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Research

USE OF MOLECULAR TOOLS TO MONITOR MICROBIAL COMMUNITIES DURING THE BIOREMEDIATION OF POLYCYCLIC AROMATIC HYDROCARBON-CONTAMINATED SOILS

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ABSTRACT

One of the priority environmental pollutants, because of its high toxicity and persistence, are the polycyclic aromatic hydrocarbons (PAHs). PAHs are recalcitrant compounds exhibiting high hydrophobicity and therefore readily absorbed in the gastrointestinal tract of mammals, also having a rapid distribution in a variety of tissues with a marked tendency to fatty deposits. Because of its importance as environmental pollutants, soil contamination with PAHs is a priority environmental issue. In recent years, there have been great advances in the understanding of the mechanisms of degradation of PAHs and the techniques for the monitoring of these processes in polluted soils. However, the validation and performance of a bioremediation strategy should be based not only on the effect of the microorganisms in soil (biodegradation of the contaminant), but also in the detection and monitoring of the inoculated microorganisms. This review presents an overview of the strategies for the bioremediation of soils contaminated with PAHs, focusing on the molecular biology methods that can be used for the monitoring of these soils in the field.

INTRODUCTION

Polycyclic aromatic hydrocarbons (PAHs) are a group of chemically similar organic compounds containing two or more fused aromatic rings, produced as a result of the incomplete combustion and pyrolysis of organic matter. Several natural and anthropogenic sources contribute to the release of PAHs to the environment such as forest fires, volcanic eruptions, vehicle emissions, oil refining and industrial combustion of fossil fuels. Due to its toxicity, mutagenicity and carcinogenicity, many PAHs have been identified as priority pollutants by regulatory authorities including the Environmental Protection Agency of the United States (US-EPA, 2008). PAHs are highly hydrophobic compounds, and as the molecular weight of PAHs increases their solubility in water and volatility decreases (Haritash and Kaushik, 2009). Chemical and photochemical reactivity, as well as many physical and biological characteristics, are greatly influenced by structural aspects like the degree of saturation, number of rings and spatial configuration of PAHs (Mukherji and Ghosh, 2012). Moreover, as the association of a contaminant with the soil organic matter is directly related with its hydrophobicity, PAHs are highly recalcitrant compounds having high octanol-water partitioning coefficients (Kow) (Accardi-Dey and Gschwend, 2003).

The bioremediation of PAH-polluted soils has become an increasing environmental priority. For years, mechanisms on PAH biodegradation and the use of native and introduced organisms in polluted soils, either as single organisms or as consortia, have been studied. Many microbial species including bacteria, fungi and algae have been described as capable of partially or completely metabolize low molecular weight (LMW) or high molecular weight (HMW) PAHs under aerobic or anaerobic conditions (Seo, *et al.*, 2009; Cerniglia and Sutherland, 2010). Once in soil, PAH-degrading organisms face a series of biotic and abiotic factors that permanently affects their adaption as well as permanence

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