Degradation of pharmaceutically active compounds by immobilized *Phanerochaete chrysosporium* under non-sterile condition

Hua Zhong, Xueqing Li , Niranjan Koirala, Keng Seng Lok, Hojae Shim*

Department of Civil and Environmental Engineering, Faculty of Science and Technology, University of Macau, Macau SAR 999078, China

*Email: hjshim@um.edu.mo

Pharmaceutically active compounds (PhACs), classified as micropollutants, have been detected in many water bodies worldwide. Carbamazepine and naproxen are two typical PhACs, difficult to be degraded through the conventional activated sludge process. The white-rot fungus (WRF) *Phanerochaete chrysosporium* is known capable of degrading many PhACs efficiently. However, it is hard to keep a long-term stable reactor performance for WRF considering the bacterial contamination. Therefore, new strategies are required for the stable long-term removal of PhACs from real domestic wastewater using WRF. In this study, the strategy of immobilization was examined for enhancing the performance of *P. chrysosporium* in degradation of carbamazepine and naproxen. Two configurations of reactor were tested for *P. chrysosporium* immobilization and PhACs removal, a rotating suspension cartridge reactor with *P. chrysosporium* immobilized on polyurethane foam cubes and a countercurrent seepage reactor with *P. chrysosporium* immobilized on wood chips or sawdust [1]. The results showed both reactor configurations enhanced the carbamazepine removal efficiency significantly during a continuous cultivation period of ~160 days under non-sterile conditions and the removal mainly occurred biologically [1-5]. Both reactor configurations also suppressed the bacterial contamination effectively [2]. The naproxen removal was also improved by the immobilized *P. chrysosporium* using both reactor configurations [3-6]. The possible mechanisms for these two reactor configurations enhancing degradation of carbamazepine and naproxen include the increased resistance of the immobilized fungi to bacterial contamination [1], the conducive effect of immobilization to the synthesis of extracellular enzyme [3,6], and the efficient availability of nutrient and oxygen to the fungi in both reactors [2,4]. The insights obtained in this study would be of significance for developing new technologies to treat domestic wastewater containing PhACs.

Keywords: carbamazepine; immobilization; naproxen; *Phanerochaete chrysosporium*; pharmaceutically active compounds

Funding: Macau Science and Technology Development Fund (FDCT044/2017/AFJ) and University of Macau Multi-Year Research Grant (MYRG2017-00181-FST)

References

[1] Li, X. et al. Evaluation of different reactor configurations immobilized with *Phanerochaete chrysosporium* on the long-term carbamazepine removal from non-sterile synthetic wastewater. In: Carbamazepine: Indications, Contraindications and Adverse Effects. Nova Science Publishers Inc. 2017, Chapter 4. pp. 91-121.

[2] Li, X. et al. Enhanced carbamazepine removal by immobilized *Phanerochaete chrysosporium* in a novel rotating suspension cartridge reactor under non-sterile condition. International Biodeterioration & Biodegradation, 2016, 115: 102-109.

[3] Li, X. et al. Enhanced removal of naproxen and carbamazepine from wastewater using a novel countercurrent seepage bioreactor immobilized with *Phanerochaete chrysosporium* under non-sterile conditions. Bioresource Technology, 2015, 197: 465-474.

[4] Li, X. et al. Removal of carbamazepine and naproxen by immobilized *Phanerochaete chrysosporium* under non-sterile condition.

New Biotechnology, 2015, 32: 282-289.

[5] Li, X. et al. Establishment and Optimization of a White-rot Fungus *Phanerochaete chrysosporium* Reaction System for the Removal of Naproxen and Carbamazepine from Wastewater. Research Journal of Chemistry and Environment. 2013, 17: 1-6.

[6] De Toledo, R.A. et al. Biological removal of naproxen from non-sterile synthetic wastewater using *Phanerochaete chrysosporium*. In: Naproxen: Chemistry, Clinical Aspects and Effects. Nova Science Publishers Inc. 2018, Chapter 4. pp. 101-131.