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A preliminary study on the occurrence and behavior of sulfonamides, ofloxacin and chloramphenicol antimicrobials in wastewaters of two sewage treatment plants in Guangzhou, China

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Abstract

Wastewater samples collected from two sewage treatment plants (STPs) in Guangzhou, China were acidified, solid-phase extracted (SPE) with Oasis HLB cartridges, followed by instrumental measurement by high performance liquid chromatography (HPLC) coupled with a diode array UV detector (DAD) and a fluorescence detector (FLD) for the occurrence and fate of antimicrobial compounds sulfadiazine (SDZ), sulfamethoxazole (SMX), ofloxacin (OFX) and chloramphenicol (CAP). Antimicrobials have been detected at 5.10–5.15, 5.45–7.91, 3.52–5.56 and 1.73–2.43 μg L^{-1} for SDZ, SMX, OFX and CAP in the raw sewages of the two STPs, respectively. The concentrations of antimicrobials do not show substantial changes after preliminary mechanical sedimentation. No quantifiable sulfonamides and chloramphenicol have been identified, and >85% of ofloxacin has been removed in the effluents after activated sludge treatment in the two STPs, indicating that activated sludge treatment is effective and necessary to remove antimicrobial substances in municipal sewage.

Keywords: Antimicrobials; Wastewater; Sewage treatment plants (STPs); Solid-phase extraction (SPE); HPLC-DAD-FLD; China

1. Introduction

The occurrence of antimicrobial compounds in aquatic environment and the potential ecological risks have drawn increasing concerns (Halling-Sorensen et al., 1998; Daughton and Ternes, 1999; Erickson, 2002; Heberer, 2002; Richardson, 2003). The recognized negative effects of antimicrobials in environment to date include development of antibacterial resistance among organism (Halling-Sorensen et al., 1998, 2002; Baguer et al., 2000; Wollenberger et al., 2000; Golet et al., 2002) and some direct toxicity to micro-organisms (Kummerer et al., 2000; Halling-Sørensen et al., 2003). Antimicrobials are widely used to prevent and to treat bacterial infections by human and animals, as well as promote growth in agriculture and aquaculture. These compounds and/or their metabolites find their way to environment via a variety of routes after they have been used and subsequently excreted by human and animals. Antimicrobial compounds have been detected widely in raw sewage, sewage treatment plants

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(STPs) effluents, surface water and even groundwater in Europe and North America (Holm et al., 1995; Ternes, 1998; Ternes et al., 2001; Sacher et al., 2001; Kolpin et al., 2002, 2004; McArdell et al., 2003; Gobel et al., 2004, 2005; Miao et al., 2004; Thomas and Hilton, 2004; Yang and Carlson, 2004).

Most antimicrobials are nonvolatile, hydrophilic and polar compounds. They present in aquatic environment usually at concentrations of microgram and/or submicrograms per liter. Therefore, it is not an easy work to determine antimicrobial compounds in waters, especially in wastewaters that are very complex matrices. Up to now, a number of methods have been available for the analysis of antibiotics in environmental samples, most of them involved of liquid chromatography–mass spectrometry (LC/MS) and liquid chromatography–tandem mass spectrometry (LC/MS/MS) (Lindsey et al., 2001; Ternes et al., 2001; Miao et al., 2004; Gobel et al., 2004; Yang and Carlson, 2004; Dýaz-Cruz and Barcelo, 2005). These methods have been successfully used to investigate the occurrence and behavior of antibiotics in waters in Europe and North America (Gobel et al., 2004; Miao et al., 2004; Thomas and Hilton, 2004; Yang and Carlson, 2004). HPLC coupled with UV and/or fluorescence detections is also a sensitive alternative approach to quantify trace levels of antibiotics that respond well to UV and/or fluorescence detections (Golet et al., 2001; Prat et al., 2004; Hermo et al., 2006; García-Mayor et al., 2006). Furthermore, it is relatively simple, less expensive and currently much more easily accessible in developing countries like China.

Sulfonamides (SAs) and fluoroquinolones (FQs) are widely used antimicrobials by both human and animals. SAs are known to have a high potential to resist degradation and are hydrophilic enough to be transferred into the aquatic environment (Holm et al., 1995; Kummerer, 2001; Miao et al., 2004), posing an especially potential hazard to the health of aquatic organism and human. Detailed knowledge of the environmental occurrence and behavior of these antimicrobials must be helpful to properly assess their ecological risks. To achieve this aim, investigations on the occurrence and fate of antimicrobial compounds in municipal wastewaters become essential because municipal wastewaters represent a significant contribution to the presence of antimicrobials in various aquatic environment as they are primary pathways of continuous entry of antibiotics into environment due to potentially incomplete elimination during treatments in

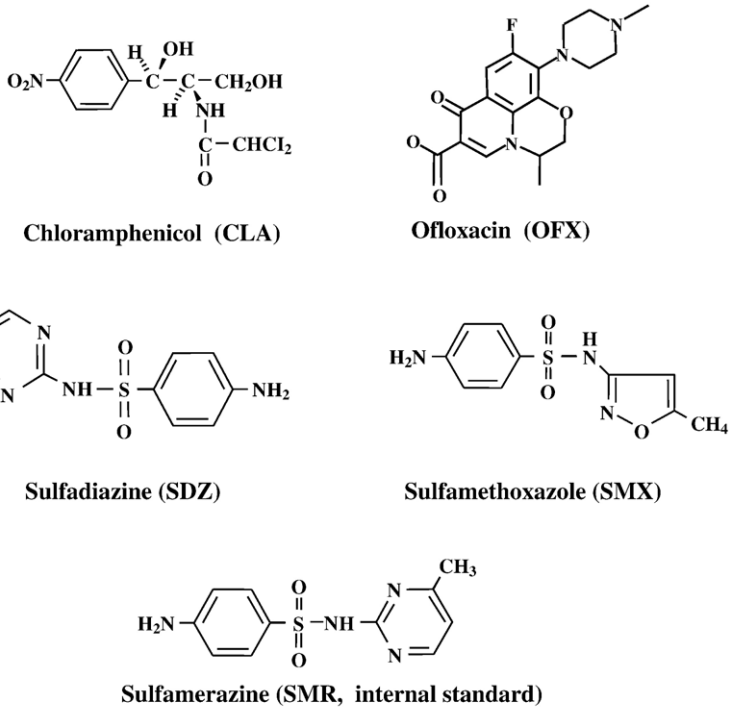

Fig. 1. Molecular structures of the selected antimicrobial compounds in this study.