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Baseline

Distribution pattern of persistent organic pollutants in aquatic ecosystem at the Rosetta Nile branch estuary into the Mediterranean Sea, North of Delta, Egypt

Moustafa Mohamed Saleh Abbassy

Department of Environmental Studies, Institute of Graduate Studies & Research, Alexandria University, 163 Horreya Avenue, Chatby, 21526 Alexandria, Egypt

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ABSTRACT

The objective of this study was to evaluate the distribution pattern of persistent organic pollutants in water, sediment and aquatic biota represented by *Oreochromis niloticus* and *Donax trunculus* at the Rosetta Nile branch estuary. α-HCH, p,p′-DDE and polychlorinated biphenyls were the predominant compounds detected at ranges of 0.54–4.90 ng/l water, 0.75–2.41 ng/g, d. wt. sediment and 2.19–28.11 ng/g, fresh wt. biota. β and γ-HCHs, endosulfan compounds, heptachlor and heptachlor epoxide were at low detection frequencies. Totally, the organochlorine pollutants were at high levels and abundances in *Donax* spp. than in *Tilapia* spp. followed by sediment and water. These levels were ranged between lower and higher than those found by the other studies established in Egypt, and well below its tolerable residue levels in fish. A correlation was found for the quantified pollutants between water, sediment and biota. This is clearly reflecting the bioaccumulation properties of these compounds.

In the aquatic environment, sediment is of major importance for the cycling of environmental pollutants. It is considered the ultimate sink for many classes of anthropogenic contaminants including persistent organic pollutants (POPs) where accounting a high risk of significant ecological effects. (Liu et al., 2017). So, the simultaneous exposure of fish and another aquatic biota to multiple environmental pollutants leads to different alterations in concentrations causing adverse effects to aquatic organisms. More accumulation and biomagnification has been occurred by aquatic biota, hence, using such organisms (e.g., fish and oyster) are good bioindicators for contaminant loads in coastal and estuarine systems have many advantages as they are concentrating many chemicals in their tissues. In addition, either fish or most of the oysters are of commercial interest and measuring the chemical contaminants in them is of public interest. So, measures should be taken in order to prevent their occurrence and toxic effects (Schafer et al., 2015 and Barni et al., 2016).

The occurrence of the organic pollutants, mainly POPs is the reported major in the aquatic environment pollution of which released into water bodies from a large variety of anthropogenic sources such as industrial, agricultural and municipal waste effluents, atmospheric deposition, coastal activities, maritime transport and accidental spill (Tolosa et al., 2010; Montuori et al., 2016). Many studies have been carried out for monitoring of organic pollutants and their various impacts on different aquatic ecosystems around the Mediterranean region. From these studies are: Kucuksezgin and Gonul (2012); Syakti et al. (2012); Verhaert et al. (2013); Cai et al. (2014); Akan et al. (2015); Gupta et al. (2016); Maurya and Malik (2016); Teklit (2016); Brown et al. (2017); Galatchi et al. (2017). In Egypt, although the use of organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs) has been legally banned for more than three decades, many studies indicated that, the widespread of these contaminants along the Mediterranean coast mainly at the river estuaries sites is due to the discharged of untreated effluents from industrial, agricultural and municipal activities. Also, Nasr et al. (2009) detected PCBs and OCPs such as HCHs, DDTs and cyclodienes in fresh and drainage water, sediment and fish at El Menofiya governorate. El-Bouraie et al. (2011) determined chlorinated hydrocarbon residues in surface water and bed sediment samples from El-Rahawy drain. Salah El-Dien and Mahmoud (2011) detected OCPs and PCBs in Nile Tilapia (*O. niloticus*) and Mullet (*Mugil cephallus*) at Sharkia governorate. Barakat et al. (2012a, b, and 2013a, b) monitored persistent organic pollutants in surface sediment in Egyptian lakes and different Mediterranean sea locations. Yahia and EL-Sharkawy (2013) detected certain of OCP residues and PCBs in Nile catfish and Tilapia in Assiut. Dahshan et al. (2016) identified certain residues of organochlorine and organophosphorus pesticides in water of the Nile River.

The Mediterranean coast of Egypt with different inland and offshore activities, the estuaries of the Nile, at Rosetta and Damietta, and the

E-mail address: moustafabbassy@gmail.com.

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Fig. 1. Satellite map representing the sampling sites at Rosetta estuary into the Mediterranean coast of Egypt.

coastal lakes; Maryut, Idku, Burullus, Manzalah and Bardawil carries a heavy load of pollutants with its discharged water into the Mediterranean sea. The Rosetta branch runs for about 220 km in length with average width 180 m and with a depth reaching to about 16.0 m. The Rosetta branch is delimited by a barrage for controlling water discharge at Edfina City, 30 km before its connection with the Mediterranean Sea at Rosetta region, north of delta, Egypt. Unfortunately, it receives daily huge quantities of polluted waters from different sources including industrial, agricultural and urban sewage besides fish cages feeding waste that are causing serious negative impacts on the aquatic environment. (Abdel-Satar and Elewa (2001) and Elewa et al. (2009). Therefore, the objective of this study is to evaluate the distribution pattern of some persistent organic pollutants of OCPs and PCBs in surface water, sediment and aquatic biota before and outside the Rosetta Nile branch mouth discharging into the Mediterranean Sea, during July–September 2017.

The sampling sites were selected to be representative for the study area of the Rosetta branch estuary into the Mediterranean Sea, north of delta, Egypt (Longitude: 30 21 33 E – Latitude: 31 26 56 N) as shown in Fig. 1. Four sites for water and sediment sampling during July and September 2017; two sites at west and east sides about 2 km before the Rosetta Nile branch mouth (W_1 and E_1 sites), and the another two sites at about 2 km along the Mediterranean coast, west and east outside the mouth (W_2 and E_2 sites). A total of eight duplicate water samples (2 L each) were collected at about 7–10 m inside the coast using empty organic solvent glass bottles not used before for sampling. At the same time, eight of duplicate surfacial sediment samples (about 1 kg each of 2–5 cm thickness) were collected in a cleaned aluminum dish using a cleaned metal tool from the same sampling sites as water. Water and sediment samples were transferred directly to the laboratory, where they stored at −4 °C until processing. Nile Tilapia (*Oreochromis niloticus)* as a limited mobile biota of fresh to moderate freshwater fish and *Donax trunculus* bivalve (known as Um-El-Kholol in Egypt, and consumed as a food) as relatively fixed marine biota were selected. About 1 kg/sample of the *Tilapia* spp. (10–15/kg) and *Donax* spp. (shell length about 0.8–1.2 cm) were purchased for three times directly from the fisherman whose catch it within the estuary area during July, August and September 2017. All the biota samples were kept in n-hexane rinsed glass jars and preserved in a cool box until received to the laboratory.

Standards of the organochlorine pesticides (OCPs); hexachlorocyclohexane isomers ((α, β, γ, HCHs), and δ –HCH (surrogate standard)), dichlorodiphenyltrichloroethane (p,p′-DDT) and its degradates (p,p′-DDD and p,p′-DDE), cyclodienes [(Endosulfan isomers (I, II), endosulfan sulphate, aldrin, dieldrin, endrin, heptachlor and heptachlor epoxide. All were purchased from Accu-Standard, Inc. (USA). Polychlorinated biphenyl (PCB) congeners; PCB 15, PCB 19, PCB 22, PCB 28 (surrogate standard), PCB 46, PCB 53, PCB 59, PCB 72, PCB 91, PCB 118, PCB 120, PCB 127, PCB 128, PCB 135, PCB 136, PCB 170, PCB 175, PCB 178, PCB 194, PCB 208 and PCB 209. All were purchased from Supelco, (USA). Dichloromethane and n-hexane (pesticide residue grade). Acetone p.a., Reag. ACS + ISO + Ph; Carlo Erba (Italy). Granular anhydrous sodium sulfate ACS reagent grade (MP Biomedicals, LLC (France)) was dried at 400°C for 4 h before use according to US-EPA method 608. Florisil (60–100 U.S. mesh) was activated and deactivated before use (Fillmann et al. 2002). Mercury; BDH Chemicals Ltd. Poole England (USA). Glassware was rinsed with acetone followed by n-hexane before use according to UNEP/IOC/IAEA (1992).

Mechanical teflon grinder (JURGENS-FRITCH, Germany), rotary evaporator (Stuart, UK), Nitrogen evaporator (Thermo scientific, USA), Sonicator (Selecta, Spain), Muffle furnace (Heraeus, Germany), Mechanical convection oven (Precision, USA), drying oven (Heraeus, Germany) and analytical balance (Highland, UK). Gas chromatograph (Thermo scientific, USA) equipped with micro-electron capture detector (63 N-μECD) was used for qualitative and quantitative analysis of the tested compounds.

The Water samples were filtered through 0.45 μm fiberglass filters to remove sand and debris based on the method of APHA (1985). Extraction was performed according to US-EPA 608 (1984) method for OCPs and PCBs analysis. Two litters of water sample was spiked with 0.5 ml surrogate mixture of 40 pg/μl of δ –HCH and 40 pg/μl of 2, 4, 4-