1,4-Dioxane is used as a stabilizer in chlorinated compounds, as a solvent in paper and textile processing, and in the manufacture of organic chemicals and personal care products. It is a probable human carcinogen and a priority pollutant. In January 2002, nine drinking water wells in Orange County, California, were closed because of dioxane. In Washtenaw County, Michigan, groundwater aquifers at a filters manufacturing facility are contaminated with dioxane at concentrations up to 30,000 ppb. Recent detection of dioxane at several previously remediated sites has raised concerns that it may cause closed sites to be reopened. Sorption onto activated carbon and air-stripping have proven to be ineffective in removing dioxane from water because of its high solubility and low volatility. Photocatalytic oxidation is expensive and requires ex-situ remediation with pump-and-treat operations. A few studies have shown that dioxane can be biodegraded but the mechanisms and pathways have not yet been investigated.

In this study, several monooxygenase-expressing bacteria were tested for their dioxane-degrading ability because dioxane is metabolized in the human body by cytochrome P-450 monooxygenase enzymes. Dioxane served as a sole growth substrate for two actinomycete strains. Cometabolic degradation of dioxane was carried out by twelve cultures expressing methane, propane, tetrahydrofuran or toluene monooxygenase enzymes. Acetylene, an inhibitor of several monooxygenases, prevented oxidation of dioxane, supporting our hypothesis that the monooxygenase pathway is responsible for dioxane degradation. Further, Escherichia coli containing cloned toluene monooxygenase genes cometabolically oxidized dioxane. Dioxane degradation rates ranged from 0.04 to 0.43 mg hr\(^{-1}\) mg protein\(^{-1}\). Isotope studies showed that nearly half of the dioxane was mineralized to CO\(_2\).

This study will present a mechanistic understanding of dioxane degradation by aerobic microorganisms, provide quantitative data and kinetic models of degradation reactions, and facilitate the development of monitoring tools for dioxane bioremediation in natural and engineered systems.

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