Sustainable Environment Research 26 (2016) 20–27

Contents lists available at ScienceDirect

Sustainable Environment Research

journal homepage: www.journals.elsevier.com/sustainable-environment-research/

Original research article

Presence of e-EDCs in surface water and effluents of pollution sources in Sai Gon and Dong Nai river basin

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ARTICLE INFO

Article history:
Received 17 March 2015
Received in revised form
21 July 2015
Accepted 5 September 2015
Available online 5 April 2016

Keywords:
e-EDCs
LC-MS/MS
Surface water
Water pollution sources
EEQ

ABSTRACT

This study aimed to assess the presence of estrogenic endocrine disrupting compounds (e-EDCs) including estriol, bisphenol A (BPA), atrazine (ATZ), octylphenol, octylphenol diethoxylate, octylphenol triethoxylate, nonylphenol, Nonylphenol triethoxylate (NPE3), nonylphenol diethoxylate (NPE2) and 17β-estradiol in: (i) Sai Gon and Dong Nai river waters which have been major raw water sources for drinking water supply for Ho Chi Minh City (HCMC) and neighbouring provinces, and (ii) water pollution sources located in their catchment basin. NPE3 and NPE2 were detected in most of the surface water samples. Concentrations of NPE3 were in a range of less than 5.9–235 ng L^{-1}, whereas BPA was detected at significantly high concentrations in the dry season in canals in HCMC. In the upstream of Sai Gon and Dong Nai Rivers, ATZ concentrations were observed at water intake of water treatment plants served for HCMC water supply system. Similarly, high potential risk of NPE2 and NPE3 contamination at Phu Cuong Bridge near Hoa Phu water intake was identified. The significant correlation between NPE2, dissolved organic carbon and total nitrogen was found. Estrogenic equivalent or estrogenic activity of Sai Gon and Dong Nai Rivers was lower than those of the previous studies. Compared with other studies, e-EDCs of pollution in Sai Gon river basin were relatively low.

1. Introduction

Endocrine Disrupting Compounds (EDCs) are compounds of natural or synthetic origin. When EDCs enter the body, they cause negative effects on endocrine systems of humans and wildlife [1]. Estrogenic EDCs (e-EDCs) are subclass of EDCs. e-EDCs are chemicals which mimic or induce estrogen-like response in an organism [1]. Many e-EDCs could lead to an estrogenic response at very low concentrations (ppb to ppt) [1]. These e-EDCs have been found in wastewater, surface waters, sediments, groundwater, and even drinking water [2].

Vietnam has 68 water supply companies for civil activities, services and industries of urban areas with 70% of water supply companies using surface water and 30% of them groundwater [3]. Sai Gon and Dong Nai rivers play an important role in the water supply system for the cities in this basin. However, Sai Gon river is polluted by organic matters in terms of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) [4] that exceed the limits of raw surface water quality standards for water supply (column A2 QCVN 08:2008/BTNMT [5]).

In addition, e-EDCs were observed by Le [6] and the concentrations of e-EDCs of water samples taken in Saigon river and canals in Ho Chi Minh City (HCMC) were 0.02–6.2 E2 (17β-estradiol) eq ng L^{-1} in the dry season and 0.33 to 1.17 E2 eq ng L^{-1} in the wet season. Caldwell et al. [7] determined a PNEC (Predicted No Effect Concentration) in surface water to be 0.35 ng EE2 (17a-ethynylestradiol) L^{-1}. Parrott and Blunt [8] proposed that an estrogen concentration of less than 1 ng L^{-1} in surface water could cause reproductive problems in some fish species. Thus, the Sai Gon river and canals in the HCMC may pose potential risks to aquatic organisms [6]. To date, information on e-EDCs in upstream and pollution point sources in Sai Gon and Dong Nai river basins is insufficient to assess potential risks. Hence, this study aimed: (i) to

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Peer review under responsibility of Chinese Institute of Environmental Engineering.

http://dx.doi.org/10.1016/j.serj.2015.09.001

investigate the concentrations of e-EDCs in the surface water and effluents from potential water pollution sources in Sai Gon and Dong Nai river basins; and (ii) to determine correlation among e-EDCs and physico-chemical parameters including dissolved organic concentration (DOC), total nitrogen (TN), dissolved oxygen (DO), Electrical Conductivity (EC), pH, ammonia, total phosphorus (TP) and turbidity.

2. Materials and methods

2.1. Sampling

The surface water samples were collected from the upstream of Sai Gon River which originates from Dau Tieng reservoir to Hoa Phu water intake and Dong Nai River upstream which starts from Tri An reservoir to Hoa An Water Intake. These samples were collected in April 2013 (dry season) and September 2013 (wet season). Surface water samples were taken in the middle of the river or its branches or at the points far from the river bank with minimum distance of 5 m. The sampling locations are shown in Fig. 1.

EDCs of effluent from pollution point sources and non-point sources from agricultural activities in Sai Gon river basin were tested. The location of the pollution sources is presented in Fig. 2. The point sources included an industrial park, a tannery factory, a paper mill factory, two rubber latex processing factories and a municipal landfill. The non-point sources were from agricultural activities including effluent from a biogas digester of household-scale pig farm, surface run-off water from rice paddy field, and two irrigation canals at Thai My Commune – Cu Chi District. Samples were contained in amber glass bottles and stored in the ice box during transportation to the laboratory in HCMC University of Technology and preserved at 4 °C before analysis.

2.2. Analytical methods

The physico-chemical parameters including pH, EC, DO, turbidity and ammonium were analyzed according to Standard Methods [9]. DOC was measured using Shimadzu Total Organic Carbon Analyser (TOC-$V_{VPH/CPN}$ model). TN was determined using the TOC-$V_{VPH/CPN}$ analyser with Total Nitrogen Unit TNM-1.

To analyze e-EDCs, suspended solids in the samples were removed using paper filters with pore size of 0.7 μm (GF/F, Whatman). The volume for extraction depends on type of water sample. 250 mL of surface water and 100 mL of wastewater were used for extraction. pH value of water sample was adjusted to 6.0–8.0 by using 5% NaOH solution or 5% orthophosphoric acid solution [10].

The solid phase extraction procedure was similar to that described by Gomez et al. [11]. Oasis hydrophilic–lipophilic balance cartridges (60 mg 3 mL^{-1}, from Waters, Guyancourt, France) installed on a vacuum manifold were used in this study. Cartridges were conditioned with 1 mL MeOH and 1 mL of ultra-pure water. Samples were passed through at a flow rate of 3 mL min^{-1}. The

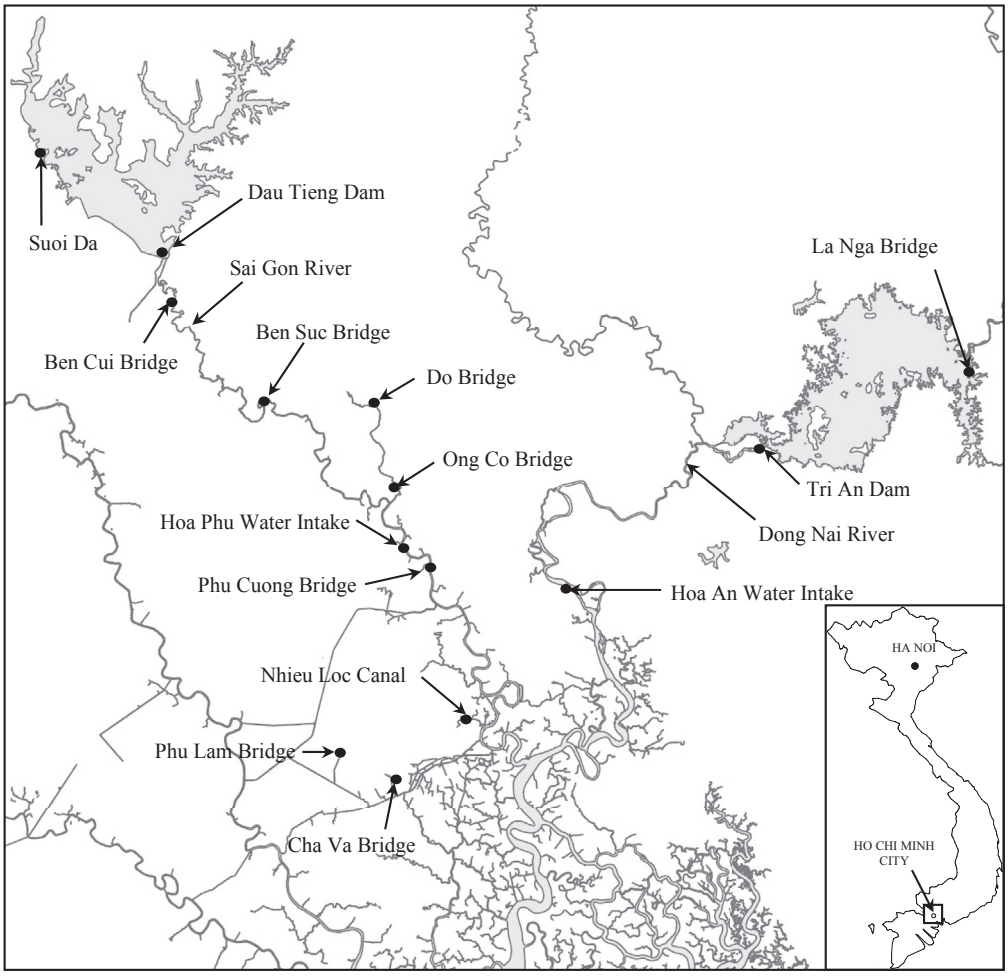

Fig. 1. Map of surface water sampling sites in Sai Gon – Dong Nai river basin.