



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Different pollutants arising from natural and anthropogenic sources have contaminated our nature and have grave impact on human health. Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous pollutant which cause great damage to terrestrial and aquatic ecosystems. Efficient and safe removal of these pollutants from environment has been an intensely active research area. Bioremediation is a well-established technique employed for the clean-up of PAHs. In this thesis, we have studied the process of PAHs removal through yeast, *Candida tropicalis*. This type of non-ligninolytic fungi have an edge over other fungi owing to their higher tolerance towards pollutants. To begin with, we have addressed the primary facet of a typical bioprocess, i.e. optimization of physical parameters and kinetic analysis of microbial growth. The model system was phenanthrene and pyrene as pollutants and native yeast strain of *Candida tropicalis* MTCC 184. The physical parameters related to phenanthrene and pyrene biodegradation were optimized using statistical design of experiments. The tolerance test revealed marked decrease in yeast cell growth after 100 and 75 mg L⁻¹ of phenanthrene and pyrene, respectively. The values of the optimised parameters were similar for both the PAHs. Under optimum conditions, ~ 66% of phenanthrene and ~ 53% of pyrene was degraded in 14 days. Kinetics of the process was studied using different substrate inhibition models. The profiles were best described with Haldane substrate inhibition model. Next intensification of biodegradation of PAHs with ultrasound was studied from a mechanistic viewpoint. After optimization of sonication duty cycle, ultrasound was applied in the log phase of yeast growth cycle. A marked rise of ~ 25% in phenanthrene removal and ~ 30% in pyrene removal was seen with sonication. Kinetic analysis revealed that the biomass yield coefficient increased while the decay coefficient of the cells reduced in presence of sonication. No significant alteration in the cellular morphology

and topography was seen with ultrasound treatment. Further, we have studied the biomechanism of degradation of phenanthrene and pyrene by *Candida tropicalis*. It was found that same route of degradation (*meta*- pathway) was followed in both test and control experiments, thereby signifying that ultrasound did not alter the route of degradation. SDS-PAGE analysis revealed higher protein expression in the test samples as compared to control samples. GC-MS analysis of intermediate metabolites revealed two parallel pathways of degradation, first triggered by intracellular cytochrome P450 monooxygenase enzyme, and second initiated by dioxygenase enzymes. Finally, the co-bioremediation of both the PAHs have been studied. Experimental results have been analyzed using a kinetic model for cell growth that takes into account self- and cross-inhibition of both substrates. In dual substrate system, specific degradation rate of phenanthrene was significantly higher than pyrene, which indicated relatively lower tolerance of *C. tropicalis* cells towards pyrene. The values of interaction parameters of inhibition revealed strong competitive cross-inhibition between two substrates, due to which biomass yield with dual substrates was reduced significantly. Inhibition induced by pyrene on cell growth was higher than phenanthrene. On a whole the thesis presents a complete lab scale process design and intensification of bioremediation of PAHs through non-ligninolytic fungi. Moreover, the methodology presented in the thesis forms a general framework that can be extended to other bioremediation systems.