Is TEQ Enrichment of PCBs in Fish Tissue a Common Phenomenon?

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Introduction

When environmental samples are analyzed for PCBs, the U.S. Environmental Protection Agency (USEPA) recommends analyzing for 'dioxin-like' PCB congeners and calculating the dioxin toxic equivalency (TEQ) concentrations for use in human health risk assessments based on the cancer slope factor (CSF) for 2,3,7,8-tetrachlorodibenzo-p-dioxin. An underlying assumption of this approach is that environmental PCBs possess enriched toxicity compared to that of the commercial PCB test mixtures upon which EPA's upper-bound PCB CSF is based. EPA had selected the PCB CSF to be protective of the four PCB mixtures tested, and the Aroclor 1254 test material contained the highest TEQ content at 46.4 mg TEQ/Kg PCB.[1] Therefore, the PCB CSF is protective of exposures to any PCB mixture containing TEQ levels less than or equal to this value. To investigate this issue, we examined multiple PCB congener databases to assess whether PCBs in fish fillets are enriched beyond the level of protection afforded by the PCB CSF.

Materials and Methods

On-line or other public domain databases[2-11] that reflect a large range of total PCB concentrations and that originate from different areas of the U.S. were identified. Fillet tissue data were used since the focus of this assessment is on potential human health risks. Recognizing that certain ethnic groups consume nearly all portions of a fish, an assessment using whole body PCB residues was also performed as part of a sensitivity analysis.

A decision tree was employed to determine the suitability of the datasets for the current assessment. The two key conditions for inclusion of the PCB congener datasets were either (1) a minimum of 45 PCB congener results, of which a minimum of 6 are the "dioxin-like" PCB congeners, or (2) a minimum of 15 NOAA PCB congener results, of which a minimum of 6 are the "dioxin-like" PCB congeners. The datasets were also examined for any apparent data quality anomalies before further assessing the results.

For the suitable datasets the total TEQ for each fish sample was calculated by summing the products of the non-*ortho* and mono-*ortho* substituted PCB congener concentrations and their respective WHO TEF values.[12] The total TEQ for each fish sample was then divided by the total PCB concentration in that sample in order to quantify the TEQ content of the PCBs present. These results were expressed in units of mg-TEQ/Kg-PCBs.

Results and Discussion

Our analysis reveals that fish fillet PCB samples taken from a large variety of PCB-impacted waterways across the US that varied in the type of PCBs that were the source of the contamination (e.g., Aroclor-1242 in the Kalamazoo River and Aroclor-1260 in the Housatonic River) have mean and 95 percent statistical confidence limit TEQ levels lower than 46.4 mg-TEQ/Kg-PCB (Figure 1). Consequently, the use of the upper-bound PCB CSF appears to be adequately protective for evaluating potential cancer risks of PCB mixtures found in these fish tissues. There does not appear to be a need to use the TEQ approach to ensure that cancer risks are not underestimated.

A key component of this assessment was the *a priori* determination of the suitability of different datasets prior to calculating the TEQ levels in PCBs. For some datasets, such as the NOAA Newark Bay dataset, less than 10% of the samples met the data quality requirements for this assessment. It is possible to calculate higher TEQ levels if an inadequate number of congeners were used for calculating total PCBs or if less stringent adherence was paid to following data quality requirements. Where sparse congener data exist, the NOAA approach is available for estimating total PCBs, assuming that certain minimum data requirements are met.[13] To use the NOAA approach, the

sum of 18 NOAA PCB congeners is doubled to estimate the total PCB concentration. Our comparison of the two methods for calculating total PCBs (e.g., by using the sum of 159 PCB congener concentrations or by doubling the sum of the 18 NOAA congener concentrations) was conducted on the National Lake Fish Study datasets (total of 284 samples). It showed that the two methods agreed very closely with one another, giving results within the 10% variability typically seen in laboratory analytical reporting.

The decision to use a PCB congener method versus an Aroclor method for PCB quantification is part of the Data Quality Objective development process. Although it is often presumed that the Aroclor method is less accurate than the congener-based method, it has been reported that total PCBs calculated from summing Aroclor PCBs agreed well with those calculated using the sum of PCB congeners for several different types of biological matrices. [14]

Risk assessments need to balance the analytical costs with the collection of a sufficient number of samples to accurately characterize risk. The cost to perform the PCB congener method is typically 5 to 10 times the cost of the Aroclor PCB method. Therefore, a decision must be made as to whether it is more important to collect additional samples using a lower-cost method or to use more costly data developed from a smaller and potentially less representative dataset. Our review of public domain data suggests that the PCB congener method and TEQ calculations are not needed to ensure that a thorough evaluation of potential human health risks is performed, especially in light of much higher analytical costs. A cancer risk assessment based on the use of the PCB CSF and Aroclor PCB analytical methods is sufficiently rigorous to serve as the basis for evaluating risk management options.

The focus of this assessment was an analysis of fish fillet tissues in light of health risk assessment methods and the importance of the fish ingestion pathway for human exposure to PCBs. While the conclusions of this assessment may extend to other pathways of exposure, a similar analysis could be performed using available data on other biota or food items that may be consumed by humans.

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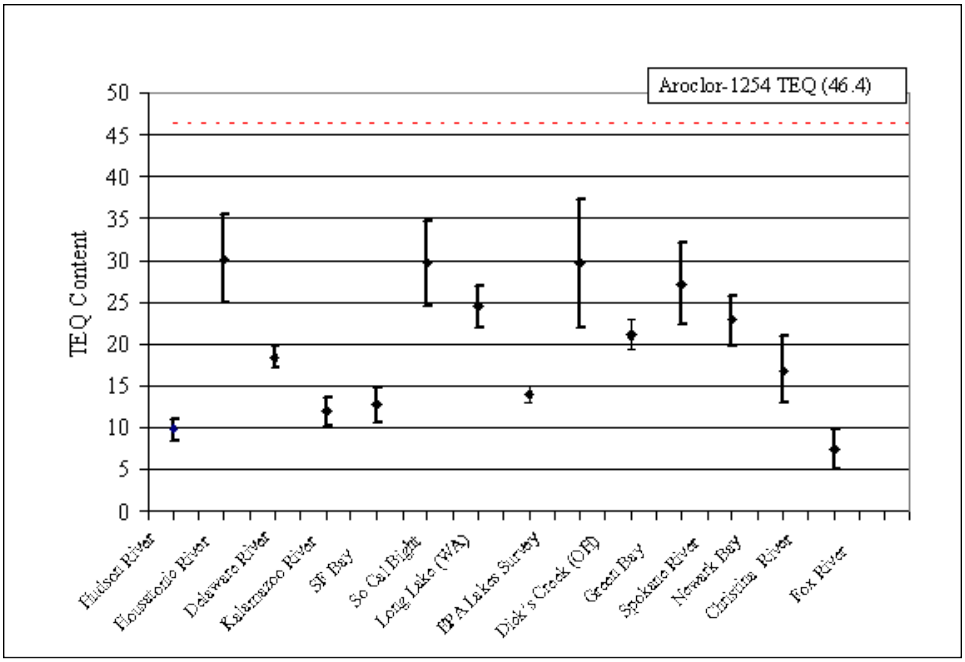

Figure 1. TEQ Content (as ng-TEQ/Kg-PCB) of Fish Fillet Tissue from Different US Waterbodies Compared to TEQ Levels of Aroclor 1254 (Mean and 95% C.I.)