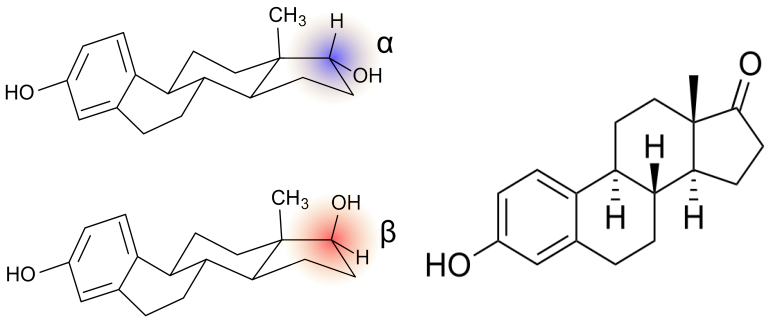
Anaerobic Transformation Kinetics and Mechanism of Steroid Estrogenic Hormones in Dairy Lagoon Water

Dairy products are a staple of the American diet. The main ingredient of the dairy industry, milk, has a byproduct even before it reaches the pasteurizing factory. For cows to produce milk, they need to have given birth recently. Pregnancy and lactation hormones include estrogen compounds. These hormones are excreted through urine and feces. Liquid manure and wastewater from precipitation and washing processes of the herd end up in a series of dairy farm lagoons designed to remove solids from the water. What happens to the estrogen compounds? How can we prevent hormones from contaminating the environment and causing detrimental effects in aquatic species? One research query is to determine if the lagoons have long enough retention times for hormones to degrade.

Lab experiments conducted by mixing dairy lagoon water with deionized water at a 1:1 ratio, and then spiking that solution with starting concentrations of 5 mg/L estrogen compounds showed that the estrogen compounds mainly biodegraded, and little to no abiotic degradation occurred at various temperatures. In addition, degradation rates increased with rising temperatures (15, 25, and 35°C), but declined at 45°C. These results indicate that the well-known optimum temperature for biological growth, ~37°C, would be effective at degrading estrogen compounds.

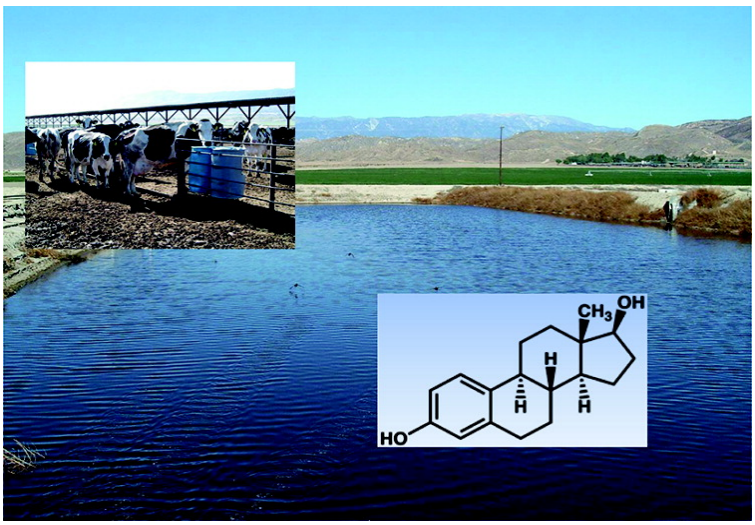
Estrogen Compounds



17(α/β)-estradiol estrone

Additionally, degradation rates varied based on the structure of the estrogen compound. The compounds 17β-estradiol and 17α-estradiol degraded 35 and 12 times more than estrone when incubated at 25°C, respectively. This difference is most likely due to their slightly differing physical structure, and the bacteriaum's ability to use one compound more efficiently than the other. Over 52 days at an incubation temperature of 35°C, the total removal of 17α-estradiol was 85%; 17β-estradiol was 78%; and estrone was 77%.

Lab experiments at relevant starting concentrations (5 µg/L) of estrogen compounds were also conducted, showing similar results at higher concentrations. To achieve these similar results with lower concentrations, however, ISTC scientists had to develop a new analytical detection method to accommodate the low concentrations of estrogen compounds.



Meet the Scientists

Publications

One Hazelwood Drive, MC-676
Champaign, IL 61820
p: 217-333-8940
Email us

Home of Illinois' State Scientific Surveys
Illinois Natural History Survey
Illinois State Archaeological Survey
Illinois State Geological Survey
Illinois State Water Survey
Illinois Sustainable Technology Center