E3B The Elements of Bioremediation, Biomanufacturing & Bioenergy Metals in Biology

Durham University · University of Kent · Manchester 1824 The University of Manchester · UKRI Biotechnology and Biological Sciences Research Council

PROJECT PARTNERS: Helena Gomes and Konstantina Kourmentza, University of Nottingham and Sumitesh Das, Tata Steel

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University of Nottingham UK | CHINA | MALAYSIA

TATA

Bioflocculants for metal removal and recovery

"This project enabled TATA Steel to utilize the expertise of personnel and equipment at the University of Nottingham to investigate potential options to recover material from several of our waste effluents."

PROJECT AIMS: This project aimed to demonstrate that bioflocculants, in particular extracellular polymeric substances (EPS) derived from bacteria, can be used to remove metals (Zn, Pb, Ni, Cr and V) from industrial wastewaters. In addition, the project assessed potential methods for metal recovery from the flocs – small, loosely aggregated masses of flocculent material separated from the wastewater.

1. The most effective bioflocculants were selected by performing bacterial screening, extraction and characterisation.
2. Metal removal from synthetic and industrial wastewaters was quantified and the selectivity of bioflocculants was assessed.
3. Proof of concept of metal recovery from the flocs produced was provided.

RESULTS:

After characterising EPS derived from *Pseudomonas chlororaphis* DSM 19603, we showed that:

- The flocculation activity of EPS was superior to that of polyacrylamide with kaolin aqueous solution and $CaCl_2$, after 15 mins of settling.
- When multi-metal synthetic wastewater was used, EPS had higher metal removal efficiencies at pH 7 than at pH 2 and 9.
- When multi-metal synthetic wastewater was used, at pH 7 and 1% EPS, 65% of V, 52% of Mn, 52% of Cu, 53% of Zn, and 60% of Cd were removed.
- Metal removal from industrial wastewaters was 97% for Fe, 94% for Ni and 96% for Zn.
- Maximal removal of total suspended solids was 57% with real industrial wastewaters.
- Metal extraction from the used EPS was more efficient with strong acids (HCl and HNO_3), showing potential for Cu and Zn recovery.

Change in technology readiness level: 2 to 3

OUTCOMES & NEXT STEPS:

- Results were presented at the E3B conference 'Bio-recovery of technology-relevant metals' in Dec 2023.
- A fermenter will be used to obtain more bioflocculant to test with other (waste)waters.
- An application to BBSRC responsive mode is planned in 2Q24 on bioflocculant production and to EPSRC responsive mode in 3Q24 on bioflocculants for wastewater treatment and metal recovery.
- A paper is in preparation.

Extracellular polymeric substances used as bioflocculants in research for metal removal and recovery.