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Role of microbial cell properties on bacterial pathogen and bacteriophage removal in biochar-modified biofilters

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ABSTRACT

Stormwater biofilters are distributed stormwater control measures for managing urban runoff. Recent work has shown that adding biochar to biofilters can reduce stormwater contaminant concentrations, including fecal indicator bacteria (FIB). However, the potential of biochar-augmented biofilters to remove human pathogens from stormwater has not been investigated. In this study, we investigated the removal of bacterial pathogens *Salmonella enterica* serovar Typhimurium and *Staphylococcus aureus*, as well as bacterial and viral indicators *Escherichia coli* and MS2 coliphage in laboratory-scale biochar-amended biofilters. Biochar-amended biofilters performed better than sand biofilters in removing the microorganisms from stormwater and removal of pathogenic bacteria was greater than that of FIB. Biochar-augmented biofilters provided up to 3.9, 1.9, and 1.8 $\log_{10}$ removal for pathogenic bacteria, *E. coli*, and MS2, respectively. We utilized colloid filtration theory to elucidate potential microbial removal mechanisms. In biochar-amended biofilters, electrostatic interactions between the virus and collector surfaces likely controlled bacteriophage removal whereas the electrostatic interactions likely played a minor role in bacterial removal. Bacterial removal in biochar-augmented biofilters was likely controlled by straining and hydrophobic interactions. The findings of this study inform the design of geomedia-amended biofilters to reduce stormwater-derived microbial contamination in receiving waters.