Growth optimisation and kinetic profiling of diesel biodegradation by a cold-adapted microbial consortium isolated from Trinity Peninsula, Antarctica

ABSTRACT

Pollution associated with petrogenic hydrocarbons is increasing in Antarctica due to a combination of increasing human activity and the continent's unforgiving environmental conditions. The current study focuses on the ability of a cold-adapted crude microbial consortium (BS24), isolated from soil on the north-west Antarctic Peninsula, to metabolise diesel fuel as the sole carbon source in a shake-flask setting. Factors expected to influence the efficiency of diesel biodegradation, namely temperature, initial diesel concentration, nitrogen source type and concentration, salinity and pH were studied. Consortium BS24 displayed optimal cell growth and diesel degradation activity at 1.0% NaCl, pH 7.5, 0.5 g/L NH_4Cl and 2.0% v/v initial diesel concentration during one-factor-at-a-time (OFAT) analyses. The consortium was psychrotolerant based on the optimum growth temperature of 10–15 °C. In conventionally optimised media, the highest total petroleum hydrocarbons (TPH) mineralisation was 85% over a 7-day incubation. Further optimisation of conditions predicted through statistical response-surface methodology (RSM) (1.0% NaCl, pH 7.25, 0.75 g/L NH_4Cl, 12.5 °C and 1.75% v/v initial diesel concentration) boosted mineralisation to 95% over a 7-day incubation. A Tessier secondary model best described the growth pattern of BS24 in diesel-enriched medium, with maximum specific growth rate, μ_{max}, substrate inhibition constant, K_i and half saturation constant, K_s, being 0.9996 h^{-1}, 1.356% v/v and 1.238% v/v, respectively. The data obtained suggest the potential of microbial consortia such as BS24 in bioremediation applications in low-temperature diesel-polluted soils.

Keyword: Diesel; Microbial consortium; Biodegradation; Response-surface methodology (RSM); Kinetic model