



Food as a source of dioxin exposure in the residents of Bien Hoa City, Vietnam.

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Abstract:
Recently, elevated dioxin levels, over 5 parts per trillion (ppt) 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), from **Agent Orange** was reported in 95% of 43 selected residents of Bien Hoa City, a city in southern Vietnam near a former air base used for **Agent Orange**-spraying missions. **Agent Orange** herbicide, contaminated with TCDD, was sprayed in Vietnam between 1962 and 1971 primarily for use as a defoliant. Typical blood TCDD levels are 2 ppt in Vietnamese, but levels are as high as 413 ppt in Bien Hoa City. Elevated TCDD was found in children born many years after **Agent Orange** spraying ended and in immigrants from non-Agent Orange-sprayed parts of Vietnam, which documented new exposures. Extremely elevated soil TCDD samples, over 1 million ppt, and elevated TCDD in sediment were found in some nearby areas such as Bien Hung Lake. The primary route of intake of almost all dioxins in humans is food. However, in our prior studies in Bien Hoa, food was unavailable for dioxin analysis so the route of intake was not confirmed. In the 1970s, while **Agent Orange** was still being sprayed, elevated human milk TCDD levels as high as 1850 were detected in milk from Vietnamese people living in **Agent Orange**-sprayed areas where consumption of fish was high. Furthermore, also in the 1970s, elevated TCDD levels (up to 810 ppt) were found in fish and shrimp from the same area as the milk donors. In the 1980s, we found elevated TCDD and also other organohalogen levels in human tissue, pork, fish, a turtle, and a snake in Southern Vietnam. For these reasons, we recently collected food from Bien Hoa and analyzed it for dioxins, polychlorinated biphenyls (PCBs), DDT and its metabolites, and other organochlorines. We found marked elevation of TCDD, the dioxin characteristic of **Agent Orange**, in some of the food products, including ducks with 276 ppt and 331 ppt wet weight, chickens from 0.031-15 ppt wet weight, fish from 0.063-65 ppt wet weight, and a toad with 56 ppt wet weight. Usual TCDD levels in food are less than 0.1 ppt. Total TEQ for ducks was from 286-343 ppt wet weight or 536 ppt and 550 ppt lipid; for chickens from 0.35-48 ppt wet weight or 0.95-74 ppt lipid, for fish from 0.19-66 ppt wet weight or 3.2 ppt and 15,349 ppt lipid, and the toad was 80 ppt wet weight and 11,765 ppt lipid. Interestingly, this study did not find elevated levels of TCDD in the pork and beef samples. Clearly, food, including duck, chicken, some fish, and a toad, appears responsible for elevated TCDD in residents of Bien Hoa City, even though the original **Agent Orange** contamination occurred 30-40 years before sampling. Elevated levels of PCBs and DDT and its metabolites were found in some food samples. Furthermore, measurable levels of hexachlorocyclohexanes (HCH) and hexachlorobenzene (HCB) were found in a wide range



of measurable levels. All of the 11 dioxin-like PCBs measured and presented plus 6 dioxins in addition to TCDD and 10 dibenzofurans contributed to the total dioxin toxicity (TEQ). However, when elevated, TCDD frequently contributed most of the TEQ. Thirty-six congeners from 7 classes of chemicals were measured in each of the 16 specimens providing a total of 576 congener levels.

Major Subjects:

- 2,4,5-Trichlorophenoxyacetic Acid / * isolation & purification / toxicity
- 2,4-Dichlorophenoxyacetic Acid / * isolation & purification / toxicity
- Defoliants, Chemical / * isolation & purification / toxicity
- Environmental Exposure / * analysis
- Food Contamination / analysis / * statistics & numerical data
- Tetrachlorodibenzodioxin / * isolation & purification / toxicity

Additional Subjects:

- Animals
- Birds
- Cattle
- Fishes
- Humans
- Meat Products
- Poultry
- Research Support, Non-U.S. Gov't
- Sus scrofa
- Vietnam

Chemical Compound Name:

(Defoliants, Chemical); 1746-01-6(Tetrachlorodibenzodioxin); 39277-47-9(**Agent Orange**); 93-76-5(2,4,5-Trichlorophenoxyacetic Acid); 94-75-7(2,4-Dichlorophenoxyacetic Acid)