Sustainable approach for microfibres removal: bacterial cellulose residues

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Abstract

The environmental worry over microplastic morphotypes such as beads and films has been prevalent for a long time; however, microfibres are another important source of microplastic contamination. Microfibres (MFs) are the predominant microplastics type in domestic wastewater effluents, which are considered a focal release point into aquatic systems. Due to the bio-sustainability features of natural flocculants, these are attracting interest. Known for its unique structural properties, bacterial cellulose is a natural extracellular polymer secreted by bacteria, that exhibits tremendous potential in a variety of fields. It was investigated whether bacterial cellulose membranes (BC) and hydrogels (grounded residues of BC) (BCH) could be used to remove MFs from contaminated waters. BC and BCH were assessed for their viability in removing MFs, using response surface methodology (RSM), UV-Vis spectrophotometry, fluorescence, and scanning electron microscopy. Using MFs-contaminated water (2g/L), numerous operational factors impacting MPs flocculation were assessed to simplify the translation to the industry – BCH:MFs ratio, BCH griding time, immersion time, and temperature. BC and BCH revealed a very high MFs removal rate, up to 99.75%, in which the MFs were adsorbed and retained in the biopolymers' network. The effective MFs removal activity is caused by the BC's microporous nature and by the morphological characteristics (high length-to-width ratio) of the MFs, as evidenced by electron and fluorescence microscopy. In conclusion, these results show that BC residues offer a high-performing, environmentally friendly, sustainable option in wastewater treatment.

Keywords: Bacterial cellulose, Biopolymer, Microfibres, Flocculation, Bioremediation

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