PhD Candidate Profile

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Research Group (if relevant): GruPOA – Grupo de Estudos sobre Processos Oxidativos Avançados

Research Centre (if relevant):

Department/School(s) (if relevant): Departamento de Engenharia Sanitária e Ambiental/Escola de Engenharia

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Funding body: CNPq

Area (field) of study: Characterization, prevention, and control of pollution

Thesis Title:

Application of Solar Irradiated Oxidative Processes on the Combat of Antimicrobial Resistance in Municipal Wastewater Treatment Plant Effluent

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Abstract:

Municipal Wastewater Treatment Plant Effluent (MWWTPE) contains thousands of resistant strains that carry numerous genes and their variants. Avoiding the spread of these contaminants to the environment is a public health concern. Therefore, the main goal of this work is to evaluate the use of solar photo-Fenton as an advanced treatment of MWWTPE. The effectiveness of advanced technologies on eliminating antibiotic-resistant bacteria (ARB) and resistance genes (ARG) from wastewaters and, consequently, combating antimicrobial resistance (AMR) spreading. For instance, the effectiveness of solar photo-Fenton in the elimination and inactivation of resistance-conferring plasmids (RCPs) was assessed, as these are important vectors for the dissemination of AMR. As a result, solar photo-Fenton completely removed and inactivated RCPs initially present in both matrixes. These results indicate the potential of solar photo-Fenton to improve wastewater quality and reduce the spread of AMR in the environment by hampering the discharge of cell-free RCPs onto the environment. Besides that, most studies have relied solely on cultivable methods to assess ARB removal. Thus, the analysis of removal of ARB and ARGs in the bench-scale was carried out through the high throughput metagenomics analysis. This is the first study to investigate the effect of solar photo-Fenton upon ARB and ARGs in MWWTPE by 16S rDNA and Whole Genome Sequencing (WGS). As a result, solar photo-Fenton effectively removed the main phyla, ARGs, and achieved the removal of some high-priority pathogens and intrinsically multi-drug ARB. Although these results demonstrate the potential of solar photo-Fenton as an effective complementary treatment for MWWTPE, some gaps still need to be filled. For example, the efficiency of alternative oxidants has not yet been extensively investigated. Therefore, this work also investigated using PS-mediated solar photo-Fenton and a combined oxidant system (H_2O_2 and $S_2O_8^{-2}$) to combat AMR from MWWTPE. The PS-mediated system reached the lowest richness and diversity of the microbial community, along with the effective removal of the main phyla present in MWWTPE. In contrast, the proposed combined system did not significantly impact microbial diversity. Nonetheless, this system led to total DNA fragmentation. Thus, the mechanisms involved in combining these oxidants must be better assessed. As the last stage of the project, the proposed treatments will be evaluated using a CPC-type solar reactor on a semi-pilot scale.

Collaborations:

Prof. Tiago Antônio de Oliveira Mendes - Grupo de pesquisa Biologia Sintética e Modelagem de Sistemas Biológicos – Universidade Federal de Viçosa

Profa. Renata Cristina Picão - Instituto de Microbiologia Paulo de Góes

Prof. Jeppe Lund Nielsen - Environmental Microbiology and Biotechnology – Aalborg University

Publications:

VILELA, PÂMELA B.; STARLING, MARIA CLARA V.M.; MENDONÇA NETO, RONDON P.; DE SOUZA, FELIPE A.R.; PIRES, GIOVANNA F.F.; AMORIM, CAMILA C. Solar photo-Fenton mediated by alternative oxidants for MWWTP effluent quality improvement: impact on microbial community, priority pathogens and removal of antibiotic-resistant genes. CHEMICAL ENGINEERING JOURNAL, v. 441, p. 136060, 2022. doi: 10.1016/j.cej.2022.136060

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VILELA, P. B.; MENDONCA NETO, R. P.; STARLING, M. C. V. M.; MARTINS, A. S.; PIRES, G. F. F.; SOUZA, F. A. R.; AMORIM, C. C. Metagenomic analysis of MWWTP effluent treated via solar photo-Fenton at neutral pH: Effects upon microbial community, priority pathogens, and antibiotic resistance genes. SCIENCE OF THE TOTAL ENVIRONMENT, v. --, p. 149599, 2021. doi: 10.1016/j.scitotenv.2021.149599

VILELA, P. B.; MARTINS, A. S.; STARLING, M. C. V. M.; SOUZA, F. A. R.; PIRES, G. F. F.; AGUILAR, A. P.; PINTO, M. E. A.; MENDES, T. A. O.; AMARAL, C. C. A. Solar photon-Fenton process eliminates free plasmid DNA harboring antimicrobial resistance genes from wastewater. JOURNAL OF ENVIRONMENTAL MANAGEMENT, v. 285, p. 112204, 2021. doi: 10.1016/j.jenvman.2021.112204

Presentations:

5th Iberoamerican Conference on Advanced Oxidation Technologies. Application of Solar photo-Fenton in CPC reactor for the removal of ARB and ARGs from MWWTP effluent. 2022.