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Biodegradation Ability of Polycyclic Aromatic Hydrocarbon (PAHs) Degrading Bacillus cereus Strain JMG-01 Isolated from PAHs Contaminated Soil

Authors : Momita Das, Sofia Banu, Jibon Kotoky

Abstract : Environmental contamination of natural resources with persistent organic pollutants is of great world-wide apprehension. Polycyclic aromatic hydrocarbons (PAHs) are among the organic pollutants, released due to various anthropogenic activities. Due to their toxic, carcinogenic and mutagenic properties, PAHs are of environmental and human concern. Presently, bioremediation has evolved as the most promising biotechnology for cleanup of such contaminants because of its economical and less cost effectiveness. In the present study, distribution of 16 USEPA priority PAHs was determined in the soil samples collected from fifteen different sites of Guwahati City, the Gateway of the North East Region of India. The total concentrations of 16 PAHs (Σ16 PAHs) ranged from 42.7-742.3 µg/g. Higher concentration of total PAHs was found more in the Industrial areas compared to all the sites (742.3 µg/g and 628 µg/g). It is noted that among all the PAHs, Naphthalene, Acenaphthylene, Anthracene, Fluoranthene, Chrysene and Benzo(a)Pyrene were the most available and contain the higher concentration of all the PAHs. Since microbial activity has been deemed the most influential and significant cause of PAH removal; further, twenty-three bacteria were isolated from the most contaminated sites using the enrichment process. These strains were acclimatized to utilize naphthalene and anthracene, each at 100 µg/g concentration as sole carbon source. Among them, one Gram-positive strain (JMG-01) was selected, and biodegradation ability and initial catabolic genes of PAHs degradation were investigated. Based on 16S rDNA analysis, the isolate was identified as Bacillus cereus strain JMG-01. Topographic images obtained using Scanning Electron Microscope (SEM) and Atomic Force Microscope (AFM) at scheduled time intervals of 7, 14 and 21 days, determined the variation in cell morphology during the period of degradation. AFM and SEM micrograph of biomass showed high filamentous growth leading to aggregation of cells in the form of biofilm with reference to the incubation period. The percentage degradation analysis using gas chromatography and mass analyses (GC-MS) suggested that more than 95% of the PAHs degraded when the concentration was at 500 µg/g. Naphthalene, naphthalene-2-methy, benzaldehyde-4-propyl, 1, 2, benzene di-carboxylic acid and benzene acetic acid were the major metabolites produced after degradation. Moreover, PCR experiments with specific primers for catabolic genes, ndo B and Cat A suggested that JMG-01 possess genes for PAHs degradation. Thus, the study concludes that Bacillus cereus strain JMG-01 has efficient biodegrading ability and can trigger the clean-up of PAHs contaminated soil.

Keywords : AFM, Bacillus cereus strain JMG-01, degradation, polycyclic aromatic hydrocarbon, SEM
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