Research Project

Photo-degradation Kinetics of Selected Antimicrobials in Natural and Nano-pure water

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Statement of Problem:

Occurrence of antibiotics in the environment is cause of concern due to its potential toxicity to non-targeted species, emergence of antibiotic resistance micro-organisms, and threats to drinking water resources. As such, it is imperative that the persistence of antibiotics in the aqueous environment should be investigated. Perusal of the literature suggests that, few studies have documented the environmental persistence of Sulfamethazine (SMN) and Trimethoprim (TMP) in aqueous environment. This study bridges that knowledge gap through analysis of photo-stability of antibiotics in natural and drinking water. The question being addressed here is, when exposed to the simulated solar radiation, do SMN and TMP undergo photo-degradation? Does presence of fluvic and humic substances in natural water facilitates or inhibit degradation? In natural waters, which photo-degradation mechanism (direct/indirect) is predominant? How does the degradation rate vary in the nano-pure water, groundwater and surface water? Studies on aqueous photolysis of SMN and TMP are warranted to obviate the pollution of nation's water resources.

Background and Relevance to Previous Work:

Antimicrobials are routinely used in livestock operations or concentrated animal feed operations (CAFO) for therapeutic uses as well as for growth promotion. A major concern regarding the use of antimicrobials at CAFOs is that animals often do not completely metabolize an antimicrobial and up to 90% of it, gets excreted back in the environment within 1-2 days of administration. Most recently, the PI has demonstrated that Bosque Watershed is impacted with low levels of monensin antibiotic in the surface water samples. Because of their common use, observed occurrence in the environment, it is important to understand their stability when exposed to simulated solar radiation.

General methodology and procedure to be followed:

To conduct the photo-degradation experiment, individually labeled triplicate (A, B, C) samples of SMN and TMP and respective control samples will be prepared. A solar radiation simulator will be used to expose the analytical grade standards of SMN and TMP. The samples will be collected at predetermined intervals between 0 to 168 hours. Antibiotics in the aqueous phase samples exposed to the simulated sunlight will be analyzed using a Waters HPLC system using reverse-phase gradient separation technique. A standard curve of known concentration vs. absorbance will be plotted and used for quantifying the unknown concentrations in the exposed samples.

Expected Results and Broader Impact:

Most recently, the Food and Drug administration has announced to restrict the use of antibiotics in animal agriculture for sub-therapeutic purposes. This is primarily due to the adverse effect of antibiotics on non-target species, particularly the growth of antibiotic resistant micro-organisms. The findings of this research will help better understand the environmental fate of antibiotics and subsequent vulnerability of water resources to antibiotic pollution. The study not only emphasizes thorough experimental protocol to investigate stability of these compounds in aquatic environment, but also seeks to mathematically model the observed degradation rate kinetics so that generalization can be made. This study has a direct implications to engineered water treatment

system and proliferation of antibiotic resistance micro-organisms. In summary, through extensive laboratory experiments, the study seeks to develop a solid understanding of persistence and stability of emerging micro-pollutants such as antibiotics in the aquatic environment.