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Comparative degradation of emerging pollutants using chemical and enzymatic approach

by

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Date & Venue

11:00 AM
Thursday, 16 November 2017
Room 40, F3 Building

Abstract

Organic pollutants, especially those found in water bodies; pose a direct threat to various aquatic organisms as well as humans. A variety of different remediation approaches, including chemical and biological methods have been developed for the degradation of these organic pollutants. However, comparative mechanistic studies of pollutant degradation by these different systems are almost non-existent. In this study, the degradation of an antibiotic pollutant, Sulfamethoxazole (SMX) and a model thiazole pollutant, Thioflavin T (ThT), was carried out in the presence of either an advanced oxidation process (AOP), using UV + H_2O_2 or a peroxidase enzyme system. The optimization conditions for Sulfamethoxazole degradation by peroxidase enzyme showed a requirement for a redox mediator (Hydroxybenzotriazole) and acidic medium. Furthermore, the optimum conditions for the efficient degradation were as follows: the concentration of hydrogen peroxide, peroxidase enzyme and SMX needed were 56 µM, 78 nM and 5 ppm respectively. The degradation was followed both spectrophotometrically and using liquid chromatography-mass spectroscopy (LC-MS), and the products formed were identified using tandem liquid chromatography-mass spectrometry-mass spectrometry (LC-MS-MS). The results showed that the two remediation approaches produced different sets of intermediates suggesting that different degradation schemes were operating in the two systems (AOP vs. Peroxidase enzyme system). Phytotoxicity studies carried out using *Lactuca sativa* (lettuce) showed different levels of detoxification of the pollutants by the two different remediation approaches. This is the first time that a comparative mechanistic study showing in detail the intermediates generated in chemical and biological remediation methods has been presented. Furthermore, the results show that different remediation systems have very different degradation schemes and result in products having different toxicities.

Keywords: Bioremediation, advanced oxidation process, peroxidases, enzymes, chloroperoxidase, Soybean peroxidase