

Letters to the Editor

Food as a Source of Dioxin Exposure in the Residents of Bien Hoa City, Vietnam—Schechter et al.

Response

We thank Dr Truyet T. Mai for his interest in our recently published article on dioxin from **Agent Orange** as a continuing source of current contamination of food in one location in Vietnam. ^[1] We appreciate his interest in the environmental and health effects of dioxin exposure in Vietnam. ^[2]

Although Dr Mai voices no criticisms of our analytical methods, we feel that it is appropriate to re-emphasize what method we used to examine human blood, soil, sediment, wildlife, and food for 2,3,7,8-TCDD (TCDD) where **Agent Orange** had been sprayed or stored. After cleanup, all samples were analyzed by high-resolution gas chromatography-high resolution mass spectroscopy (GC-MS) with the use of appropriate chemical standards conducted by ERGO Research Laboratory, which is certified by the World Health Organization for the determination of congener specific dioxins, dibenzofurans, and PCBs in human tissue and food. This method is the current “gold standard” for determination of dioxin exposure regardless of the original source of the dioxin. ^[3]
^[4] ^[5] ^[6] ^[7] ^[8]

2,3,7,8-TCDD, unquestionably from **Agent Orange**, has been identified in humans and their food sources since 1970 when one of us (J.D.C.) collected human milk and fish from heavily **Agent Orange**-sprayed areas of Vietnam for dioxin analyses. These pioneer dioxin analyses showed as much as 1850 parts per trillion of 2,3,7,8-TCDD on a lipid basis in some nursing mothers’ milk, which is the highest human milk level ever recorded and which can be compared to the US and south of Vietnam current background level of approximately 2 ppt; whereas in fish up to 1020 ppt wet weight (ww) was detected compared with a usual background of less than 0.01 ppt ww. ^[9] ^[10] ^[11] ^[12] Subsequently, blood and fat samples were used to estimate **Agent Orange** exposure. As a result, some US Vietnam veterans were shown to be carrying elevated levels of the specific dioxin (2,3,7,8-TCDD), which contaminates **Agent Orange**. ^[7] ^[13] ^[14] ^[15]

Part of Bien Hoa City is a dioxin “hot spot” not only because of the history of herbicide spraying and of a major **Agent Orange** spill as documented by the US Department of Defense but also by the determination of elevated 2,3,7,8-TCDD (and only this of many dioxin congeners measured) in selected inhabitants chosen for greater likelihood of herbicide exposure. Contamination of human or environmental samples with products of incineration, ^[16] ^[17] pentachlorophenol, ^[8] ^[18] contaminated rice oil ^[19] ^[20] ^[21] or, as here, **Agent Orange**, results in characteristic patterns of the 7 chlorinated dioxin, 10 chlorinated dibenzofuran, and 12 PCB congeners, which characterizes or “fingerprints” the source of the exposure. The elevation of only this specific dioxin, and no dibenzofurans or PCBs, ^[3] ^[4] ^[6] ^[22] ^[23] ^[24] ^[25] ^[26] ^[27] is persuasive evidence that the material originated from **Agent Orange** either sprayed, spilled, or inadequately stored with resulting leakage.

To elaborate, as a result of municipal waste incineration, many other dioxins and dibenzofurans are characteristically formed, especially octachlorodibenzodioxin. ^[16] If chlorine is used for bleaching, paper and pulp effluents typically contain 2,3,7,8-TCDF and 2,3,7,8-TCDD. Pentachlorophenol is typically contaminated with higher chlorinated dioxins and dibenzofurans with eight, seven, and six chlorines, not tetrachlorinated dioxins or dibenzofurans. ^[8] ^[18]

The fact that food of animal origin is the route of intake of over 95% of the intake of dioxins in humans is now well documented. ^[28] ^[29] ^[30] ^[31] ^[32] The purpose of our article was to document, in this location and at this time, the link between the dioxin-contaminated population and the contamination of their food. The food that we sampled

was, in fact, representative of that eaten by our human subjects. All our higher levels of TCDD were found in food from the contaminated lake or nearby in this study, consistent with findings from previous work. [\[24\]](#) [\[25\]](#) [\[33\]](#) [\[34\]](#)

The Bien Hoa “hot spot” is quite similar to the one in the central highlands studied by a Canadian environmental team which shows similar elevation of 2,3,7,8-TCDD in human tissue, soil, sediment, and food. [\[5\]](#) [\[6\]](#)

In his reference to PCBs, Dr Mai seems to be mistaken in describing them as being characteristically contaminated with dioxins and dibenzofurans. In fact, their characteristic contaminants are dibenzofurans. [\[35\]](#) When heated to certain temperatures in the presence of oxygen, even more dibenzofurans are typically formed. [\[36\]](#) [\[37\]](#) Although there is considerable similarity between dioxins and dibenzofurans, they are different compounds. It was the dibenzofurans in rice oil resulting from heated PCBs that were primarily responsible for the Yusho rice oil poisoning of 1969 in Japan and the Yucheng rice oil poisoning of 1979 in Taiwan. [\[21\]](#) [\[22\]](#)

From a public health perspective, we agree that it would be useful to determine the history of PCB importation in Vietnam and the current levels of contamination in humans and the environment because these and their contaminants are very persistent compounds.

We certainly agree with Dr Mai that **Agent Orange** is not the only toxic chemical that is to be found in Vietnam. Since the 1980s we and others have reported the presence of contaminating chemicals other than TCDD in Vietnam. [\[38\]](#) [\[39\]](#) [\[40\]](#) [\[41\]](#) [\[42\]](#) [\[43\]](#) However, the report under discussion was mainly confined to the study of **Agent Orange**. We can refer to our previous studies of sediment or silt performed many years ago, which found elevated TCDD in areas that had been sprayed whereas none was found in Hanoi (unsprayed), but at the same time we found other dioxins than 2,3,7,8-TCDD in both locations, presumably from incineration or other industrial sources. Since then, the article under discussion joins others in showing many dioxins as well as other chlorinated organics not from **Agent Orange** in the Vietnamese population and environment. These may also contribute to adverse health outcomes. We have focused much of our work on 2,3,7,8-TCDD in Vietnam because the TCDD contamination from **Agent Orange** is, to the best of our knowledge, the largest and potentially most significant dioxin exposure that has occurred to date and which has the potential to have caused serious health effects on exposed Vietnamese and also American and other Vietnam veterans.

The evidence is overwhelming that, although it has been 30 years since the last direct contamination with **Agent Orange** in Vietnam, there is continued exposure of the population and that these high levels come through food because many of those with high levels of TCDD, up to 413 ppt, which is the highest blood level ever found in a Vietnamese, were born long after the use of **Agent Orange** had ceased. Levels of TCDD above current background of approximately 2 ppt were found in 95% of the population tested. Bien Hoa remains a dioxin hot spot, currently with high levels of TCDD in human blood, soil, food, and sediment samples. Because most dioxin enters humans through the food chain and because we found many food samples with elevated levels of 2,3,7,8-TCDD, and this particular dioxin only, among the more than 20 dioxins, dibenzofurans and PCBs we studied, we can feel very confident that their food is the continuing route of intake in the people of Bien Hoa, regardless of the precise origin of every food tested. Although our research focuses mainly on TCDD exposure in Vietnam, the reason for our concern is the known human toxicity of dioxins and dioxin-like compounds to Vietnamese or others exposed to these compounds. [\[19\]](#) [\[20\]](#) [\[23\]](#) [\[30\]](#) [\[31\]](#) [\[44\]](#) [\[45\]](#) [\[46\]](#) [\[47\]](#)

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