

Polybrominated Diphenyl Ethers (PBDEs) in Aquatic Organisms from Lake Michigan

Abstract

This research of polybrominated diphenyl ethers (PBDEs) incorporated three studies to investigate PBDE biotransformation, bioaccumulation, and biomagnification in aquatic organisms from Lake Michigan. First, diets spiked with four nominal concentrations (control, 0.1, 1, and 2 $\mu\text{g/g-diet}$) of BDE-209 were fed to laboratory-reared lake whitefish (*Coregonus clupeaformis*) for 30 days. Less than 10% uptake efficiency was found in treated groups. Hepatic BDE 209 concentrations in the 1 and 2 $\mu\text{g/g}$ groups were significantly higher than in the control group (1.25 and 5.80 nmol/g lipid compared to 0.183 nmol/g-lipid). The liver was the primary organ where BDE-209 accumulated and BDE-206 was the major product from debromination of short-term BDE-209 exposure. Additionally, the otolith increments of the 2 $\mu\text{g/g}$ group displayed a retarded growth rate, which implies a negative impact on lake whitefish growth during BDE-209 exposure.

Second, Chinook salmon (*Oncorhynchus tshawytscha*), lake trout (*Salvelinus namaycush*), and lake whitefish as well as invertebrates (plankton and *Diporeia* spp.) were collected from Lake Michigan in 2006. Liver and muscle tissues from fish were separately analyzed for BDE-47, 99, 100, 153, 154, and 209. Geometric mean concentrations of ΣPBDE in fish tissues ranged from 0.911 to 2.02 nmol/g-lipid; BDE-209 ranged from 0.192 to 1.28 nmol/g-lipid. $\Sigma\text{BDE-47, 99, and 209}$ comprised 80-94% of ΣPBDE concentration (on a molar basis). The bioaccumulation relationship of each brominated congener depended on species and fish characteristics (e.g., total length and weight).

Third, biomagnification along the food webs was examined through analysis of invertebrates combined with the above fish data. The stable nitrogen and carbon isotope ratios were used to determine the trophic levels. Not only the biomagnification on BDE-47, 99, and 100 but the biotransformation potential of BDE-209 was found within these food-web members. Similarly, the calculated biomagnification factors for all specific predator/prey relationships were larger than one for BDE-47 and 100 but less than one for BDE-209.

Evidence of BDE-209 accumulation was shown in both the laboratory-reared lake whitefish and the aquatic organisms from Lake Michigan. In addition, BDE-209 biotransformation occurred not only in lake whitefish but also within the food web of Lake Michigan.