DOCTORAL THESIS

Use of food waste feeds for culturing low trophic level fish (grass carp, bighead carp and mud carp): persistent toxic substances

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ABSTRACT

This study aimed at using different types of food wastes as major sources of protein to replace the fish meal used in fish feeds to produce quality fish. The major objectives were to (1) investigate the variations of metalloid/metals, polycyclic aromatic hydrocarbons (PAHs) and organochlorine pesticides (OCPs) in the fish ponds (pond mud and water), and food wastes used as fish feeds; (2) analyze bioaccumulation and biomagnification of pollutants in the food chains; and (3) evaluate the potential health risks of exposure (to these pollutants) via dietary intake of fish fed with food waste feeds.

The traditional fish farming model was used to culture low trophic level fish: a filter feeder (bighead, *Aristichthys nobilis*), a herbivore (grass carp, *Ctenopharyngodon idellus*) and a bottom feeder (mud carp, *Cirrhina molitorella*), which are more environmental friendly as they can utilize more solar energy. Furthermore, low-trophic level fish are less susceptible to the accumulation of toxic chemicals. Two types of food wastes (mainly containing cereal (Food Waste A) and meat waste meal (Food Waste B)) were used as the major source of protein to replace the fish meal in fish feed to culture fish.

The concentrations of metalloid (arsenic (As)), metals (mercury (Hg), cadmium (Cd), chromium (Cr), lead (Pb), zinc (Zn), copper (Cu) and nickel (Ni)) in water, suspended particulate matter and sediment of the 3 experimental fish ponds located in Sha Tau Kok Organic Farm were monitored (bi-monthly during the first half year and tri-monthly during the second half year) and the results were similar to or lower than those in the commercial fish ponds around the Pearl River Delta (PRD) region. Results of the health risk assessments indicated that human consumption of grass carp (a herbivore) which fed

food waste feed pellets would be safer than other fish species (mud carp, bighead carp and largemouth bass). There were no or lower magnifications, and low concentrations of metalloid/metals contained in the ponds indicated that the practice of traditional pond management by draining pond water regularly can provide a better fish pond habitat for birds and other wildlife. Furthermore, the use of food waste instead of fish meal (mainly consisted of contaminated trash fish) further reduced Hg accumulation in the cultured fish.

During October 2011 - December 2012, the concentrations of PAHs and OCPs in three experimental fish ponds were monitored (bi-monthly during the first half year and tri-monthly during the second half year). The results were similar to or lower than those obtained in commercial fish ponds around the PRD region. The mean concentrations of ΣPAHs and ΣOCPs in sediment and fish collected from the experimental fish ponds during the 2nd half year (May 2012 to December 2012) were significantly higher ($p<0.05$) than those in the 1st half year (October 2011 to April, 2012). ΣPAHs and ΣDDTs in the two species of fish (grass carp and bighead carp) were significantly increased ($p<0.05$) with time, and PAHs and DDTs in grass carp and bighead carp fed with commercial fish feed pellets (control group) were significantly higher ($p<0.05$) than the fish fed with food waste pellets (Food Waste A and Food Waste B). Fruit, vegetables, bone meal and meat products were the major sources of PAHs and OCPs contamination for producing Food Waste A and Food Waste B. No significant increases in PAHs and DDTs concentrations with trophic levels were observed in the experimental ponds, showing that PAHs were not biomagnifed in the omnivorous food chains (plankton, grass carp, bighead carp and mud carp). DDTs were lower magnifications than those predatory food chains (plankton, trash fish, and largemouth bass) in farmed ponds. There was a very low cancer risk for

PAHs and DDTs exerted on humans via consumption of bighead carp, grass carp and mud carp (fed with food waste and commercial pellets). Furthermore, the use of food waste instead of fish meal (mainly consisted of contaminated trash fish) further reduced accumulation of PAHs and DDTs in the cultured fish.

The present results revealed that recycling of food waste for cultivating low trophic level fish (mainly bighead carp and grass carp) is feasible, which will also ease the disposal pressure of the large volume of food waste, a common problem encountered in densely populated cites such as Hong Kong.

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