Strategy for hydrous microplastic bioremediation: cellulose biopolymer-based hydrogel

Ivana Mendonça[a], Jessica Sousa[a], César Cunha[a], Marisa Faria[a,b], Artur Ferreira[c] , Nereida Cordeiro[a,b]

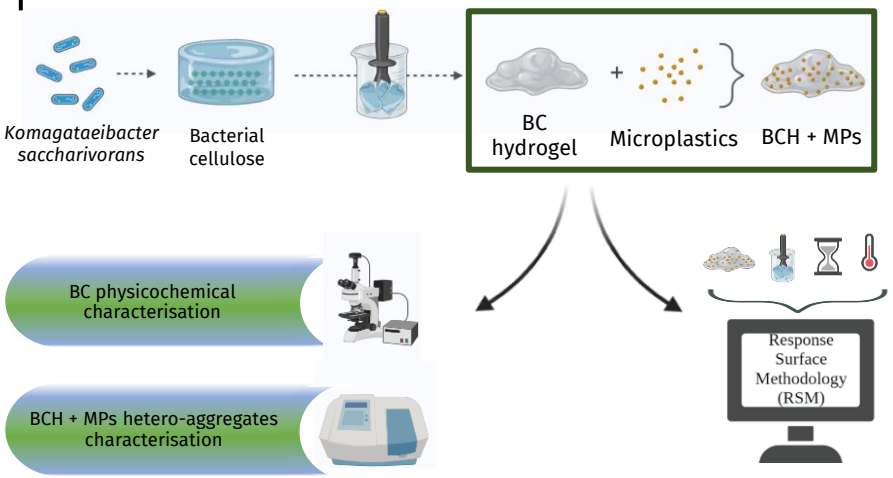
[a] LB3 - Faculty of Science and Engineering, University of Madeira, Portugal
[b] CIIMAR - Interdisciplinary Centre of Marine and Environmental Research, University of Porto, Portugal
[c] CICECO - Aveiro Institute of Materials and Águeda School of Technology and Management, University of Aveiro, Portugal

MICRO 2022 ONLINE ATLAS EDITION

Background and Goals

Nowadays, the drastic environmental damage caused by microplastics (MPs) is of great concern, in which wastewater treatment plants (WWTPs) are considered a focal point for MPs release. Natural flocculants as an alternative to inorganic flocculants, due to their eco-friendly features. Bacterial cellulose (BC), a natural extracellular polymer secreted by bacterial species, presents unique structural features showing vast potential in a wide range of fields. Therefore, bacterial cellulose hydrogel (BCH) was evaluated as a potential bioflocculant for the removal of MPs from contaminated waters.

Experimental Design



Results

$$\text{Flocculation rate (\%)} = -86.2 - 3.12GT + 0.118R + 11.30T + 0.275IT + 0.0566GT^2 - 0.000093R^2 - 0.2478T^2 - 0.001814IT^2$$

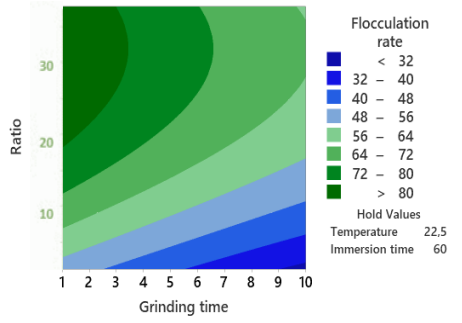


Fig. 1. Contour plot - flocculation rate and equation.

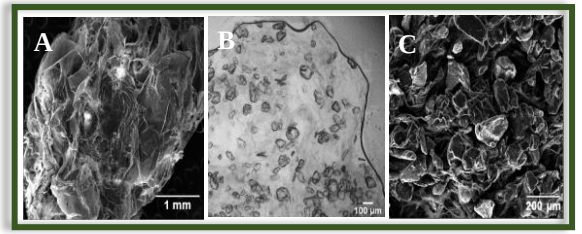


Fig. 2. (A) BCH – SEM; BCH/MPs hetero-aggregate: (A) fluorescence (C) SEM.

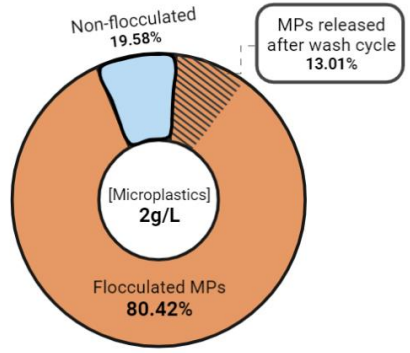
Optimised parameters:

R	GT	IT	T
31.65:1 (w/w)	1 min	76 min	22.9 °C

Max Flocculation: **88.59%**

High resilience (72-81%):

Mixing time	Salinity	pH	Metal ions
(5 min)	(0-37 ‰)	(3-8)	(Fe^{3+}, Ca^{2+}, Mg^{2+}, K^{+})



Conclusions

- BC proves to be a highly efficient bioflocculant, in a wide range of conditions, potentiating its economic viability.
- The stability of the hetero-aggregates allows easier removal and subsequent disposal of MPs, preventing re-entry into the environment.
- BCH carries enormous promise as a potential replacement of synthetic flocculants in wastewater remediation processes.

Acknowledgements:

PCT-MAC 2014-2020 , project REBECA-CCT (MAC/1.1.B/269)
Foundation for Science and Technology for Marisa Faria PhD grant (2020.06615.BD)
Fundação Amadeu Dias under the scope of the programme BYT+, promoted by CIIMAR for Ivana Mendonça's research grant