Uptake efficiencies of PCB 153 in fathead minnows through food chain of sediment-midge-fish

Kyungho Choi[1*] · Peter G. Meier[2]

[1]School of Public Health, Seoul National University, Seoul, 110-799 Korea
[2]School of Public Health, University of Michigan, Ann Arbor, MI 48109 USA

Abstract

Uptake efficiencies of PCB 153 in fathead minnow through food chain of sediment-midge-fish were evaluated. Contaminated fish food, the midge *Chironomus plumosus* was prepared by exposing to sediments with PCB 153. We could harvest the midges with body PCB 153 levels of ~ 1.0 mg/g and ~ 10.0 mg/g, respectively, in 2 wk of exposure. PCB 153 level in fish fed with midge of 10.0 mg/g PCB 153 (high-dose group) reached its highest at 11.2 mg/g after 30 d of exposure. However, PCB level in fish fed with midge of 1.0 mg/g PCB 153 (low-dose group) kept increasing following first order rate kinetics until the end of exposure (38 d).

When the fish food was changed to the uncontaminated ones, the fish body PCB levels were stabilized in ~ 3 wk. The uptake efficiency in high-dose fish group was 37%, whereas low-dose group was 55%. Uptake efficiencies in fathead minnows were notably lower than that of pike (~ 70%). This finding suggests that the uptake efficiency of this PCB congener may depend on the amount of the PCB in diet.

Introduction

Bioaccumulation of PCBs depends on uptake/elimination/metabolism. In addition, hydrophobicity and stereochemistry affect bioaccumulation.

PCB153 (2,2,4,4,5,5-hexachlorinated biphenyl) had been used in many commercial mixtures, e.g., Aroclors 1242, 1248, 1254, and 1260. Due to its widespread presence in various environmental media including biological specimen, it was once suggested as a marker of total PCB exposure.

Previously several studies have been reported for dietary uptake of PCB 153 in freshwater fish. In these studies, fish were generally fed with dried fish pellets unlike natural conditions, which may affect the test results (Sijim et al. 1993). Studies simulating natural conditions, i.e., trophic transfer, have rarely been conducted. Parameters under investigation were mostly physicochemical features of PCBs. Effect of amount of dietary consumption on uptake efficiency was not investigated.

In the present study, we evaluated uptake efficiencies of PCB 153 in fathead minnow in a condition simulating natural environment, i.e., through food chain of sediment-midge-fish. The effect of dose (amount of dietary consumption) on uptake efficiencies was also investigated.

Materials and Method

Preparation of PCB-contaminated fish food

- 20 g midge larvae were exposed to 25 g contaminated sediment, based on preliminary study
- Exposed until target PCB body burdens of 1.0 and 10 mg/g were reached
- Midges were harvested, washed, and frozen for future use as a fish food

PCB Uptake in fathead minnows through food

- 2 treatment (midges with 1.0 mg/g and 10.0 mg/g body PCB) and control
- Frozen midge larvae were thawed, chopped and fed to fish (3-5 % fish body weight per day)
- After 38 d of exposure to contaminated food, fish food was changed to the uncontaminated midges for 21 d
- PCB 153 was analyzed for every 2-3 days during the exposure using liquid scintillation method

Results and Discussion

Uptake of PCB 153 in midge from sediment

Target midge PCB body burdens of 1.0 and 10.0 mg/g were obtained in approximately 2 wk of exposure to the sediments contaminated with 1.0 and 10 mg/g PCB 153, respectively. PCB uptake followed first order rate kinetics and showed a greater accumulation rate at higher sediment concentration

Uptake of PCB 153 in fish from midge

Fish exposed to higher dose food (10 mg/g) reached at plateau after 4 wk of exposure. Fish exposed to lower dose food (1.0 mg/g) did not reach at plateau at the test completion (38 days).

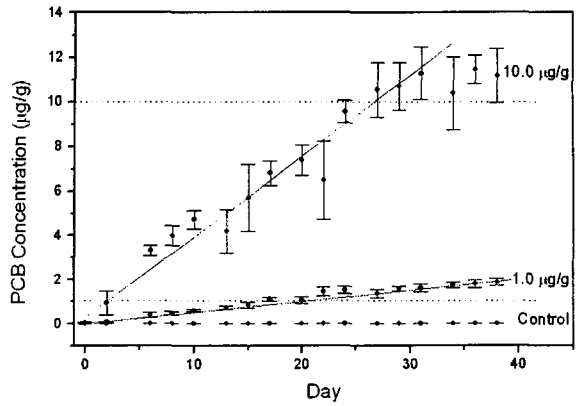

Fig 1. Uptake of PCB 153 in fish consuming contaminated midges with body burden of 1.0 and 10.0 mg/g PCB 153.

Excretion of PCB153 in fish

In 3 wk, PCB concentrations of both dose groups were halved, and slopes were leveled off as shown on Fig 2.

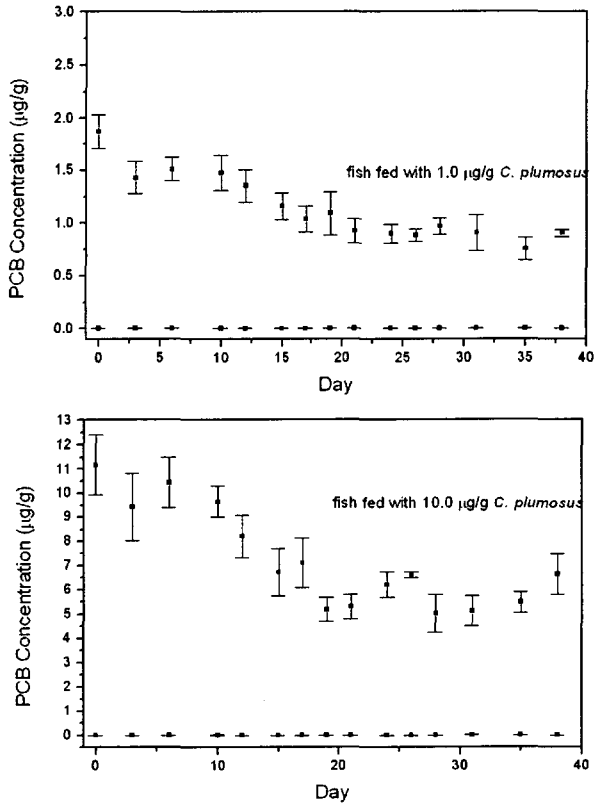

Fig 2. Excretion of PCB 153 in fish with different body PCB burden.

Uptake efficiency of PCB 153 in fish

Uptake efficiency was calculated from the following equation.

$$\text{Uptake efficiency} = \frac{\text{PCB amount in fish (g)}}{\text{Total amount exposed (g)}}$$

For fish exposed to 10 mg/g, 37% of uptake efficiency was observed. For fish exposed to 1.0 mg/g, 55% of uptake efficiency was observed, but it should be noted that the fish of this exposure group did not reach the maximum tissue concentration of PCB 153 as suggested in Fig 1.

Conclusion

Utake efficiencies in fathead minnows were notably lower than that of pike (~ 70% as reported in Burreau et al., 1997). Amount of PCB 153 in food may affect the uptake efficiencies in fish, but it was not evident from this report due to insufficient exposure duration at the lower exposure group. Exposure to low dose for extended period of time may be required.