ANAEROBIC MICROBIAL DEGRADATION OF ORGANOCHLORINE INSECTICIDE ALDRIN

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Introduction

Aldrin (1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo-exo-5,8-dimethanon-naphthalene), a cyclodiene organochlorine insecticide, was banned by nations and classified as B2 carcinogen by United States Environmental Protection Agency (EPA). Because of its chemical stability and lipophilicity, aldrin is regarded as a persistent and recalcitrant compound.

The dissipation process of aldrin in aerobic environments has continuously been paid much attention by researchers. However, limited information has been shown under anaerobic conditions. For this reason, the degradation potential of aldrin by anaerobic microorganisms obtained from indigenous river sediment was evaluated, and the effect of environmental factors such as temperatures and nutrients on the aldrin degradation was also investigated in this study.

Materials and Methods

Chemicals

Chemical standard aldrin with 97% purity was purchased from Riedel-deHaën Co., Ltd, Germany. HPLC-graded solvents used in this experiment such as *n*-hexane and acetone were purchased from E. Merck Co, Germany.

Preparation of anaerobic mixed stock culture

The river sediment was gathered from the Er-Jen River, a serious contaminated river in southern Taiwan. A grab sampler was used to collect the river sediment in a depth of 0 ~ 10 cm. Anaerobic mixed culture was prepared in a 1-L serum bottle by adding sediment (100g) to culture medium (400mL) in a modular atmosphere controller system (dwscientific Co, England) filling with N_2, H_2, and CO_2 gases in ratio of 85:10:5.

Anaerobic batch experiments

For investigating the effects of environmental factors (different incubation temperatures, aldrin concentrations, and different carbon sources) on aldrin degradation, the anaerobic batch degradation experiments of aldrin were performed by adding 5 mL of anaerobic mixed culture into a 125-mL serum bottle containing 45 mL of culture medium (with different carbon sources), and then aldrin was spiked to serum bottle. In order to avoid oxygen and possible photolysis involving, the serum bottle was sealed with a butyl rubber stopper capped with an aluminum top and incubated in darkness.

Residue analysis

Residues of aldrin in sample culture was extracted by *n*-hexane and measured with GC-ECD.

Results and Discussion

The half lives ($t_{1/2}$, days) of aldrin at different temperatures were 22 (40℃) > 33 (30℃) ≈ 33 (20℃) > 44 (10℃) in orders. based on our experimental consequences, 40℃ was the optimal degradation temperature for aldrin under anaerobic conditions.

The degradation was obviously delayed when the anaerobic mixed culture incubated with 100 μg/mL of aldrin. This result indicated that there is a threshold value for aldrin degradation in this anaerobic mixed culture and the excess concentration of aldrin may be an obstacle to microbial degradation.

Based on the result of figure 3, degradation rates of aldrin were not affected by using different compounds as major carbon source after 105 days of incubation periods.

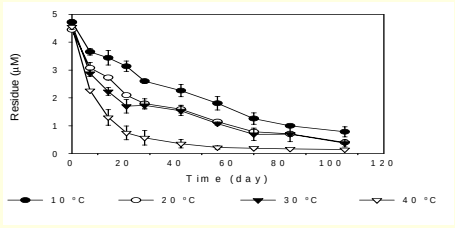

Figure 1. The effect of incubation temperature on the anaerobic microbial degradation of aldrin.

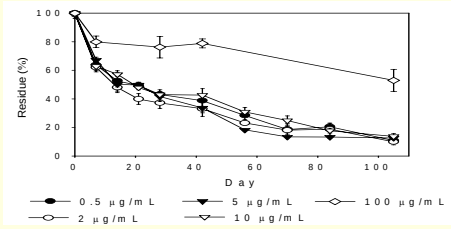

Figure 2. The effect of initial concentration on the anaerobic microbial degradation of aldrin.

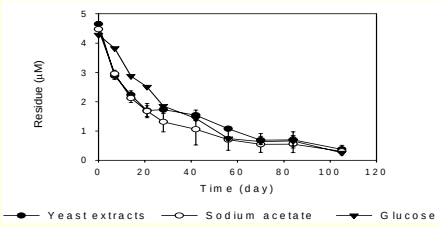

Figure 3. The effect of carbon source on the anaerobic microbial degradation of aldrin.

Conclusion

1. The half lives ($t_{1/2}$, days) of aldrin at different temperatures were 22 (40℃) >33 (30℃) ≈ 33 (20℃) > 44 (10℃) in orders. The incubation temperature was an important factor to affect the degradation rates of the aldrin. The degradation rate of aldrin was faster at 40℃ than other lower temperatures (10 ~ 30℃).
2. The microbial degradation can proceed better by the presence of aldrin concentrations in the mixed culture between 0.5 to 10 μg/mL. However, the microbial degradation was inhibited by adding 100 μg/mL of aldrin to the culture.
3. Aldrin were not significantly affected by using different compounds as major carbon source after 105 days of incubation periods.