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Prevalence and risk assessment of antibiotics in riverine estuarine waters of Larut and Sangga Besar River, Perak*

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Abstract Antibiotics released into the environment through anthropogenic activities exert selective pressure, driving bacteria towards increasing antimicrobial resistance. The prevalence of antibiotics and the ecological risks posed in the riverine estuarine of Larut River and Sangga Besar River, which included wastewater effluents from hospital, zoo, and poultry slaughterhouse sources were investigated. Solid phase extraction (SPE) followed by high-performance liquid chromatography tandem mass chromatography (HPLC-MS/MS) were used to extract and quantify the antibiotic residues from 22 antibiotics belonging to six major antibiotic classes (sulfonamide, macrolide, fluoroquinolone, phenicol, trimethoprim, and tetracycline). Sixteen antibiotic residues were detected with concentrations ranging from limit of detection (LOD) to 1 262.3 ng/L. Fluoroquinolones and macrolides were the most frequently detected compounds. Erythromycin, clarithromycin, and ofloxacin detected in hospital and zoo effluents posed a high risk to algae while tetracycline had low to medium ecological risks toward all the relevant organisms from aquatic environments (algae, invertebrate *Daphnia magna*, and fish).

Keyword: antibiotic residues; prevalence; ecological risk; anthropogenic pollution; riverine; estuarine

1 INTRODUCTION

Antibiotic residues as an emerging contaminant generated several environmental risk implications in recent years due to its increased consumption rate in human and animal sectors (Cabello, 2006; Zhang et al., 2012; van Boeckel et al., 2014). Deaths related to antimicrobial resistance (AMR) is currently estimated at 700 000 annually but could rise to approximately 10 million annually and potentially cost US$ 100 trillion in lost economic output by the year 2050 (O'Neill, 2016). According to the National Surveillance on Antibiotic Utilization (NSAU) program of Malaysia, the mean defined daily doses' (DDD) per 1 000 patient days for antibiotic utilization in hospital wards showed an overall upward trend (Ministry of Health Malaysia, 2017b).

The concern arising from this emerging contaminant lies in the considerable amount of antibiotics and its partially metabolized products being expelled through pharmaceutical, healthcare, agriculture, aquaculture and poultry industries (Iglesias et al., 2013; Lundborg and Tamhankar, 2017). Constant input paired with multiple contamination sources had led to pseudo-persistent antibiotics in an environment (Houtman et al., 2004). The primary risk arising from misuse and overuse of antibiotics is its ability to culminate the development of AMR in both pathogenic and non-pathogenic bacteria (Cabello et al., 2016; Zarfel et al., 2017; Pérez Gaudio et al., 2018; Divya and Hatha, 2019) while the secondary risk involves altering the

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