Editorial: Efficient Treatment of Industrial Wastewater With Microbiome and Synthetic Biology

frontiers | Frontiers in Environmental Science

EDITORIAL
published: 14 April 2022
doi: 10.3389/fenvs.2022.902926

Editorial: Efficient Treatment of Industrial Wastewater With Microbiome and Synthetic Biology

Shan Jiang[1], *Jinfeng Tang*[2]*, *Shadi Rahimi*[3], *Ivan Mijakovic*[3,4] *and Yongjun Wei*[5,6]*

[1]State Key Laboratory of Estuarine and Coastal Research, East China Normal University, Shanghai, China, [2]Key Laboratory for Water Quality and Conservation of Pearl River Delta, Ministry of Education, School of Environmental Science and Engineering, Linköping University—Guangzhou University Research Center on Urban Sustainable Development, Guangzhou University, Guangzhou, China, [3]Department of Biology and Biological Engineering, Chalmers University of Technology, Göteborg, Sweden, [4]The Novo Nordisk Foundation Center for Biosustainability, Technical University of Denmark, Lyngby, Denmark, [5]Key Laboratory of Advanced Drug Preparation Technologies, Ministry of Education, School of Pharmaceutical Sciences, Zhengzhou University, Zhengzhou, China, [6]Laboratory of Synthetic Biology, Zhengzhou University, Zhengzhou, China

Keywords: industrial wastewater, microbiome, synthetic biology, wastewater treatment, synthetic microbiota

Editorial on the Research Topic

Efficient Treatment of Industrial Wastewater With Microbiome and Synthetic Biology

The development of human civilization depends on a wide range of anthropogenic industries. Expanding industrial activities provide substantial products for our society, but also produce significant volume of wastewater, containing tons of excessive nutrients, organic pollutants (Li et al., 2015) and heavy metals (Qasem et al., 2021). To efficiently remove these anthropogenic pollutants in industrial wastewater, diverse physicochemical strategies, such as adsorption, membrane filtration, photocatalytic reactions, have been applied (Qasem et al., 2021). After decades of study and technical improvement, the application of these classical technologies reaches a relatively stable performance in wastewater treatments and has reduced a wide range of contaminates from industrial effluents. For instance, both conventional (e.g., activated carbons and zeolites) and nanostructured (e.g., fullerenes) absorbents could produce a nearly 90% removal of heavy metal ions in wastewater (Burakov et al., 2018). Despite being very effective in purification, these strategies show many disadvantages, such as high cost and energy consumption, as well as solid waste production from treatments. All these drawbacks bring a significant economy burden for factories and the byproducts likely cause secondary pollution to the environment. Accordingly, the introduction and adoption of microbial and synthetic biology approaches to improve the efficiency of wastewater treatment have received significant attention from researchers globally (Zhang et al., 2021).

The biological strategies, mainly driven by microbial reactions, are effective and environmentally friendly. These biological treatment strategies not only remove pollutants with low investment, but also generate methane and other sustainable natural resources from industrial wastewater, improving the economy benefits for applied factories (Li et al., 2021; Liang et al., 2021). Currently, the microbiota in many wastewater treatments has been investigated, while the information regarding the functional microorganisms, the molecular mechanisms for pollutant degradation, and the ecological network of the microorganisms in the industrial wastewater treatment plant, is still limited (Wei et al., 2020).

Addressing the present knowledge gap, Kumar et al. analyzed the microbial composition within the textile industry wastewater from several wastewater treatment plants in India. They found the dominance of *Aeromonas caviae*, *Desulfovibrio desulfuricans*, *Klebsiella pneumoniae*, etc. during the treating process. They also identified important catalytic enzymes from Pseudomonadaceae and suggested their potential application during the dye degradation process. Jing et al. focused on the

Edited and reviewed by:
Paolo Perona,
Swiss Federal Institute of Technology Lausanne, Switzerland

***Correspondence:**
Jinfeng Tang
jinfeng@gzhu.edu.cn
Yongjun Wei
yongjunwei@zzu.edu.cn

Specialty section:
This article was submitted to Water and Wastewater Management, a section of the journal Frontiers in Environmental Science

Received: *23 March 2022*
Accepted: *29 March 2022*
Published: *14 April 2022*

Citation:
Jiang S, Tang J, Rahimi S, Mijakovic I and Wei Y (2022) Editorial: Efficient Treatment of Industrial Wastewater With Microbiome and Synthetic Biology. Front. Environ. Sci. 10:902926. doi: 10.3389/fenvs.2022.902926

application of fungi in the wastewater treatment process. They performed a series of incubation experiments to identify the removal efficiency of edible fungi residue on lead in wastewater. Together with the significant quantity of fungi residue supply, this might be an effective approach for heavy metal removal in a wide range of industries. Apart from bacteria and fungi, microalgae also play an important role during the wastewater treatment process. Sattayawat et al. examined the biological roles of 49 unique genes and proteins from microalgae during the heavy metal removal. They outlined that the genetic parts within their constructed library could be implemented in synthetic biology-based designs, providing opportunities for microalgae as heavy metal bio-removers globally.

The development of microbiome and synthetic biology provides an insight into the microbiota for complex pollutant removal. Currently, the comparison of industrial-scale wastewater treatment plants is rarely reported, though the microbial inoculation, especially highly efficient strains, among different plants might significantly improve the removal process. More importantly, the development of additional microbiota sources from natural environments, such as oceans and benthic sediments, to wastewater treatment is urgent for dealing with brackish and low carbon supply wastewaters (Mai et al., 2021). Accordingly, Jin et al. described the similarity and difference in nitrogen transformation between wastewater treatments and marine environments. The functional key genes/enzymes and microorganisms in the processing of nitrogen from oceans showed a great potential for adoption in wastewater treatments. Similarly, the further development and introduction of natural or engineered microbiota for complex pollutants in industrial wastewater is of great interest in the future (Zou et al., 2021).

To conclude, the present research topic focuses on the use of microbiome and synthetic biology tools, to recover the pathway/genes/enzymes for enhancing pollutant removal in industrial wastewater. The microbiota, including living microorganisms and residue, used in different types of industrial wastewater was described. Their unique genes and proteins related with contaminant removal in wastewater plants were outlined, and the application potential for synthetic biology-based designs were highlighted. For the future application, the inoculation of pollutant removal microbial strains among different treatment plants should be strongly encouraged. In addition, given the abundant microbial sources in the biosphere (e.g., Jiang et al., 2020, 2021), the selection and introduction of suitable microbial strains from natural environments for dealing with contaminant removal at industrial settings is recommended.

AUTHOR CONTRIBUTIONS

YW and SJ conceived the study. SJ wrote the manuscript. All authors revised the manuscript.

FUNDING

This work was supported by grants from the National Natural Science Foundation of China (Grant Number: 32111530179) to YW, the Science and Technology Program of Guangzhou, China (Grant Number: 202102010401) to JT and the Novo Nordisk Foundation (NNF10CC1016517) to IM.

REFERENCES

Burakov, A. E., Galunin, E. V., Burakova, I. V., Kucherova, A. E., Agarwal, S., Tkachev, A. G., et al. (2018). Adsorption of Heavy Metals on Conventional and Nanostructured Materials for Wastewater Treatment Purposes: A Review. *Ecotoxicology Environ. Saf.* 148, 702–712. doi:10.1016/j.ecoenv.2017.11.034

Jiang, S., Kavanagh, M., Ibánhez, J. S. P., and Rocha, C. (2021). Denitrification-nitrification Process in Permeable Coastal Sediments: An Investigation on the Effect of Salinity and Nitrate Availability Using Flow-Through Reactors. *Acta Oceanol. Sin.* 40, 1–12. doi:10.1007/s13131-021-1811-5

Jiang, S., Zhang, Y., Jin, J., Wu, Y., Wei, Y., Wang, X., et al. (2020). Organic Carbon in a Seepage Face of a Subterranean Estuary: Turnover and Microbial Interrelations. *Sci. Total Environ.* 725, 138220. doi:10.1016/j.scitotenv.2020.138220

Li, W.-W., Yu, H.-Q., and Rittmann, B. E. (2015). Chemistry: Reuse Water Pollutants. *Nature* 528, 29–31. doi:10.1038/528029a

Li, Y., Fu, L., Li, X., Wang, Y., Wei, Y., Tang, J., et al. (2021). Novel Strains with superior Degrading Efficiency for Lincomycin Manufacturing Biowaste. *Ecotoxicology Environ. Saf.* 209, 111802. doi:10.1016/j.ecoenv.2020.111802

Liang, J., Mai, W., Wang, J., Li, X., Su, M., Du, J., et al. (2021). Performance and Microbial Communities of a Novel Integrated Industrial-Scale Pulp and Paper Wastewater Treatment Plant. *J. Clean. Prod.* 278, 123896. doi:10.1016/j.jclepro.2020.123896

Mai, W., Chen, J., Liu, H., Liang, J., Tang, J., and Wei, Y. (2021). Advances in Studies on Microbiota Involved in Nitrogen Removal Processes and Their Applications in Wastewater Treatment. *Front. Microbiol.* 12, 746293. doi:10.3389/fmicb.2021.746293

Qasem, N. A. A., Mohammed, R. H., and Lawal, D. U. (2021). Removal of Heavy Metal Ions from Wastewater: a Comprehensive and Critical Review. *Npj Clean. Water* 4, 36. doi:10.1038/s41545-021-00127-0

Wei, Y., Wu, Y., Zhang, L., Zhou, Z., Zhou, H., Yan, X., et al. (2020). Genome Recovery and Metatranscriptomic Confirmation of Functional Acetate-Oxidizing Bacteria from Enriched Anaerobic Biogas Digesters. *Environ. Pollut.* 265, 114843. doi:10.1016/j.envpol.2020.114843

Zhang, P., Liang, J., Mai, W., Wu, Y., Dai, J., and Wei, Y. (2021). The Efficiency of Integrated Wastewater Treatment Plant for Pollutant Removal from Industrial-Scale Lincomycin Production. *J. Water Process Eng.* 42, 102133. doi:10.1016/j.jwpe.2021.102133

Zou, G., Li, B., Wang, Y., Yin, X., Gong, M., Shang, J., et al. (2021). Efficient Conversion of Spent Mushroom Substrate into a High Value-Added Anticancer Drug Pentostatin with Engineered *Cordyceps Militaris*. *Green. Chem.* 23, 10030–10038. doi:10.1039/D1GC03594K

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.