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Editorial

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Editorial: Antibiotics in Water: Impacts and Control Technologies

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Editorial on the Research Topic

Antibiotics in Water: Impacts and Control Technologies

The extensive application of antibiotics in human and veterinary medications to prevent and treat infections has resulted in the vast discharge of antibiotics into the natural water bodies worldwide. In the present Research Topic, Ncube et al. detected 15 antibiotics in a stream receiving wastewater effluents and dumpsite leachates in South Africa. They further quantified the concentration of some antibiotics: sulfonamides up to 133 ng L^{-1}, flumequine up to 686 ng L^{-1}, diaminopyrimidine and trimethoprim up to 61.8 ng L^{-1}. Antibiotics in the environment could be transferred to human *via* water supply when they are not effectively eliminated in water treatment facilities and *via* food, especially that prepared from aquaculture and livestock products which may experience the high dosage of antibiotics to prevent infections during cultivation. Consequently, antibiotics have been found in human body at a frequency beyond the normal medication intake. For instance, researchers detected 17 antibiotics and three metabolites in 52% of all urine samples from 684 school children in Shanghai, China (Wang et al., 2021).

The exposure of antibiotics can cause some ecotoxicological effects on the aquatic life, such as the genotoxicity and the developmental toxicity to fish (Yang et al., 2020). The long-term impact of the antibiotics on human health is still not clear. Nevertheless, based on their environmental levels and ecotoxicological data, many frequently detected antibiotics may have a risk quotient >1, indicating a high risk to the local ecosystem (Kovalakova et al., 2020). In addition, the frequent occurrence of antibiotics also leads to the development of antibiotic resistance genes (ARGs) in microorganisms. ARGs can be transferred across different habitats species, e.g., from environmental microbes to human body microbiota, from nonpathogens to pathogens (Zhang et al., 2022). As a result, human beings would be confronted with the ineffectiveness of existing antibiotics and the interminable search for new antibiotics. Thus, antibiotics and ARGs in the environment should be properly controlled.

To control the presence of antibiotics and ARGs in the environment, effective water treatment technologies are required. Great research efforts have been made on the development of such technologies, among which oxidation processes are widely investigated. The processes are usually based on strong oxidative species than can effectively degrade the antibiotic molecules and inactivate the antibiotics resistant bacteria (ARB) and their ARGs. It should be noted that various other contaminants co-exist with antibiotics and ARGs, such as pharmaceuticals, industrial additives, nutrients, inorganic ions. When developing treatment technologies for ARB and ARGs, one also should consider those co-existing contaminants. In the present Research Topic, Spit et al. demonstrated the effectiveness of ozonation, coagulation and granular activated carbon (GAC)

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filtration to eliminate emerging organic contaminants (EOCs) and ARGs in a secondary effluent which is an important entry of those contaminants into the environment. They found that more ozone (2.5–4 times) should be added to achieve 2–3 log removal of ARGs than the dosage required for the removal of EOCs. For chlorination as another widely applied disinfection process, researchers also found that a high dosage of free chlorine was required for an effective removal of ARGs (Stange et al., 2019). As a promising AOP, UV/TiO_2 photocatalytic process has been demonstrated by Cai and Hu (2018) to remove antibiotics efficiently in wastewater and the promotion of ARGs by treated antibiotics and their intermediates in subsequent biological process has not been found. However, during those processes, some transformation products (TPs) of EOCs can be generated, which might be more harmful than their parent molecules. In the present Research Topic, Zhai et al. found that the toxicity of sucralose can be significantly elevated after chlorination, chloramination, and UV treatment, possibly due to the formation of toxic TPs. On the other hand, some TPs of antibiotics and EOCs can also be formed in natural water bodies via biodegradation and abiotic reactions like photolysis. It should be noted that although the photolysis kinetics is mostly low, the presence of organic matters may largely enhance the reaction kinetics (Li et al., 2021).

Therefore, we call for more attentions toward the negative impacts of single and mixed TPs of antibiotics which are frequently generated during the popular technical systems (e.g., ozonation, chlorination, photocatalysis) and the natural degradation processes (e.g., photolysis with the presence of organic and inorganic matters).

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

REFERENCES

Cai, Q., and Hu, J. (2018). Effect of UVA/LED/TiO_2 Photocatalysis Treated Sulfamethoxazole and Trimethoprim Containing Wastewater on Antibiotic Resistance Development in Sequencing Batch Reactors. *Water Res.* 140, 251–260. doi:10.1016/j.watres.2018.04.053

Kovalakova, P., Cizmas, L., McDonald, T. J., Marsalek, B., Feng, M., and Sharma, V. K. (2020). Occurrence and Toxicity of Antibiotics in the Aquatic Environment: A Review. *Chemosphere* 251, 126351. doi:10.1016/j.chemosphere.2020.126351

Li, J., Zhao, L., Feng, M., Huang, C.-H., and Sun, P. (2021). Abiotic Transformation and Ecotoxicity Change of Sulfonamide Antibiotics in Environmental and Water Treatment Processes: A Critical Review. *Water Res.* 202, 117463. doi:10.1016/j.watres.2021.117463

Stange, C., Sidhu, J. P. S., Toze, S., and Tiehm, A. (2019). Comparative Removal of Antibiotic Resistance Genes during Chlorination, Ozonation, and UV Treatment. *Int. J. Hyg. Environ. Health* 222 (3), 541–548. doi:10.1016/j.ijheh.2019.02.002

Wang, H., Tang, C., Wang, Y., Han, M., Jiang, F., Jiang, L., et al. (2021). Urinary Antibiotic Level of School Children in Shanghai, East China, 2017-2020. *Environ. Pollut.* 291, 118167. doi:10.1016/j.envpol.2021.118167

Yang, C., Song, G., and Lim, W. (2020). A Review of the Toxicity in Fish Exposed to Antibiotics. *Comp. Biochem. Physiology Part C Toxicol. Pharmacol.* 237, 108840. doi:10.1016/j.cbpc.2020.108840

Zhang, Z., Zhang, Q., Wang, T., Xu, N., Lu, T., Hong, W., et al. (2022). Assessment of Global Health Risk of Antibiotic Resistance Genes. *Nat. Commun.* 13 (1), 1553. doi:10.1038/s41467-022-29283-8

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