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Use of Cold Active Biosurfactants for Biodegradation of Crude Oil in the Cryosphere

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Within the cryosphere, the persistence and environmental impact of pollutants is heightened due to extreme physical and chemical properties of polar regions. Particularly, the tracking and cleanup of oil spills is challenging due the dynamics of freezing and thawing ice and soil. Because of the environmental constraints associated with polar ecosystems, microorganisms from cold temperature environments are the best candidates for bioremediation since they are the best adapted to the extreme biotic and abiotic stresses. While the investigation of cold-active biosurfactants from psychrophilic microorganisms is early on, they show great promise for sustainable biotechnologies. Biosurfactants are biologically produced, surface active molecules that can reduce interfacial tensions between phases, making them effective agents in bioremediation efforts in fragile polar environments [1]. Biosurfactants have a lower toxicity, and higher stability across pH, temperature, and salinity ranges rather than synthetic compounds often utilized in large-scale oil spill cleanups. This study investigated a biosurfactant producing bacteria (*Serratia* sp. PL17) that was isolated from an Antarctic coastal pond [2]. Liquid chromatography mass spectrometry (LCMS) identified the biosurfactant as serrawettin W1, a cyclic lipopeptide, making this the first characterization of a biosurfactant producing Serratia species from a cold temperature environment. Generation of a biosurfactant deficient mutant (PL17_20) enabled a comparative investigation of the role of biosurfactants in crude oil degradation at an environmentally relevant temperature (15 °C). This study quantified the solubility of specific crude oil components with the addition of biosurfactants, establishing a connection between these components and their degradation rates. Gas Chromatography Mass Spectrometry (GCMS) was used to assess the solubilization of hydrophobic hydrocarbons into the water accommodated fraction (WAF) and to monitor the subsequent degradation of longer chain hydrocarbons that are typically more recalcitrant at cold temperatures. Hydrocarbon degradation was significantly enhanced at low temperatures in the presence of biosurfactants, achieving levels comparable to those observed in mesophilic environments. Combined, results from this study demonstrate the potential of cold-active biosurfactants to overcome challenges in bioremediation efforts in the cryosphere.

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