Ability of bacteria isolated from oil-contaminated soil to utilize lindane under aerobic and anaerobic conditions

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Introduction

Lindane is an organochlorine compound that belongs to the group of hexachlorocyclohexane (HCH). HCH is a group of compounds consisting of cyclohexane having one chlorine and one hydrogen attached to each carbon, their common chemical formula is $C_6H_6Cl_6$ (Zdravkoski *et al.*, 2004). The estimated amount of lindane used globally for agricultural purposes, livestock, forestry, human health in the period from 1950 to 2000 is about 600,000 tons. Since the 1990s, research has begun on possible ways to remove lindane. In addition to more traditional methods such as storage or incineration, catalysts have been discovered that enable faster photodegradation such as TiO_2 or mixtures of TiO_2 with other metal oxides like CeO_2 (Radić et al., 2022). Meanwhile, the microbial breakdown of lindane contamination is becoming more and more recognized as an economical and environmentally friendly alternative to traditional treatment methods (Bhatt et al, 2019).

Materials and methods

For our experiment, we used bacterial strains isolated from oil-contaminated soil. Mineral medium supplemented with diesel D2 was used for isolation microorganisms that decompose hydrocarbons (Löser et al., 1998). We successfully isolated six bacterial strains. Because of their ability to survive in extreme conditions and use oil as a source of energy and carbon, we hypothesized that they could also use lindane. A mineral salt medium with glucose and lindane (10 ppm) (Sahoo and Chaudhuri, 2019) was made. After 7 days at 28 °C, 150 rpm microbial growth was observed. Microorganisms (1 mL) were transferred to a medium supplemented only with lindane (10 ppm). The microorganisms were grown aerobically and anaerobically in parallel. The number of aerobic bacteria was determined on nutrient agar and the number of anaerobically grown bacteria was determined on the same agar supplemented with 0.5 % glucose.

Results and discussion

Six bacterial strains were successfully isolated (two strains of the genus *Pseudomonas* (PS1 and PS2), two strains of the genus *Acinetobacter* (ACB1 and ACB2), one strain of the genus *Achromobacter* (ACH1), and one strain from the genus *Citrobacter* (CB1)) and assessed for their ability to utilize lindane as the sole source of carbon. The following results were obtained, in aerobic conditions: PS1 9.9 x 10^7 CFU mL^{-1}, PS2 8.2 x 10^6 CFU mL^{-1}, ACB1 7.5 x 10^6 CFU mL^{-1}, ACB2 1.27 x 10^7 CFU mL^{-1}, ACH1 1.14 x 10^8 CFU mL^{-1}; CB1 there are no overgrown colonies; in anaerobic conditions observed growth of only one microorganism, CB1 >10^6 CFU mL^{-1}.

Conclusion

The growth and ability of these bacteria to use lindane as the sole source of carbon and energy reflects the ability of these strains to biodegrade lindane in contaminated soil. These findings contribute to the growing body of evidence supporting bacterial degradation as an eco-friendly way for lindane removal. Further research could explore kinetics of lindane removal by these bacterial strains.

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