Risk Assessment of Organochlorine Pesticides and Polycyclic Aromatic Hydrocarbons in Fish Collected from Fish Ponds in the Pearl River Delta

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Abstract

Hong Kong and South China are the most developed regions within China. The rapid socio-economic growth, industrialization and urbanization in these areas resulted in severe environmental problems. Persistent organic pollutants (POPs) such as polycyclic aromatic hydrocarbons (PAHs) and organochlorine (OC) pesticides are transferred into aquatic food chains where they accumulate in fish and impose health hazards on human beings through consumption. Sediment, water and biotic samples including tilapia (*Tilapia mossambicus*), bighead carp (*Aristichthys nobilis*), grass carp (*Ctenopharyngodon idellus*), crucian carp (*Carassius auratus*), mandarin fish (*Siniperca chuatsi*), mud carp (*Cirrhina molitorella*), tilapia fingerling (*Tilapia mossambicus*), shrimp (*Palaeomonetes sp.* and *Macrobrachium sp.*) and apple snail (*Pomacea sp.*) were collected from different fishponds (Tanzhou, Sanjiao, Guangzhou, Shipai, Changan and Mai Po) located in the Pearl River Delta for the analyses of PAHs and OC pesticides.

Elevated levels of $p,p'$-DDT detected in the sediment and the very low ratio of $p,p'$-DDE to DDTs in fish samples suggested that recent release of DDT into the fishpond ecosystems. Mandarin fish, which belongs to the highest trophic level, seems to accumulate higher concentrations of PAHs and DDTs than other species. Furthermore, these POPs tended to build up in the monoculture ponds due to low nutrient and metabolic waste recycling. However, no evidence of biomagnification of PAHs and DDTs was observed in the food webs of freshwater fishponds, possibly due to the effects of artificial modification of the fishpond ecosystems. Bioconcentration and bioaccumulation could be major routes for the entry of organic pollutants into biota. Higher Biota-sediment accumulation factors of PAHs and DDTs were observed in filter and detritus feeders (shrimp, apple snail and mud carp) which are in frequent contact with sediments. The release of contaminated particles or sediments from the pond bottom to the water column could also act as a source of PAHs and DDTs which can be
bioconcentrated in the filter feeders (shrimps, fingerlings and bighead carps). The levels of DDTs in fish samples ranged from 0.5 to 62 ng g$^{-1}$ (wet wt.), with 35% of the fish samples exceeded the limit of 14.4 ng g$^{-1}$ (wet wt.) for human consumption (US EPA 2000), but the potency-weighted total concentrations of PAHs (0-0.2 ng g$^{-1}$ wet wt.) in all fish tissues were below the guideline value of 0.67 ng g$^{-1}$ (wet wt.) (US EPA 2000).

Tilapia purchased from the markets (with fish supplied from the mainland) showed higher concentrations of DDTs and PAHs than those collected from Hong Kong fishponds and gei wais, confirmed that the fishponds in the mainland are more polluted due to the rapid socio-economic growth in the region. The tilapia were heavily polluted by Pb, with the highest level (3519 ng g$^{-1}$ wet wt.) exceeded the EUROPA guideline (400 ng g$^{-1}$ wet wt.) 8 times, and Cr with 36% of the samples exceeded the China guideline of 500 ng g$^{-1}$ wet wt. for human consumption (NEPA, 1997). Populations like Chinese and most Asians who consume larger quantities of fish may be at risk. Tilapia collected from gei wais (Mai Po) showed the highest levels of Cr, which may also impose adverse effects on water birds. The use of comet assay (DNA breakage in contaminated tilapia) as a fast screening method in monitoring pollutants in fish showed a low potential for the range of pollutants (PAHs, DDTs, Cd, Cr, Pb) tested.
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