Occurrence, distribution and ecological risk of antibiotics in wastewater treatment plants around Luoma Lake, China

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**Background:** Massive antibiotics have been produced continuously and employed extensively in biomedicine, aquaculture and animal husbandry in decades. The resulting large amount of production wastewater and domestic sewage is eliminated through wastewater treatment plants (WWTPs). However, due to the limited ability to remove pollutants of WWTPs, the discharged effluent has become an important source of antibiotics in the aquatic environment of the lake, which subsequently causes harm to the lacustrine ecosystem. This work focused on antibiotic contamination in the effluent of WWTPs around Luoma Lake of China, analyzes the occurrence and distribution of typical antibiotics, and evaluates their ecological risk. The aim of this work is to explore the sources of antibiotics in the lake and provide some supports for the prevention and control of antibiotic pollution in the lakes.

**Methods:** Water samples were collected in December 2021 from the discharged effluent of 11 WWTPs (CQ, YW, QP, CL, XH, ZD, ZC, TF, ST, YQ and RS) around Luoma Lake. All samples were analyzed using solid-phase extraction (SPE) and UPLC-MS/MS to explore the concentration, spatial distribution characteristics and ecological risk of the 26 representative antibiotics: 9 Sulfanilamides (SAs) of Sulfadiazine (SDZ), Sulfamethoxazole (SMZ), Sulfathiazole (ST), Sulfamethazine (SMT), Sulfamonomethoxine (SMM), Trimethoprim (TMP), Sulfaquinoxaline (SQX), Sulfadimethoxine (SMX) and Sulfacetamide (STM), 7 Quinolones (QNs) of Norfloxacin (NOR), Ciprofloxacin (CIP), Lomefloxacin (LOM), Enrofloxacin (ENR), Ofloxacin (OFL), Flerofloxacin (FLX) and Difloxacin (DIF), 5 Macrolides (MLs) of Lincomycin (LIN), Erythromycin (ETM), Azithromycin (AZI), Roxitromycin (RTM) and Tylosin (TYL), 4 Tetracyclines (TCs) of Doxycycline (DOC), Tetracycline (TC), Oxytetracycline (OTC) and Chlortetracycline (CTC), as well as Chloramphenicols (CHs) of Thiamphenicol (TAP).

**Results:** The total concentrations of 26 antibiotics in the effluent of the 11 WWTPs ranged from 35.38~1857.01 ng·L-1. Wherein the concentration of SAs, QNs, MLs, TCs and TAP were 4.81~433.18 ng·L-1, 2.06~823.97 ng·L-1, 27.25~520.3 ng·L-1, 0.61~79.56 ng·L-1 and 0.68~1.75 ng·L-1, separately.

**Conclusions:** Spatially, antibiotic contamination of effluent from 11 WWTPs was as follows: XH > ZC > QP > YW > CL > ZD > CQ > TF > YQ > ST > RS. Ecological risk assessment indicated that SMZ and STZ were the dominant risk contributors to daphnia, with the remaining antibiotics in the effluent samples posing low to moderate risk to all green algae, daphnia and fish. Improving the removal efficiency of antibiotics from WWTPs and controlling the discharge of effluent to lakes are effective measures to prevent lake pollution.