Toxicity Reduction of Metal Pyrithiones by Near Ultraviolet Irradiation

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ABSTRACT: Zinc pyrithione (ZnPT) or copper pyrithione (CuPT) have been effectively used as ship-antifouling agents, as an alternative to organotin compounds. Because of their instability in light and a lack of suitable analytical procedures, there is little data on their residue levels in environmental matrices. It is possible to investigate the fate of such compounds by toxicity alteration with certain treatments. The purpose of this study was to evaluate the degradation of pyrithiones through toxicity reduction by near ultraviolet (UV-A) irradiation. Metal pyrithiones dissolved in acetonitrile were irradiated with a UV-A lamp for 0, 0.5, 1, and 2 h, and were subjected to UV spectral measurement and toxicity evaluation using both sea urchin and freshwater rotifer bioassays. For the bioassays, photolyzed samples were dissolved in dimethyl sulfoxide after evaporation of the acetonitrile. The changes in UV spectra of photolyzed ZnPT or CuPT showed a time-dependent degradation, and the UV spectra at 2 h irradiation suggested substantial decomposition. Toxicities of ZnPT and CuPT were 12 and 5 μg/L as 24 h LC50 to the survival of rotifers and 10^{-6} ng/L and 2.3 ng/L as 27 h EC50 to normal pluteus formation, respectively. By evaporation of the acetonitrile, the EC50 of ZnPT was 2.2 ng/L, which was the same as that of CuPT. The EC50s of ZnPT or CuPT for both species increased with longer irradiation times. Photolyzed ZnPT or CuPT demonstrated substantial degradation in the UV spectra, but possessed marked toxicity, which is probably due to toxic degradation products. One reason why photolyzed CuPT was toxic to rotifers was explained by the high toxicity of copper ions formed by UV-A irradiation. © 2006 Wiley Periodicals, Inc. Environ Toxicol 21: 305–309, 2006.

Keywords: antifouling agent; photodegradation; rotifer; sea urchin

INTRODUCTION

The need for effective antifoulants, which prevent the settlement and growth of marine organisms on submerged structures, such as oil rig supports, buoys, fish cages, and ship hulls, is recognized worldwide. Some booster biocides are introduced as antifouling compounds that are alternatives to organotins, which will be banned worldwide after 2008. The worldwide occurrence and effects of some antifouling paint booster biocides have been reviewed by Konstantinou and Albanis (2004). Nevertheless, there is limited data available on their environmental effects on nonfouling organisms and on their aquatic fate. The toxicity of alternative antifouling biocides such as copper pyrithione (CuPT) and zinc pyrithione (ZnPT), as well as Irgarol 1051,

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