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FULL LENGTH ARTICLE

Organochlorines and their risk in marine shellfish collected from the Mediterranean coast, Egypt

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Abstract Shellfish is a useful tool for active environmental biomonitoring. According to levels of persistent organic pollutants (POPs) in shellfish, we can calculate the risk observed for public health. Accordingly, this study covers the determination of POP concentration in some shellfish collected from the Mediterranean coast of Egypt. The obtained results revealed that the concentrations of total OCPs range from 47.07 ng g^{-1} to 113.9 ng g^{-1} with an average of 85.77 ng g^{-1}. The organochlorine pesticide (OCP) concentration in collected shellfish followed the order: Total cyclodienes < PCBs < DDTs < HCHs. Meanwhile, the total concentration of PCBs in the collected shellfish samples range from 15.13 ng g^{-1} to 37.49 ng g^{-1} with an average of 25.72 ng g^{-1}. The highest PCB concentrations (37.49, and 33.42 ng g^{-1}) were found in the samples collected from the Eastern Harbor and Abo-Qir locations, respectively. The higher chlorinated congeners are of particular environmental interest because they have a long half life and easily bioaccumulate along the trophic chain. According to the world health authorities, the concentration of POPs in shellfish of the studied area can generally be considered not to be at levels posing a health risk.

Introduction

Over the last decades, increasing attention has been paid to the occurrence of persistent organic pollutants (POPs) in coastal and estuarine environments. They are ranked among the top 5 priority hazardous substances along with arsenic, lead, mercury and vinyl chloride (ATSDR, 2007). PCBs were manufactured commercially in Europe from 1929 until the mid-1980s (OSPAR, 2010), and were primarily used in industry due to their insulating and flame retardant properties. Due to their toxicity, potential to bioaccumulate on fatty tissues and biomagnification through the food chain, exposure to these pollutants is a topic of huge concern (Otchere, 2005; Tomza et al., 2006). In fact, POPs have been directly related to deleterious health problems, including endocrine disruption, reproductive disorders, cardiovascular diseases, carcinogenicity and neurotoxicity (El Nemr et al., 2011; El Nemr, 2013; Amodio et al., 2012). Their release into environment is mainly unintentional and related to human activities (Kennish, 1997; Breivik et al., 2004). The marine environment is considered as the ultimate receptor for these compounds that have been

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detected even in remote areas, such as the Polar Regions (Stegeman et al., 2001).

Biota could potentially acquire PCBs from three sectors in the environment: atmosphere, water and food. Because of their lipophilicity, changes in PCB concentration might also be related to changes in lipid content (Nakata et al., 2002). For example, in aquatic organisms, uptake involves: adsorption/absorption/partitioning of PCBs in water through gills and epidermis and consumption of contaminated food. PCB levels in marine invertebrates are best explained by equilibrium partitioning between body lipids and ambient water. So, PCBs in the tissues of bivalves such as *Mytilus edulis* should reflect the PCB concentration in its environment.

Bivalves are widely used as bioindicators of organic pollution in coastal areas because they are known to concentrate these compounds (Coelho et al., 2006; Lobo et al.,2010; Cardoso et al., 2012, 2013), providing a time integrated indication of environmental contamination, as well as reliable information on the potential impact of seafood consumption on public health (Fang, 2004; Otchere, 2005). In comparison to fish and crustaceans, bivalves have a very low level of activity of enzymatic systems capable of metabolizing persistent organic pollutants (POPs), such as aromatic hydrocarbons and PCBs. Therefore, contaminants' concentrations, in the tissues of bivalves, more accurately reflect the magnitude of environmental contamination (Phillips, 1980, 1990). In this context, the aim of this study was to investigate and assess the level of organochlorine contaminations in shellfish tissues of the Egyptian Mediterranean coast and to establish a baseline for organochlorine residue.

Material and methods

Samples

Sample collection was carried out at 7 sampling points (El-Mex, Eastern Harbor, Abu Qir, Rosetta, Port Said, El-Arish 1 and 2) from the Mediterranean Sea, Egypt (Fig. 1). Two types of biota were collected (i) Gastropoda (*Mancinella mancinella*, *Dolium galea*) from Abu Qir, El Arish 1, (ii) Bivalve (*Lutraria elliptica*, *Donax trunculus*) from El Mex, Eastern Harbor, Rosetta, El Arish 2 (Tables 1 and 2).

Procedure

Thirty individual shellfish of similar sizes (50–75 mm) were used for each analysis (El Nemr et al., 2003, 2012; Khaled et al., 2004). Homogenized shellfish flesh was frozen (−20 °C). Frozen samples of shellfish (soft tissues) were soxhlet extracted for 8 h using distilled-in-glass hexane. Five gram of sample and 15 g of anhydrous Na_2SO_4; 250 ml of hexane for 8 h were soxhlet extracted. The sample extracted (hexane) was concentrated under vacuum to 5 ml and to 1 ml under a gentle stream of pure nitrogen gas. This extract was applied to a Florisil chromatography column for the separation of classes of compounds. From the Florisil column, a first fraction is obtained by the elution of 70 ml of hexane and contains mainly aroclors, HCB, DDEs, and aldrin. A second fraction is obtained by the elution of 50 ml of a mixture of hexane-dichloromethane 70:30 which contains toxaphene, DDDs, DDTs, and HCHs. A third fraction, eluted with 40 ml of dichloromethane, contains dieldrin and endrin. Activation of the Florisil was achieved by heating at 130 °C for 12 h, followed by partial deactivation of 0.5% water by weight and stored in a tightly sealed glass jar with ground glass stopper and the mixture was allowed to equilibrate for one day before use.

Each fraction was concentrated and injected into a CLASS-GC10 gas chromatograph (Shimadzu, Japan) equipped with a ^{63}Ni electron capture detector. A fused-silica capillary column (30 m × 0.32 mm × 0.52 μm) DB-1 (coated with 5% diphenyl and 95% dimethyl polysiloxane) was used for the quantification. The oven temperature was programed from an initial temperature of 70 (2 min hold) to 280 °C at a rate of 5 °C min^{-1} and was then maintained at 280 °C for 20 min.

Table 1 Sampling locations, depth and pollution sources.

Location	Lon. (E)	Lat. (N)	Depth (m)	Pollution sources
El Mex	29.75°	31.18°	4.0	Industrial, agricultural, sewage, domestic discharge wastes
Eastern Harbor	29.86°	31.26°	4.5	Harbor
Abu Qir	30.08°	31.37°	4.0	Industrial, agricultural, sewage, domestic discharge wastes
Rosetta	30.33°	31.53°	5.0	Outlet of Nile River
Port Said	32.34°	31.29°	3.0	Eutrophied area
El Arish-1	33.36°	31.23°	3.0	Public beach
El Arish-2	33.39°	31.22°	3.0	Public beach

Table 2 The identification of phyllum: mollusk species collected from the studied locations along the Egyptian Mediterranean coast.

Class	Family	Genus	Scientific name	Location
Gastropoda				
	Muricidae	Mancinella	*Mancinella mancinella*	Abu Qir
	Tonnidae	Dolium	*Dolium galea*	El Arish-1
Bivalvia				
	Mactridae	Lutraria	*Lutraria elliptica*	El Mex
	Mactridae	Lutraria	*Lutraria elliptica*	Eastern Harbor
	Donacidae	Donax	*Donax trunculus*	Rosetta
	Donacidae	Donax	*Donax trunculus*	El Arish-2