Photocatalytic Degradation of Common Pharmaceuticals and Characterization of their Products

Carlos Campos, Class of 2022

Introduction

Pharmaceuticals and personal care products (PPCP's), now more widely accessible and consumed, have become prevalent due to environmental pollution caused by their presence in wastewater and the ineffective measures by wastewater treatment plants (WWTP's) to remove them from sewage. Long term exposure to many of these PPCP's and their more toxic byproducts pose heavy chronic effects to the health of the environment, aquatic life, and other organisms.

Photocatalytic degradation (PD) has become a recent alternative method to remove PPCP's from wastewater. PD happens under a presence of a photocatalyst, which uses UV or visible light to either directly react with the PPCP or produce reactive oxygen species (such as superoxide or hydroxyl radicals) and break down the PPCP. Although TiO_2 (titanium dioxide) currently serves as the industry standard, newer photocatalysts such as BiOCl (bismuth oxychloride) have been developed to compete with TiO_2's removal and cost efficiencies.

Summer Goals and Accomplishments

This summer, I conducted research on the PD of ketoprofen, ibuprofen, and naproxen, 3 PPCPs that have been hard to photodegrade and are found as major sources of pollution. By optimizing a sample collection method introduced by Kai'olu DeFries '19, I conducted a PD using TiO_2, BiOCl, and no photocatalyst on these three PPCPs and then analyzed the samples by HPLC using absorbance detection to determine and compare the kinetic degradation rates of the three PPCPs under all three conditions. The samples were also analyzed on the LC-MS/MS in order to determine the structures of the photodegradation byproducts and characterize them at certain time intervals during the reaction.

Through my work, I showed that BiOCl acted as a significantly more effective photocatalyst for ibuprofen and naproxen while it acted equally as well for ketoprofen. I also successfully determined the structures of each photodegradation product that my data showed for every single reaction. Having also proposed structures for the photodegradation, I found the propanoic acid part of the structure for each molecule was the main site of reaction and caused the different levels of products. With the goals of my project having been to compare kinetics and characterize the products now completed, future work for this project may include conducting PDs in more complex systems with multiple drugs and multiple photocatalysts.

Faculty Mentor: Professor Elizabeth Stemmler

Funded by the Dana Walker Mayo Fellowship