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Polyhydroxyalkanoates (PHA) production from phenol in an acclimated consortium: Batch study and impacts of operational conditions

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Highlights

- Toxic compound phenol was used as the carbon source for microbial PHA production
- Various process conditions were tested in batch studies with an acclimated culture
- Biomass growth and PHA synthesis were hindered by low pH, DO and temperature
- Initial phenol/biomass ratio was crucial and high phenol conc. inhibited activities
- The process had comparable or higher productivity compared to previous reports

Abstract: Microbial intracellular biopolymer PHA was synthesized from toxic pollutant phenol by an acclimated consortium. Various operational conditions were experimented for their effects on biomass growth and PHA accumulation. Carbon to nitrogen ratios from 5 to 40 (w/w) showed little impact, as did the levels of Fe, Ca and Mg in a short term. Acidic pH inhibited both growth and PHA synthesis, and an optimal dissolved oxygen level of 1-4 mg L^{-1} was identified. Low temperature (7 °C) significantly slowed but did not totally repress microbial activities. A 2% NaCl shock retarded reactions and 4% NaCl caused irreversible damage. Various initial phenol (S0) and biomass concentrations (X0) were combined to study the effect of food to microbe (F/M) ratio. High S0 and F/M exerted toxicity, reducing reaction rates but generating higher ultimate PHA wt% in biomass. Increasing X0 alleviated phenol inhibition and improved productivity and carbon conversion from phenol. A pseudo-optimized F/M ratio of 0.2-0.4 and a maximum PHA% rate of 1.15% min^{-1} was identified under medium S0/high X0. This study is the first to systematically investigate the feasibility of toxic industrial waste as the carbon source for PHA production, and likely the only one indicating potential for scaling-up and industrialization.