Developing a Novel Sustainable Bio-Adsorbent Derived From Agricultural Biomass and Iron-Functionalized Biochar for the Removal of Algal Toxin From Water

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Harmful algal blooms caused by cyanobacteria have become a growing global concern due to their release of potent toxins, one of which includes microcystin (MC-LR). This toxin threatens drinking water safety and aquatic ecosystems due to increasing nutrient pollution combined with climate change. MC-LR are highly stable in water sources and resistant to conventional water treatment methods. Traditional removal methods for MC-LR have shown limitations due to several drawbacks which include high operational costs, secondary toxic waste generation, and reduced efficiency at trace toxin concentrations. This proves the need for more sustainable and low-cost alternatives using eco-friendly and naturally derived materials for purification from these harmful algal toxins. This study introduces BIOREM, a novel and sustainable composite that combines chemically activated agricultural wastes (coconut/sugarcane) with iron-functionalized biochar for the removal and catalytic degradation of MC-LR along with the self-regeneration of the filtration media. Column and batch adsorption experiments were conducted to assess the performance of BIOREM compared to biochar and biomass individually. With up to 80% removal of MC-LR, the results demonstrated that a two-tier BIOREM would have the greatest removal and degradation performance due to high adsorption capacity and affinity for these toxins with its dual functionality of degrading and capturing. These findings highlight BIOREM's potential as a cost-effective solution due to its self-regeneration capability and 80-90% lower cost than conventional filters. BIOREM offers a eco-friendly solution which does not produce secondary harmful waste because it catalyzes the toxin in the media itself, resulting in environmental friendly by-products.

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