World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:12, No:04, 2018

Biosorption of Nickel by Penicillium simplicissimum SAU203 Isolated from Indian Metalliferous Mining Overburden

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Abstract : Nickel, an industrially important metal is not mined in India, due to the lack of its primary mining resources. But, the chromite deposits occurring in the Sukinda and Baula-Nuasahi region of Odhisa, India, is reported to contain around 0.99% of nickel entrapped in the goethite matrix of the lateritic iron rich ore. Weathering of the dumped chromite mining overburden often leads to the contamination of the ground as well as the surface water with toxic nickel. Microbes inherent to this metal contaminated environment are reported to be capable of removal as well as detoxification of various metals including nickel. Nickel resistant fungal isolates obtained in pure form from the metal rich overburden were evaluated for their potential to biosorb nickel by using their dried biomass. Penicillium simplicissimum SAU203 was the best nickel biosorbant among the 20 fungi tested and was capable to sorbing 16.85 mg Ni/g biomass from a solution containing 50 mg/l of Ni. The identity of the isolate was confirmed using 18S rRNA gene analysis. The sorption capacity of the isolate was further standardized following Langmuir and Freundlich adsorption isotherm models and the results reflected energy efficient sorption. Fourier-transform infrared spectroscopy studies of the nickel loaded and control biomass in a comparative basis revealed the involvement of hydroxyl, amine and carboxylic groups in Ni binding. The sorption process was also optimized for several standard parameters like initial metal ion concentration, initial sorbet concentration, incubation temperature and pH, presence of additional cations and pre-treatment of the biomass by different chemicals. Optimisation leads to significant improvements in the process of nickel biosorption on to the fungal biomass. P. simplicissimum SAU203 could sorb 54.73 mg Ni/g biomass with an initial Ni concentration of 200 mg/l in solution and 21.8 mg Ni/g biomass with an initial biomass concentration of 1g/l solution. Optimum temperature and pH for biosorption was recorded to be 30°C and pH 6.5 respectively. Presence of Zn and Fe ions improved the sorption of Ni(II), whereas, cobalt had a negative impact. Pre-treatment of biomass with various chemical and physical agents has affected the proficiency of Ni sorption by P. simplicissimum SAU203 biomass, autoclaving as well as treatment of biomass with 0.5 M sulfuric acid and acetic acid reduced the sorption as compared to the untreated biomass, whereas, NaOH and Na_2CO_3 and Twin 80 (0.5 M) treated biomass resulted in augmented metal sorption. Hence, on the basis of the present study, it can be concluded that P. simplicissimum SAU203 has the potential for the removal as well as detoxification of nickel from contaminated environments in general and particularly from the chromite mining areas of Odhisa, India.

Keywords : nickel, fungal biosorption, Penicillium simplicissimum SAU203, Indian chromite mines, mining overburden
Conference Title : ICEBB 2018 : International Conference on Environmental Biotechnology and Biomonitoring
Conference Location : Paris, France
Conference Dates : April 19-20, 2018