Report for 2004AR72B: Oxide-Catalyzed Oxidation of 17b-Estradiol to Estrone

- Other Publications:
  - Park, Jeong and G. Sheng. 2005. Catalytic oxidation of 17b-estradiol to estrone in soil. Arkansas Water Resources Center Annual Conference. Fayetteville, Arkansas.

Report Follows

Problem and Research Objectives:

Estrogens in the environment interfere with the endocrine / reproductive functions of wildlife and humans. Land application of biosolids and animal wastes as fertilizers in Arkansas is a common practice. Surface runoff and potential leaching may significantly contribute to the occurrence of estrogens in the aquatic environment. The objectives of this project are to examine the abiotic oxidation of 17β-estradiol in soil, to identify the soil oxides responsible for the degradation, and to evaluate the factors that influence the degradation.

Methodology:

A soil was collected from the University of Arkansas Animal Farm, dried, and sterilized. The soil was subjected to chemical treatment with $NH_2 \cdot HCl$ to remove manganese oxides. The soil and water containing 17β-estradiol were mixed and rotated at pH of 4.4 or 7.7. At various sampling times, soil was extracted for degradation product(s). Both solution and soil extract were analyzed for 17β-estradiol and its product(s) by HPLC and GC-MS and for Mn(II) by AAS.

Principal Findings and Significance:

The GC-MS analysis identified that 17β-estradiol in soil was oxidized to estrone. The amount of 17β-estradiol continuously decreased while estrone increased with reaction time. No other degradation products were found. The degradation was faster at pH 7.7 than at pH 4.4, as the oxidation releases protons. The amount of Mn(II) increased with time, suggesting that soil manganese oxides were reduced. The degradation was not observed in Mn-free soil, demonstrating the oxidative role of soil manganese oxides. Manganese oxides may thus be used to effectively remediate the soil and water contaminated with 17β-estradiol.