Human Exposure to Dioxin-Like Compounds in Fish, Eggs and Soil

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Background

- Polychlorinated dioxins (PCDDs) and polychlorinated furans (PCDFs), referred to collectively as “dioxin-like compounds” or DLCs, are persistent compounds that build up in the body and remain stored in fat and other tissues for years.
- Health effects of DLCs observed in human studies include: cancer; chloracne; diabetes; disruption of the endocrine, immune and reproductive systems; and developmental effects in children.
- DLC toxic equivalents (TEQs) are calculated by multiplying the measured level of each DLC by its toxicity equivalency factor (TEF) and summing the results to determine the total DLC TEQ concentration.
- High levels of DLCs are found in sediments of the Tittabawassee River and soils in the river floodplain downstream of the city of Midland, Michigan.
- The Tittabawassee River frequently overflows its banks, sometimes more than once per year, carrying DLC contamination onto residential properties.
- We report the results of investigations conducted at a residential property in the Tittabawassee River floodplain where residents consumed local-caught fish and eggs from chickens raised on the property.

Fish, Chicken Egg and Soil Data

Table 1. Concentrations of DLCs in parts per trillion (ppt) in local-caught walleye, chicken eggs and soil samples collected from a property in the Tittabawassee River floodplain.

Conclusions

- High levels of PCDFs are predominant in soil samples collected at this property, and in soil and sediment samples throughout the Tittabawassee River floodplain.
- The distribution of DLCs in eggs from chickens raised on this property is very similar to that of soil samples. Chickens likely ingest soil directly during free-range feeding.
- In contrast, TCDD constitutes a higher percentage of the TEQ found in walleye, which feed primarily on smaller fish. The congener-specific half-lives of DLCs in biota range from a few months to several years.
- Congeners with longer half-lives, such as TCDD, are therefore more likely to be biologically magnified in the food chain.
- No congener-specific background serum DLC data are available for people under the age of 18 years. Data presented here for 18 to 29 year olds likely overestimates background levels in youth aged 14 to 17 years because serum TEQ concentrations are known to be positively correlated with age.
- Serum TEQ levels in all four Youth Cases are greater than the median background level in a Michigan control population aged 18 to 29 years. In addition, the percent contribution of PCDFs to the total TEQ in the Youth Cases is roughly twice that of control data.
- The serum TEQ level in the Adult Case is greater than the median background level of an age-appropriate Michigan control population. In addition, the percent contribution of PCDFs to the total TEQ in the Adult Case (19%) is greater than that of the control data (17%).
- These results suggest that living on contaminated soil in the Tittabawassee River floodplain, eating eggs from chickens kept there, and eating local-caught fish are sources of DLC contamination in the residents serum.

Table 2. Concentrations of DLCs in picograms per gram of lipid (pg/g) in serum of Michigan-specific controls and five Tittabawassee River floodplain residents.

Reference


Patterson Jr., D.G. et al. 2007. Total TEQ reference range (PCDDs, PCDFs, cPCBs, mono-PCBs) for the US. Chemosphere, doi:10.1016/j.chemosphere.2007.05.074
