Bioremediation of Crude Oil Using Halotolerant and Thermotolerant Bacteria from Saudi Arabia

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While global oil production exceeds 100 million barrels per day, over 40 million liters of crude oil have contaminated marine ecosystems since 2020, resulting in catastrophic ecological and economic consequences. Conventional physicochemical remediation strategies are often hazardous or inefficient, calling for sustainable, naturally sourced alternatives. This study investigates the crude oil bioremediation potential of halotolerant and thermotolerant bacteria isolated from a hypersaline pink lake and a hot spring in western Saudi Arabia. Twenty extremotolerant strains were screened via OD600 growth kinetics, from which ten candidates were selected for a 14-day incubation with crude oil under low-nutrient conditions. Bioremediation performance was evaluated through qualitative biodegradation assessments, biosurfactant production assays, and bioinformatic analyses using the Hydrocarbon Aerobic Degrading Enzymes and Genes (HADEG) database to functionally annotate genes and metabolic pathways and predict protein structures involved in degradation. The results identified Priestia filamentosa and Bacillus paralicheniformis KJ-16 as leading degraders, exhibiting rapid growth within 72 hours, followed by significant oil layer thinning, emulsification, and dispersion by day 10. Notably, P. filamentosa harbored 22.8% of listed HADEG oil-degrading genes, possessing unique genetic and metabolic determinants that distinguish it from other known species within its genus. These findings highlight the potential of native extremotolerant bacteria as effective, locally sourced candidates for in-situ bioremediation of aquatic oil spills to mitigate the global crisis of crude oil contamination.

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