

The degradation of carbazole and the production of ligninolytic enzyme by isolated marine fungi

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ABSTRACT

Biodegradation of carbazole heterocyclic hydrocarbon by isolated marine fungi were tested. Out of the 64 fungal isolates tested, 5 fungi were able to decolorize more than 50% of 0.01% Remazol Brilliant Blue R. Isolate B3 were able to decolorize 99% of RBBR in all concentrations tested. Isolate B3 and B4 showed the highest removal of carbazole at 88% and 53%, respectively as observed with GCMS in the degradation trial. Laccase enzyme was produced in high concentration of 528.00±11.33 U/L and 642.67±11.43 U/L for isolate B3 and B4. It is observed that the presence of carbazole triggered the production of laccase as it was produced only at 106.67±3.33 U/L and 14.00 U/L for isolate B3 and B4 without carbazole. Results suggested that isolate B3 belonged to the Basidiomycota. The prospects of carbazole biodegradation by these isolates are suspected to be contributed through the production of laccase (Lac).

Keywords: heterocyclic hydrocarbon, fungi, carbazole.

INTRODUCTION

The oil industry deals with the global processes of exploration, production, transportation, refining and marketing of natural hydrocarbons (crude oil and natural gas). Hydrocarbons, besides being the basic raw materials for the chemical industry represents the largest source of energy on the planet. Release of hydrocarbons into the environment whether accidentally or due to human activities is a main cause of water and soil pollution. Polycyclic aromatic hydrocarbons (PAHs) and heterocyclic aromatic compounds (HACs) are two major group of chemical pollutant present in the environment. Activation of electrophilic metabolites are required for PAH and HAC to exert their mutagenic or carcinogenic effects. Polycyclic aromatic compound and heterocyclic aromatic compound can be easily present in the petroleum compounds. Polycyclic aromatic hydrocarbons (PAHs) are composed of two or more condensed aromatic rings of carbon and hydrogen atoms; the rings are linked together in linear and angular arrangements. While, heterocyclic have a cyclic structure of five- or six-membered rings containing at least one or more heteroatom of sulfur (S), nitrogen (N), and oxygen (O). These heterocyclic compounds co-occur in PAHs mixtures and can constitute 1 to 10% of the total PAH concentration in contaminated sediments, and tend to make up higher percentages in mixtures derived from creosote or tar. However, the focus of research has been more into the degradation of global pollution by polycyclic aromatic hydrocarbon (PAH) such as naphthalene and phenanthrene. Although many heterocyclic hydrocarbon compounds especially sulfur, nitrogen and oxygen heterocycles have been found widely in seawater at sites contaminated with petroleum, little awareness has been taken to degrade heterocyclic hydrocarbon compounds.

Hydrocarbons in the environment are biodegraded primarily by bacteria, yeast, and fungi. The reported efficiency of biodegradation ranged from 6% to 82% for soil fungi, 0.13% to 50% for soil bacteria, and 0.003% to 100% for marine bacteria. Over the last decade, marine-derived fungi have become a great interest in mycoremediation. Fungi cometabolize PAHs to a wide variety of oxidized products and in some cases to CO₂. There are two identified and widely reported mechanisms of fungal PAHs metabolism, one involving cytochrome p450 system and another one is using extracellular enzymes. The ligninolytic fungus produces soluble extracellular enzymes that directly attack the CAR and other PAHs whereas bacterial CAR degrading enzymes are intracellular in nature. These extracellular ligninolytic enzymes, includes lignin peroxidases (LiP), manganese peroxidases (MnP), and laccases (Lac). Moreover, ligninolytic fungi can also incorporate hydroxyl group in the aromatic ring of heterocycles. These enzymes may oxidize PAHs to form transient PAH diphenols. Hence lead to the detoxification. However, as much as the pathway of bacterial CAR degradation has been well studied, data regarding similar activities in fungi is limited till date. No data has ever recorded in the pathways of fungi in the degradation on carbazole heterocycles. In fact, these organisms can grow in stressful habitats, characterized by high salinity and pH, low water activity, high concentration of sodium ions and high pressure. In response to these stimuli they produce a wide range of different and structurally complex products. Hence, the objective of the present study is to isolate potential fungal isolates that may help in the degradation of carbazole heterocycles. Two isolates with the ability to produce high level of laccase enzyme has been isolated and studied. Degradation trial was done to quantify the loss of carbazole heterocycles and also the production of laccase enzyme by these fungi.