Biodegradation of crude oil and phenanthrene by heavy metal resistant *Bacillus subtilis*isolated from a multi-polluted industrial wastewater creek

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Abstract

A critical bottleneck associated with bioremediation technology in multi-polluted environments is microbiostasis due to metal toxicity. Autochthonous *Bacillus* species that would harness a repertory of traits to catabolize hydrocarbons and simultaneously sequester heavy metals (HMs) is invaluable in the environment contaminated with divergent pollutants. Fourteen HM-resistant bacilli from polluted creek were characterized using phenotypic and molecular criteria, and studied for hydrocarbon degradation in chemically defined media amended with Co^{2+} and Ni^{2+} (5.0 mmol l^{-1} each). Phylogeneticanalyses revealed distribution of the bacilli into three clades. Two dissimilar strains of *Bacillus subtilis* (M16K, and M19F) with 19.1% sequence divergence, exhibited excellent degradation of crude oil (>94.0%) with evidence of early degradation of isoprenoid hydrocarbons and concurrent metal removal 18 d post-inoculation. Similarly, phenanthrene degradation (>85.0%), and corresponding metal detoxification occurred in 28 d axenic culture of the strains. Strain M16K and M19F were metabolically active in matrices containing HMs, degraded hydrocarbons and simultaneously removed HMs from the medium. To the best of our knowledge, this is the first report of metal-resistant *Bacillus subtilis* strains showing simultaneous degradation of hydrocarbons and detoxification of metals, particularly in the Sub-Saharan Africa. The bacilli could be useful as potential biological agents in effective bioremediation campaign for multi-polluted environments.

Keywords: Heavy metals, Crude oil, Phenanthrene, Heavy metal-resistant, *Bacillus subtilis*, Biodegradation, Metal-biosequestration

DOI: https://doi.org/10.1016/j.ibiod.2017.02.021

Journal of International Biodeterioration & Biodegradation

Published by: Elsevier, on 2017/5/1