POLYBROMINATED DIPHENYL ETHERS IN SOUTHERN MISSISSIPPI CATFISH

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Introduction

Polybrominated diphenyl ethers (PBDEs) are used as flame retardants in a wide variety of consumer products. Concerns surrounding these compounds are primarily due do their ubiquitous presence in the environment as well as in human tissue, such as milk, coupled with evidence indicating the potential for adverse effects. Despite these concerns, relatively few studies are available in the literature which characterize and quantify intake by humans. It has commonly been assumed that dietary intake is the primary intake pathway, although recent analyses indicate that inhalation and dermal contact with these compounds may also contribute to total body burdens. The few studies which evaluate PBDEs in food from the U.S. suggest that fish contain higher levels of PBDEs than other sources in the diet.[1,2,3]

In this study, we measure PBDE concentrations in Southern Mississippi catfish in an effort to determine background levels and daily intake of these compounds from a primary food source for residents in this area of the United States. Catfish in the Southern Mississippi region were chosen because these fish have traditionally been a common staple in the diet of this region. Dean et al[4] have reported that Arkansas and Mississippi lead the U.S. in average per capita consumption of catfish. Given this region-specific dietary pattern, catfish consumption could potentially contribute significantly to the intake of PBDEs in this population.

Materials and Methods

Sixty-one catfish samples from Southern Mississippi were collected in March, 2006. Wild catfish (n=33) were caught by local fisherman in one location along the Mississippi River (MR), two locations along the Pearl River (PR and the Ross Barnett Spillway or RBS), and two locations along the Leaf River (LR1 and LR2). Immediately after fish were caught they were measured for length and weight and then filleted using clean knives and glass plates. Final fillet weights were also recorded prior to packaging. Farm-raised catfish samples (n=28) were purchased either directly from a Mississippi farm or from local seafood markets and/or grocery stores (seven stores visited) that obtain catfish from farms in Mississippi. All samples were wrapped individually in aluminum foil, placed in labeled plastic bags and frozen on dry ice in uncontaminated coolers. Samples were kept frozen until analysis.

Fish tissue samples were analyzed by Alta Analytical Laboratory (El Dorado Hills, CA) for 43 PBDEs using high resolution gas chromatography-mass spectrometry according to EPA method 1614. BDEs 8 and 11 co-eluted, as did BDEs 12/13 and 28/33. Samples with concentrations below the limit of detection (LOD) were assumed to have a concentration equal to ½ the LOD. All data analyses were conducted using Microsoft Excel. Results are presented by fish type (wild-caught and farm-raised) and sampling location. All concentrations are given in ng/g wet weight unless otherwise noted.

Results and Discussion

Sixty-one freshwater catfish samples were collected in Southern Mississippi in 2006 and analyzed for a series of 43 PBDE congeners ranging from mono-brominated congeners through the fully brominated BDE 209. Complete descriptive data for the various types of fish and types of samples collected is provided by Ferriby et al.[5] Several different types of catfish were caught, including Wild Blue, Appaloosa, and Willow catfish. Farm-raised Channel catfish fillets were larger than wild-caught fillets and had a higher average lipid fraction. The average ∑PBDE concentration in all samples was 3.3 ng/g and ranged from 0.2 to 23.3. Wild-caught catfish fillets had an average concentration of 3.85 ng/g (410.46 ng/g lipid weight, lw), whereas farm-raised catfish fillets had an average PBDE concentration of 0.45 ng/g (5.71 ng/g lw, Figure 1A). These results are in contrast to the trend observed in salmon in which concentrations of PBDEs in farm-raised salmon are significantly higher than concentrations in wild-caught salmon.[6] The wild-caught whole fish, which were the smallest fish collected, had the highest concentrations of PBDEs. The average PBDE concentration in these fish was 10.91 ng/g (2241.61 ng/g lw). Sampling location also influenced the PBDE concentrations in wild-caught catfish (Figure 1B). The variance between levels of PBDEs in catfish collected between the two locations on the Leaf River was the most pronounced. While only three samples were collected at LR1, PBDE concentrations ranged from 0.71-2.27 ng/g, whereas the ten catfish samples collected at LR2 had concentrations ranging from 3.79 to 23.3 ng/g. The higher concentrations observed in the whole catfish from the Leaf River (LR2) as compared to filleted samples from other locations, particularly LR1, suggest potentially greater exposure at this location.

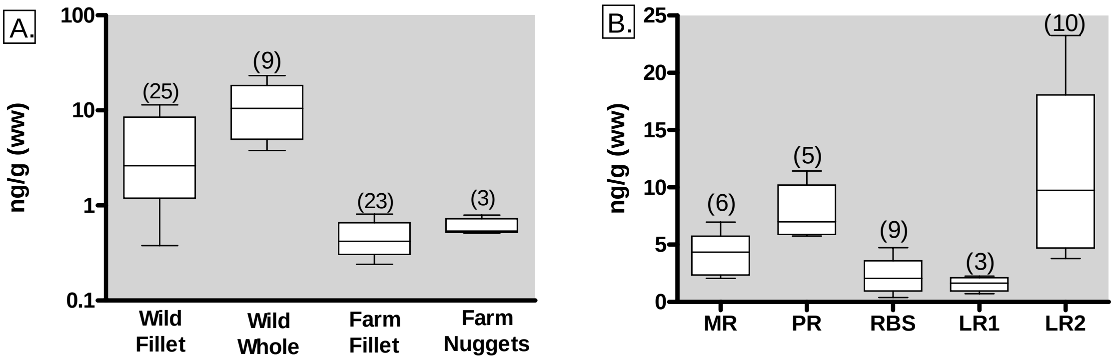


Figure 1. Wet weight concentrations of PBDEs (sum of 43 congeners) in Southern Mississippi catfish samples by A) sample type and B) location. Data presented as minimum, 25th percentile, median, 75th percentile and maximum concentrations; number of samples per group in parenthesis above each respective box plot.

BDEs 47, 99, 100, 153, 154 and 209 were the dominant contributors to the total PBDE concentration measured in both wild-caught and farm-raised catfish (Figure 2), which is consistent with congener profiles observed in humans, marine mammals, birds, and other fish.[7] Relative contributions of each congener between fish type and sample type, however, were slightly different. BDE 99 contributes significantly more to the total PBDEs measured in wild-caught whole fish than all other fish or sample types. When compared to farm fillets, which were also from Channel catfish, these data suggest that the observed differences in profile may be due to proximity to a potential source of release. However, age-related differences in metabolism can not be discounted. Comparisons of wild-caught and farm-raised profiles were similar, except for BDE 209. Although this congener contributes a greater percentage to the overall PBDE concentration in farm-raised fish, it is likely a function of BDE 209 detection limits in combination with lower overall levels of PBDEs in the farm-raised fillets. Actual concentrations of BDE 209 were higher in wild-caught catfish fillets than in the farm-raised fillets. The percent contribution of BDE 209 in the three catfish nugget samples (36%) is also noteworthy; concentrations of the fully-brominated congener were all above detection limits in these samples.

Both whole fish and fillets from the Leaf River also appear to have slightly different congener profiles when compared to the other samples (Figure 3). BDE 99 contributes approximately 38% in locations on the Leaf River as compared to approximately 20% in the samples collected along the Mississippi and Pearl Rivers. It is also interesting to note that BDE 49 contributed less than 0.2% in fish from the Leaf River as compared to upwards of 3.5% at the other locations.

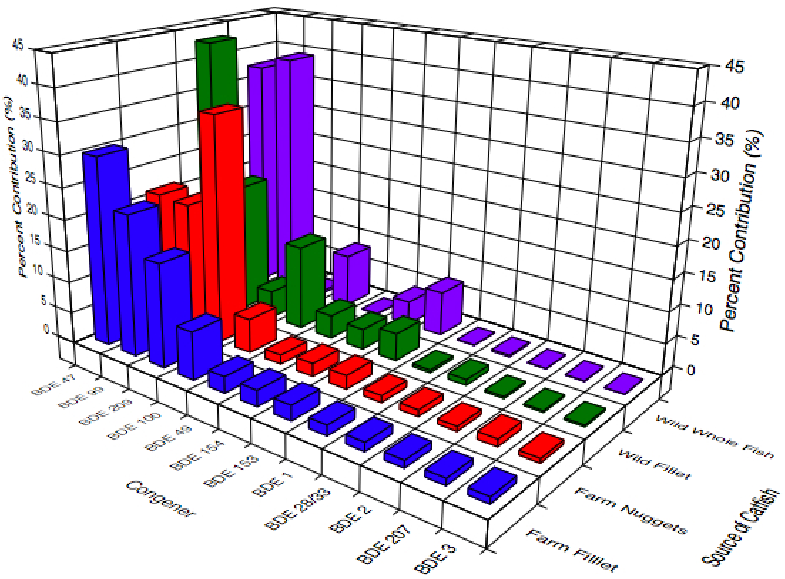


Figure 2. PBDE congener profiles in wild-caught and farm-raised catfish in Southern Mississippi (presented as percent contribution to total PBDE concentration). Note: only predominant congeners are shown.

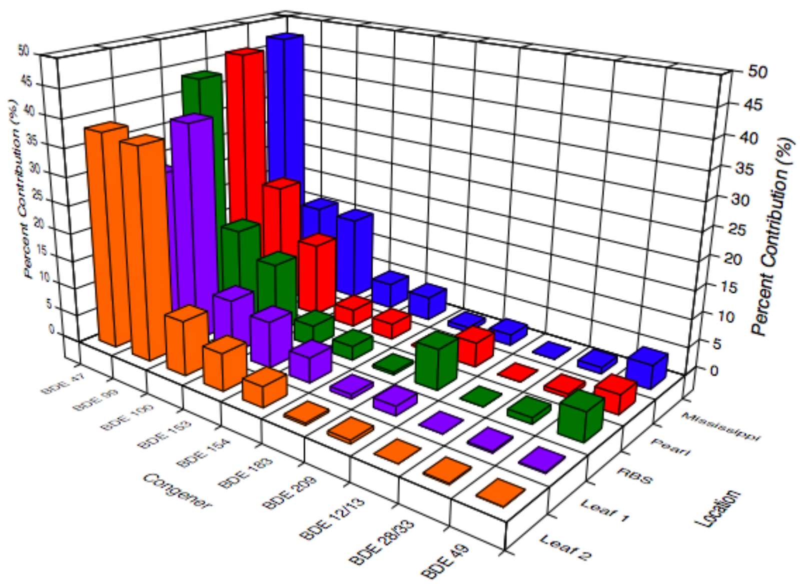
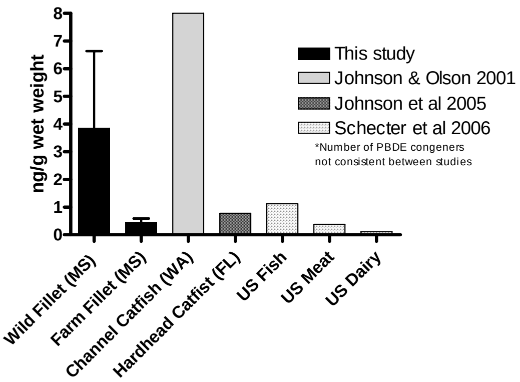


Figure 3. PBDE congener profiles in Southern Mississippi catfish arranged by sampling location (presented as percent contribution to total PBDE concentration). Note: only predominant congeners are shown.

Comparisons of PBDE concentrations observed in other fish and food sources is not straightforward because the number of congeners measured in studies available in the literature are not consistent; however, the studies discussed in this paper did include the five dominant congeners (BDEs 47, 99, 100, 153 & 154) at a minimum (Figure 4). The Channel catfish fillet samples in this study (i.e. farm-raised) had lower levels of PBDEs than Channel catfish fillets from Washington State,[8] but were approximately similar to levels measured in Hardhead catfish muscle tissue from coastal Florida.[9] When compared to food of other origin, concentrations of PBDEs in Southern Mississippi wild catfish fillets were slightly higher than other fish, meat and dairy as reported by Schecter et al.[2] In contrast, levels of PBDEs in farm-raised catfish fillets from Southern Mississippi were similar to other U.S. food products. These results provide a reasonable data set describing the current background levels of PBDEs in catfish representative of the Southeastern region of the United States and will allow for the determination of current background intake of these chemicals due to this particular food source. Future analyses may include investigations correlating fish sampling sites to potential, urban sources as well as daily intake calculations specific to consumption of catfish in Southern Mississippi.

Figure 4. Comparison of SumPBDEs* in Southern Mississippi Catfish Fillets With Other Food Types and Fish



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