Active pharmaceutical ingredients in Malaysian drinking water: consumption, exposure, and human health risk

ABSTRACT

Active pharmaceutical ingredients (APIs) are typical endocrine disruptors found in common pharmaceuticals and personal care products, which are frequently detected in aquatic environments, especially surface water treated for drinking. However, current treatment technologies are inefficient for removing emerging endocrine disruptors, leading to the potential contamination of tap water. This study employed an optimized analytical method comprising solid-phase extraction and liquid chromatography-tandem mass spectrometry (SPE-LC-MS/MS) to detect APIs in tap water in Putrajaya, Malaysia. Several therapeutic classes of pharmaceuticals and personal care products, including anti-inflammatory drugs (dexamethasone and diclofenac), antibiotics (sulfamethoxazole and triclosan), antiepileptics (primidone), antibacterial agents (ciprofloxacin), beta-blockers (propranolol), psychoactive stimulants (caffeine), and antiparasitic drugs (diazinon), were detected in the range of < 0.03 to 21.39 ng/L, whereas chloramphenicol (an antibiotic) was below the detection limit (< 0.23 ng/L). A comparison with global data revealed the spatial variability of emerging tap water pollutants. Diclofenac accounted for the highest concentration (21.39 ng/L), followed by triclosan and ciprofloxacin (9.74 ng/L and 8.69 ng/L, respectively). Caffeine was observed in all field samples with the highest distribution at 35.32%. Caffeine and triclosan exhibited significantly different distributions in household tap water ($p < 0.05$). Humans are exposed to these APIs by drinking the tap water; however, the estimated risk was negligible (risk quotient < 1). APIs are useful water quality monitoring indicators for water resource conservation and water supply safety related to emerging organic contaminants; thus, API detection is important for safeguarding the environment and human health.

Keyword: Pharmaceuticals; Endocrine disruptor; Tap water; Drinking water; Human health risk assessment; Risk quotient