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Human health risk of organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs) in edible fish from Huairou Reservoir and Gaobeidian Lake in Beijing, China

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Abstract

Organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs) were measured by a gas chromatography–mass spectometry (GC–MS) in some edible fish from Huairou Reservoir and Gaobeidian Lake in Beijing, China. The concentrations of OCPs and PCBs were higher in fish (except *Misgurnus anguillicaudatus*) from Gaobeidian Lake than in those from Huairou Reservoir. The average concentrations of HCHs, DDTs and PCBs in fish ranged from 0.58 to 8.48, 7.54 to 88.3, below limit of detection (nd) to 22.7 ng/g wet weight, respectively. β-HCH, *p,p′*-DDE and PCB153 were the most abundant compounds among HCHs, DDTs and PCBs, respectively. Risk assessments of OCPs and PCBs for humans were estimated according to three different guidelines. The results indicated that fish intake would not pose a health risk to humans with a consumption of 7.4 ± 8.6 g/person day according to the acceptable daily intake (ADI) and minimal risk level (MRL) in the two environments. However, the hazardous ratio of the 95th percentile for PCBs in fish from Gaobeidian Lake exceeded 1, which suggested that daily exposure to PCBs had a lifetime cancer risk of greater than 1 in 1,000,000.

Keywords: Composition; POPs; HCHs; DDTs; Potential risk

1. Introduction

The global environment is contaminated by persistent organic pollutants (POPs). The contamination of POPs is a significant health problem because POPs can be accumulated and magnified through the food web or food chain, and then can cause several adverse effects to human health and wildlife survival. Many examples of accidental contamination of POPs have occurred (Binelli & Provini, 2004; Chen, Luo, Wong, & Chen, 1982; Kannan, Tanabe, Ramesh, Subramanian, & Tatsukawa, 1992; Rappe et al., 1987) and the risk assessment of POPs in food for human health is important and necessary. Organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs) are two principal pollutants. In China, massive amounts of OCPs were used, especially in the 1970s and early 1980s. Although the usage for agriculture of DDTs and HCHs has been banned since 1980s, DDTs are still being used in low amounts to control certain insects in tropical and subtropical countries, including China (UNEP Regional Report, 2002).

Humans take up POPs through skin absorption, respiration and ingestion of contaminated food. Skin absorption and respiration are not the main route. Some researches have confirmed that more than 90% of contaminants come from food (Fürst, Fürst, & Groebel, 1990). Among all foods, fish is one of the main sources of contaminants although fish products account only for about 10% of diet (Alcock, Behnisch, Jones, & Hagenmaier, 1998; Harrison et al., 1998) or less. POPs in fish from some areas were detected to assess the risk for human health (Binelli &

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Provini, 2004; Jiang et al., 2005; Yang, Matsuda, Kawano, & Wakimoto, 2006). With the banning of massive usage and production of the compounds, the residual levels in foodstuffs have decreased significantly. However, there is not sufficient information on OCPs and PCBs in edible fish from some freshwaters in China. Most freshwater fish consumed by humans come from some local lakes or reservoirs which are more polluted by POPs because of the slow water cycling.

Huairou Reservoir, located in the northeast of Beijing, China, is one of the main water resources for industry, agriculture and domestic use in Beijing. There are some agricultural activities around Huairou Reservoir. Compared with Huairou Reservoir, Gaobeidian Lake is the receptor of treated industrial wastewater (about 70%) and population-used wastewater (about 30%) by the Gaobeidian Wastewater Treatment Plant (WWTP), the biggest WWTP in Beijing, China, with a treatment capacity of one million tons of wastewater daily. The ecosystem of Gaobeidian Lake is much impacted by its in-flowing water from Gaobeidian WWTP. So, Huairou Reservoir and Gaobeidian Lake are two typical bodies of freshwater affected by different contamination sources. Moreover, a lot of fish from these two waters are consumed by the local or non-local population. Therefore, it is very important to clarify the status of POPs in fish from the two waters, and especially in those that are popular with the local population. The present study will provide more information on the residues of OCPs and PCBs in fish from Huairou Reservoir and Gaobeidian Lake. The risk assessment of POPs for human health is also considered in detail.

2. Materials and methods

2.1. Sample collection

Huairou Reservoir and Gaobeidian Lake were selected for study (Fig. 1). The volume of Huairou Reservoir is approximately 9670×10^4 m^3 of water in most seasons. Gaobeidian Lake has a surface area of about 0.15 km^2. Its water source is mainly the water effluent of Gaobeidian WWTP. Water in Gaobeidian Lake is used as a coolant by the nearby Beijing Guohua Thermal Power Plant and then recycled to the aquatic environment at a higher temperature than it was originally. Water temperature in the lake is between 12 and 41 °C corresponding to seasonal changes, about 5–10 °C higher than the ambient temperature. The water in Gaobeidian Lake discharges into Tonghui River and finally into the largest estuaries, Bohai Bay in China. Fish samples, including *Carassius auratus*, *Misgurnus anguilicauatus* and *Pseudobagrus fulvidraco* were collected from Huairou Reservoir, and *Carassius auratus*, *Misgurnus anguilicauatus* and *Hemiculture leuciscultures* were collected from Gaobeidian Lake in May, 2006. The geographical position and related information of fish samples are listed in Table 1. The edible portions of fish were homogenized and frozen at −20 °C.

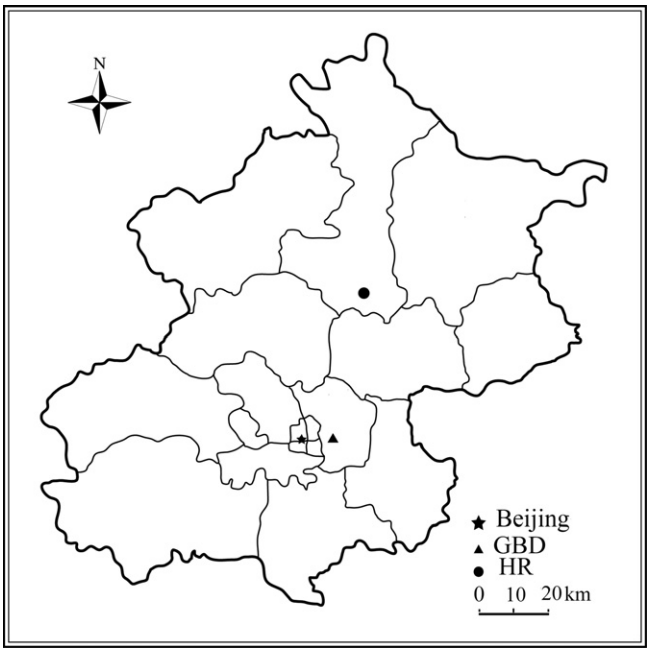

Fig. 1. Map of sampling locations.

2.2. Experimental protocol and quality assurance

Fish were extracted and cleaned up according to the method in the reference (Yang, Yao, Xu, Jiang, & Xin, 2007). The samples were analyzed for OCPs (α-HCH, β-HCH, γ-HCH, δ-HCH, *p,p′*-DDD, *p,p′*-DDE, *p,p′*-DDT, and *o,p′*-DDT) and the six indicator PCBs (PCB28, PCB52, PCB101, PCB138, PCB153, and PCB180). The results were obtained by Agilent 6890 with a ^{63}Ni electron capture detector (micro-ECD) with 30 m length × 0.25 mm

Table 1
Description of biological data of the fish samples

Sample site	Species	No.	Weight (g)	Length (cm)	Mean moisture content (%)	Mean lipid content (%)
Gaobeidian Lake	*C. auratus*	8	25.5–68.6	6.5–7.9	75.1–84.6	3.87
	M. anguillicaudatus	5	4.5–8.3	7.8–0.1	77.5–86.1	2.83
	H. leuciscultures	8	2.6–8.2	5.0–8.5	73.8–79.6	5.88
Huairou Reservoir	*C. auratus*	5	28.4–65.6	9.7–13.3	72.7–85.9	3.05
	M. anguillicaudatus	6	11.5–16.6	10.5–13.7	76.6–87.2	2.97
	P. fulvidraco	4	21.8–53.2	6.8–10.3	74.9–82.8	0.84