultures of this strain three maintenance medium with composition : glucose , 1% ; Urea , 0.6% ; $MgSO_4.7H_20$, 0.01 % ; KH_2PO_4, 0.1% ; K_2HPO_4 , 0.1 % ; $CaCl_2$, 0.2% and Agar, 4% as solidifying agent was selected for its maintenance in which the strain remained intact for one year or more. But the strain showed degeneration in other two medium.The rate of As (III) biosorption onto the fungal surface at different time intervals were depicted in Fig.1.

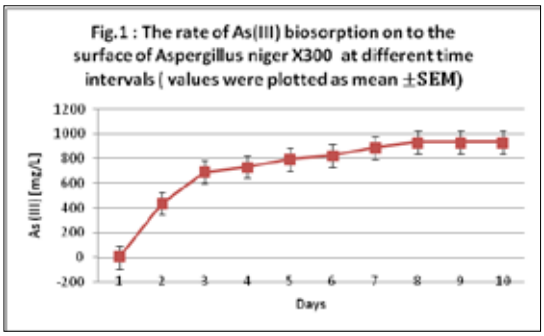

Fig.1 : The rate of As(III) biosorption on to the surface of Aspergillus niger X300 at different time intervals (values were plotted as mean ±SEM)

From this figure, it was clear that the bio sorption was increased up to 7th day (maximum 933.6±4.683 mg/ L) and then reached to its equilibrium. The zeta Potential of the As (III) resistant strain was measured in order to monitor surface electro-Chemical changes. The Zeta Potentials for Aspergillus niger X300 at different pH and the isoelectric point at different concentrations of As (III) were shown in Tables 1 and 2.

Determination of Zeta Potential for Aspergillus niger X300 at different pH (values were expressed as mean ± SEM)

pH	Zeta Potential (mv)
7.0	-22.6±0.113
6.5	-24.1±0.361
6.0	-27.6±0.661
5.5	-30.3±0.432
5.0	-33.2±0.221
4.5	-34.2±0.613
4.0	-31.6±0.213

Table 2 : Determination of pI at different concentrations of As (III)
(values were expressed as mean ± SEM)

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As (III) (mg/L)	pI
300	5.5±0.163
600	5.3±0.113
900	5.1±0.131
1200	4.8±0.166
1500	4.6±0.174

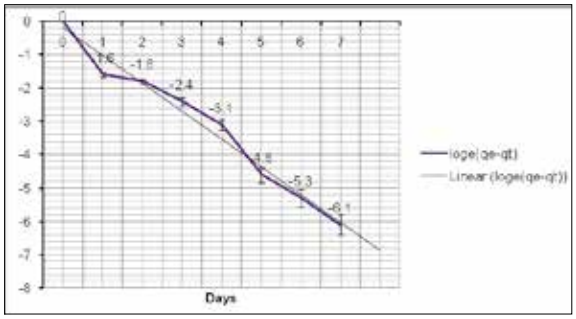

Fig.2 : Kinetic analysis of As (III) biosorption using Pseudo first order linear plot by Aspergillus niger X300 (values were plotted as mean ±SEM)

The pseudo-first order linear plot was adopted for the kinetic analysis of As (III) biosorption by the resistant strain as shown in Fig.2 which established a good correlation coefficient (R^2>0.96) . Lukidou et al. (2003) and Murgesan et al.(2006) also suggested the similar pattern of kinetics for biosorptions [11,12]. Here, the rate constant was 211.63 mg/L/daywith initial concentration of 1500 mg/L for this metalloid. Such kinetic study was significant practical importance as it will facilitate smaller reactor volumes ensuring efficiency and economy.

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