THE EFFECT OF BESA AND MOLYBDATE ON DEGRADATION OF ORGANOCHLORINE PESTICIDES ALDRIN AND DIELDRIN

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Introduction

Organochlorine pesticides aldrin and dieldrin were extensively used in the past. Because of their chemical stability and lipophilicity, aldrin and dieldrin were persistent and recalcitrant in the environment, especially in soil or sediment. In this study, we attempt to investigate the anaerobic degradation of aldrin and dieldrin by using indigenous microorganisms from river sediment in Taiwan. Besides, microbial inhibitors BESA and molybdate were also chosen to study the possible influence by eliminating certain bacteria population.

Methods and Materials

Chemicals

Aldrin and Dieldrin with 97 and 99%, respectively, and HPLC-graded solvents, *n*-hexane and acetone, were used in this experiment.

Preparation of anaerobic mixed stock culture

Anaerobic mixed stock culture was prepared in a 1-L serum bottle by adding sediment (100g) to culture medium (400mL) in a modular atmosphere controller system filling with N_2, H_2, and CO_2 gases (85:10:5).

Batch experiments

The batch degradation experiments were performed by adding 5 mL of anaerobic mixed culture into a 125-mL serum bottle containing 45 mL of culture medium, then 10 μg/mL of aldrin or dieldrin and or 5 mM and or 50 mM BESA (2-bromoethanesulfonate, $BrCH_2CH_2SO_3^-$) or molybdate was spiked into serum bottles as a given final concentration.

BESA is a structure analog of Coenzyme M (CoM; $HSCH_2CH_2SO_3$-) which is a cofactor involved in methane biosynthesis, and BESA is regarded as a methanogen inhibitor. Molybdate is an inhibitor which impedes the synthesis of ATP surfurylase, and it is regarded as an inhibitor of sufate-reducing bacteria. Therefore, Addition of BESA and molybdate could specifically inhibit methanogen and sulfate-reducing bacteria, respectively.

Residue analysis

Residues of aldrin and dieldrin in sample culture were extracted by 2.0 mL of *n*-hexane for three times, and measured with GC-ECD and GC-FID.

Results and Discussions

1.The half-life ($T_{1/2}$) of aldrin and dieldrin was fitted to the first kinetic equation and the R^2 was higher than 0.9. The $T_{1/2}$ of aldrin and dieldrin was 39.7 and 115 days, respectively. Degradation of aldrin was obviously delayed by spiking of BESA and molybdate. (Table 1) The degradation of aldrin incubated with inhibitor was obviously slower than inoculated control. Among them, addition of BESA leads delay in aldrin degradation, but concentrations of BESA do not cause any difference in degradation rate. In molybdate-treated cultured, higher concentration of molybdate could slower the degradation rate of aldrin.

2. In inoculated control, 61.2 % of dieldrin was degraded after 140 days of incubation periods. Both of BESA and molybdate impede significantly the degradation of dieldrin, and the degrees of inhibition were similar between BESA and molybdate-treated culture.(Table 2)

3. Large quantities of methane were produced in inoculated control. In comparison, production of methane was inhibited by treating with BESA and molybdate. The result presented here indicates that methanogenesis was suppressed regardless of addition of BESA or molybdate. (Figure 1)

Table 1. The half-life of aldrin by treating with microbial inhibitors

Treatment	Aldrin		
	k	$T_{1/2}$ (days)	R^2
Inoculated control	0.017	39.74	0.99
5 mM BESA	0.01	67.66	0.97
50 mM BESA	0.011	63.1	0.97
5 mM Molybdate	0.011.	65.44	0.95
50 mM Molybdate	0.008	83.39	0.95
50 mM BESA+Molybdate	0.009	79.14	0.9

Table 2. The degradation percentage of dieldrin after 140 days of incubation periods by treating with microbial inhibitors

Treatment	Degradation percentage of dieldrin after 140 days of incubation periods (%)
Inoculated control	61.2
5 mM BESA	25.75
50 mM BESA	25.19
5 mM Molybdate	16.98
50 mM Molybdate	21.14
50 mM BESA+Molybdate	29.05

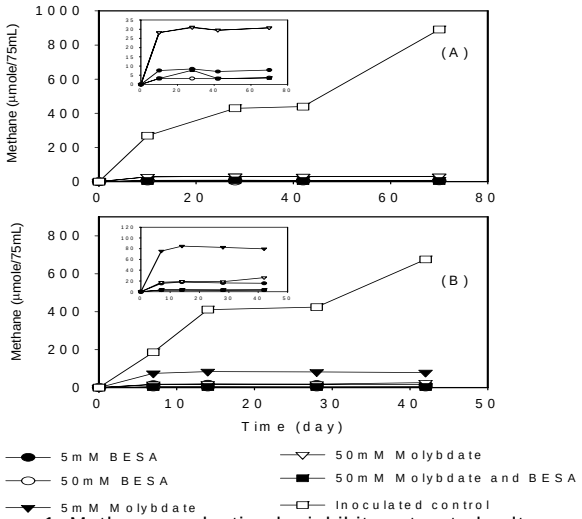

Figure 1. Methane production by inhibitors-treated culture during the degradation process of alrin (A), and dieldrin (B).

Conclusion

1.Both of BESA and molybdate impede the degradation of aldrin and dieldrin. We deduce methanogens and sulfate-reducing bacterial may involve in the process.

2. According to our observation, not only BESA but also molybadate would inhibit the methane production.