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Methanotrophs assisted bentazone degradation

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Introduction

Drinking water is increasingly threatened by contamination from pesticides and pesticide metabolites, including bentazone, a thiadiazine herbicide persistent in groundwater. Anaerobic groundwater often contains methane, which is easily oxidized by methanoxidizing bacteria (MOB) upon groundwater aeration. These bacteria have known cometabolic degradation properties against some class of organic contaminants.

Goal: Test whether MOBs enriched from rapid sand filters can cometabolically degrade bentazone.

Materials and Methods

- Material from rapid sand filters used to enrich methanotrophic culture in continuous - flow lab scale reactors
- Batch assay of bentazone removal & mineralization
- $^{14}$C carbonyl-labeled bentazone in concentrations ranging from 0.2 to 2000 ug/L with and without methane (triplicates)
- Abiotic controls (autoclaved filtralite)
- Methane analysis – GC-FID

Bentazone Removal & Mineralization

- No effect of CH$_4$ in removal kinetics.
- Higher total mineralization in the absence of CH$_4$

Concentration Effect

- Removal in all concentration ranges
- Slower removal rate in the presence of CH$_4$
- Delay observed at high CH$_4$ concentrations

CH$_4$ effect – Enzyme competition

- CH$_4$ concentration maintained at 5 mg/L
- $r$-removal rate

- At low bentazone concentrations, the effect of methane is not significant
- The higher the bentazone concentration, the higher the ratio of removal without CH$_4$/with CH$_4$

- Effect of methane observed in high CH$_4$ (>0.5 mg/L) concentrations

Conclusions

- Microbial community fed only with methane in drinking water for > 1 year shows efficient and stable bentazone degradation in all concentration ranges
- Two possible removal patterns: (a) not inhibited by methane at low bentazone concentrations, (b) methane-inhibited at high concentrations
- Not consistent pattern with the typical cometabolic process
- Methane's presence slows down bentazone degradation process unless present in low concentrations (<10 ug/L)
- Observed competitive inhibition between methane and bentazone