

Fate and Transport of Hydrophobic and Hydrophilic Cyanotoxins through Granular Activated Carbons

Bingran Chen¹, Maria Meyer², Ying Hong², Toby Sanan³, and So-Ryong Chae^{1,*}

¹ Department of Biomedical, Chemical, and Environmental Engineering, University of Cincinnati, Cincinnati, OH 45221.

² Water Quality and Treatment Division, Greater Cincinnati Water Works, Cincinnati, OH 45230.

³ Office of Research and Development, National Risk Management Research Laboratory, Water Supply and Water Resources Division, Treatment Technology Evaluation Branch, United State Environmental Protection Agency, Cincinnati, OH 45268.

* Corresponding author: Dr. So-Ryong Chae (Assistant Professor, phone: (513) 556-4353, fax: (513) 556-4162, e-mail: chaesq@ucmail.uc.edu)

Cyanobacteria (also known as “blue-green algae”) are microscopic organisms that are found in most bodies of water, which can multiply to form harmful algal blooms (HABs) under favorable conditions (*i.e.*, rich nutrients, strong sunlight, and high temperature). Many genera of cyanobacteria are known to produce cyanotoxins such as microcystins (MCs), cylindrospermopsin (CYN), saxitoxins, and anatoxin-a. HABs have been a major health and environmental issue in Europe, Asia as well as the United States.

Cyanotoxins in water can be partitioned into two categories (*i.e.*, intracellular and extracellular toxins). In most cases, cyanotoxins exist intracellularly in the cytoplasm of cyanobacteria. However, when the cells die or lyse, as well as in response to stressors in the environment, intracellular toxins may be released into the water, becoming extracellular cyanotoxins. According to literature, 95% of MCs are intracellular, but only 50% of CYN is typically intracellular under typical conditions.

Cyanotoxins are relatively stable under a variety of water quality conditions and can be persistent in aquatic environments. Conventional drinking water treatment plants (DWTPs), which typically utilize coagulation/flocculation/sedimentation (C/F/S) and sand filtration (SF) have been considered as safe barriers for cyanobacteria and associated intracellular toxins. However, these conventional drinking water treatment processes are ineffective in removing hydrophilic dissolved toxins.

Adsorption with carbon-based media such as powdered activated carbon (PAC) and granular activated carbon (GAC) is commonly utilized as a means to remove dissolved cyanotoxins. However, guidance for the selection of operating conditions to efficiently remove various cyanotoxins by GAC does not exist. Developing an understanding of the fate and transport of cyanotoxins through porous carbon barriers is important for management of the impacts of cyanobacterial blooms on public drinking water supply.

In this study, we aimed to determine the effects of hydrophilicity/hydrophobicity of cyanotoxins such as MC-LR, MC-RR and CYN on fate and transport of the cyanotoxins through virgin GAC or reactivated GAC using rapid small-scale column tests (RSSCT) (Empty bed contact time, EBCT = 15 minutes) for 18 days. The cyanotoxins were spiked into the Ohio River water having 1.4 mg/L of total organic carbon (TOC). As a result, the relatively more hydrophilic cyanotoxins showed faster breakthrough from the GACs compared to the more hydrophobic cyanotoxins.