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Occurrence and potential human health risk of pharmaceutical residues in drinking water from Putrajaya (Malaysia)

Sarva Mangala Praveena[a,*], Maizatul Zahirah Mohd Rashid[a], Fauzan Adzima Mohd Nasir[a], Wee Sze Yee[b], Ahmad Zaharin Aris[b]

[a] Department of Environmental and Occupational Health, Faculty of Medicine and Health Science, Universiti Putra Malaysia, 43400, UPM, Serdang, Selangor, Malaysia
[b] Department of Environmental Sciences, Faculty of Environmental Studies, Universiti Putra Malaysia, 43400, Serdang, Selangor, Malaysia

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ABSTRACT

Occurrence of pharmaceutical residues in drinking water has been widely reported in countries that have registered steady economic growth. This can exert concerns among the general consumers, prompting them to explore the potential human health risks associated with continuous exposure to pharmaceuticals. However, such an occurrence is rarely reported in developing or under-developed countries. To give more contexts, this study looked at the presence of nine pharmaceutical residues in drinking water (amoxicillin, caffeine, chloramphenicol, ciprofloxacin, dexamethasone, diclofenac, nitrofurazone, sulfamethoxazole, and triclosan) at Putrajaya residential area in Malaysia. Additionally, the potential health risks associated with contaminated drinking water were investigated. This study has found the presence of pharmaceutical residue concentrations up to 0.38 ng/L, with the highest concentration of caffeine (0.38 ng/L) and the lowest concentration of diclofenac (0.14 ng/L). In comparison, all the nine pharmaceutical residues were substantially lower than previously reported studies. In general, Hazard Quotient (HQ) values indicated that low potential health hazards were present for all age groups. Nevertheless, quantitative occurrences of pharmaceutical residues in drinking water will help guide future toxicological studies to examine other chronic effects, while canvassing for proper framework to look into the water risk management and regulation in Malaysia.

1. Introduction

Environmental pollution studies raise the concern that pharmaceutical residues may pose a health risk to people (Simazaki et al., 2015a,b). The global rapid pharmaceutical industries are driven by small and multinational companies with an estimated expense of 1.5 trillion USD by 2021 (Johannes Rauschnabel, 2018). Many of these companies, including Malaysia, have shifted their manufacturing operations from developed countries to Asian countries at an average rate of 12.5%. This move is generally preferred by international companies due to lower production costs, easier clinical trials, and socio-economic factors affecting healthcare systems (Malaysian Investment Development Authority, 2013; Saif et al., 2015). A sustained increase in investments from multinational pharmaceutical companies in Malaysia will turn Malaysia into one of the largest pharmaceutical producers and exporters worldwide (Malaysian Investment Development Authority, 2013).

The presence of pharmaceutical residues in environmental matrixes is attributed to pharmacological effluent discharge, municipal wastewater effluent from households and hospitals, inappropriate disposals of expired pharmaceuticals and veterinary drugs runoff from livestock farming (Wee and Aris, 2017; Praveena et al., 2018). Noticeably, most of the pharmaceutical residues have been documented in water matrixes, such as surface water (Metcalfe et al., 2003; Schneider et al., 2005; Calisto et al., 2011; Tuc Dinh et al., 2011; Simazaki et al., 2015a,b), groundwater (Jennifer et al., 2017; Weber et al., 2014) and drinking water (Watkinson et al., 2009; Gaffney et al., 2015; Białk-Bielińska et al., 2016) from developed countries, namely Japan, Canada, Korea, the United States, France, Spain and the United Kingdom. Limited study reports on pharmaceutical residues quantification in developing countries were primarily driven by surface water (Praveena et al., 2018) and wastewater (Tran et al., 2014; Al-Odaini et al., 2013) from China, Malaysia, Vietnam and India. However, up to this day, reports are scarce throughout developing countries (Leung et al., 2013). Most of the pharmaceutical studies from developing countries were more focused on occurrences of pharmaceutical residues in raw drinking water supply (surface water). In developing countries, including Malaysia, highly stable pharmaceutical compounds in

* Corresponding author.
E-mail address: smpraveena@upm.edu.my (S.M. Praveena).

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