Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.38129

Speciation and Surface-Mediated Attenuation of Ciprofloxacin in Wastewater-Influenced Freshwaters

JANICE P. L. KENNEY[1], KEIFER KLIMCHUK[2,3], ISABELLE HORNBERGER[1], ELIZABETH J FAVOT[1,4], BRIE EDWARDS[4,5], MATTHEW S ROSS[6] AND DANIEL S. ALESSI[7]

[1]Laurentian University
[2]University of Alberta
[3]Natural Resources Canada
[4]Cooperative Freshwater Ecology Unit, Laurentian University
[5]Ontario Ministry of the Environment, Conservation and Parks
[6]MacEwan University
[7]University of Texas

Ciprofloxacin (CIP) is a fluoroquinolone antibiotic that is highly prescribed, is excreted from the human body “as is”, and enters wastewater treatment facilities chemically unchanged. Wastewater effluent from sewage treatment facilities, therefore, represents a continuing source of CIP pollution into freshwater systems. CIP has been identified as a contaminant of emerging concern because its amphoteric speciation and strong metal-binding capacity lead to its persistence in aquatic environments, which increases its potential role in promoting antimicrobial resistance. In this study, we investigated the aqueous chemistry, including the CIP concentrations, in lakes within the City of Greater Sudbury, Ontario, Canada, and evaluated whether biochar produced via the slow pyrolysis of sewage sludge from a wastewater treatment plant is a suitable sorbent for CIP prior to discharge of treated water into the environment.

To quantify CIP in lake sediments, Ekman grab samples were collected from the deepest basins of multiple lakes in the Sudbury region and centrifuged to isolate associated waters for chemical analysis. Ciprofloxacin was detected in the water fraction from only one lake in significant quantities, Kelly Lake, which was a short distance downstream of a wastewater treatment facility’s effluent release point. We further evaluated wastewater treatment plant biosolids-derived biochar as a reactive carbon phase for CIP removal. The biochar studied was produced at two pyrolysis temperatures: 550ºC and 700ºC. We found that pyrolysis temperature controls surface functional groups and mineral ash content, both of which influenced CIP uptake via electrostatic attraction, hydrophobic interactions, and surface complexation. This work links environmental detection with mechanistic laboratory experiments to evaluate biosolids-derived biochar as a reactive material for mitigating antibiotic release. By integrating pharmaceutical speciation, aqueous chemistry, and engineered carbon surface properties, we aim to better constrain the controls on antibiotic persistence and attenuation in freshwater systems.