

Microbial biodegradation of paraffin wax in Malaysian crude oil mediated by degradative enzymes

ABSTRACT

The deposition of paraffin wax in crude oil is a problem faced by the oil and gas industry during extraction, transportation, and refining of crude oil. Most of the commercialized chemical additives to prevent wax are expensive and toxic. As an environmentally friendly alternative, this study aims to find a novel thermophilic bacterial strain capable of degrading paraffin wax in crude oil to control wax deposition. To achieve this, the biodegradation of crude oil paraffin wax by 11 bacteria isolated from seawater and oil-contaminated soil samples was investigated at 70°C. The bacteria were identified as *Geobacillus kaustophilus* N3A7, NFA23, DFY1, *Geobacillus jurassicus* MK7, *Geobacillus thermocatenulatus* T7, *Parageobacillus caldxylosilyticus* DFY3 and AZ72, *Anoxybacillus geothermalis* D9, *Geobacillus stearothermophilus* SA36, AD11, and AD24. The GCMS analysis showed that strains N3A7, MK7, DFY1, AD11, and AD24 achieved more than 70% biodegradation efficiency of crude oil in a short period (3 days). Notably, most of the strains could completely degrade C37–C40 and increase the ratio of C14–C18, especially during the initial 2 days incubation. In addition, the degradation of crude oil also resulted in changes in the pH of the medium. The degradation of crude oil is associated with the production of degradative enzymes such as alkane monooxygenase, alcohol dehydrogenase, lipase, and esterase. Among the 11 strains, the highest activities of alkane monooxygenase were recorded in strain AD24. A comparatively higher overall alcohol dehydrogenase, lipase, and esterase activities were observed in strains N3A7, MK7, DFY1, AD11, and AD24. Thus, there is a potential to use these strains in oil reservoirs, crude oil processing, and recovery to control wax deposition. Their ability to withstand high temperature and produce degradative enzymes for long-chain hydrocarbon degradation led to an increase in the short-chain hydrocarbon ratio, and subsequently, improving the quality of the oil.