

DIOXINS IN LAOTIAN BLOOD AND MILK

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Introduction

Laos is a small country in Southeast Asia. It is for the most part devoid of industry. It was one of three countries sprayed by Agent Orange herbicide, a phenoxyherbicide contaminated with 2,3,7,8-tetrachlorodibenzodioxin, or TCDD, at about 3 parts per million (ppm) average. Agent Orange is half 2,4,5-trichlorophenoxyherbicide, or 2,4,5-T, and half 2,4-dichlorophenoxyacetic acid, or 2,4-D. These were mixed with diesel oil and sprayed mostly by fixed wing aircraft over Vietnam, Laos and Cambodia to defoliate forests and make it difficult for enemy troops to hide. This part of the "Vietnam War" or "Second Indochina War" involved spraying from 1962-1971. In Vietnam, it has been relatively easy from 1970 to 2001 to find elevated TCDD from Agent Orange in humans, soil, sediment, and food¹⁻³. To the present time, no dioxin congener specific analysis has been performed on Laotian people. People from a non-sprayed area, Vientiane, and a sprayed area, Sepone also spelled Xepone, were studied.

Methods and Materials

Blood and milk was collected in chemically cleaned glass bottles, and frozen. It was delivered to the German and Canadian dioxin laboratories frozen on dry ice. The two laboratories have been certified by the World Health Organization for analysis of dioxins in human tissue.

High resolution gas chromatography-high resolution mass spectrometry was employed by both laboratories. Analysis was for 7 dioxin, 10 dibenzofuran and four coplanar polychlorinated biphenyls (PCBs). Methods used in the Canadian and German laboratories have been described in detail elsewhere⁴⁻⁶.

Results and Discussion

Table 1 lists the dioxin, dibenzofuran and coplanar PCB measurements and their dioxin toxic equivalents (TEQ) in blood samples. TCDD is low in all samples. Total dioxin and dibenzofuran levels are also low, with TEQs ranging from 0.29 ppt lipid to 7.78 ppt if zero is used for the limit of detection when ND is reported. When coplanar PCBs are added, the total TEQs range from 0.39 to 11.01 ppt. When ½ the detection limit is used for calculation when NDs are found, total TEQ ranges from 4.49 to 11.45 ppt.

Table 2 lists the same congeners in Laotian human milk and compares this with German milk. TCDD is low in the Laotian milk, 0.06 to .35 ppt lipid, and German milk is 1.6 ppt. Total TEQ in the German milk is 22.65 whereas the Laotian milk has a range from 0.59 to 1.62 ppt lipid, using ½ the detection limit for non-detects.

This first study of Laotian blood and milk found very low dioxin and dibenzofuran levels in humans, as would be expected in a non-industrial country. Elevation of TCDD level, the dioxin characteristic of Agent Orange exposure, was for the most part not found. Most of our subjects were relatively young, which might have accounted for this negative finding. The TCDD could have been washed away over time, not gotten into the food supply, or Agent Orange might not have been the herbicide sprayed by the American military in this location, although 85 % of herbicides used by the USA was believed to be Agent Orange.

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Table 1. Dioxin, dibenzofuran, and coplanar PCB congeners in Laotian blood and comparison to German blood samples (pg/g of lipid or parts per trillion (ppt)).

Compound Name	LS 1	LS3	LS6	LS 8	LS 9	Laos	German	
TEF								
2,3,7,8-TCDD	1	ND(1.2)	ND(1.7)	ND(1.1)	2.1	1.7	1.4	2.4
1,2,3,7,8-PnCDD	1	ND(1.0)	ND(1.4)	ND(1.8)	1.4	1.9	2.8	5.7
1,2,3,4,7,8-HxCDD	0.1	ND(1.5)	ND(2.8)	ND(1.3)	ND(1.8)	ND(1.7)	ND(2.3)	6.5
1,2,3,6,7,8-HxCDD	0.1	1.5	2.9	2.1	1.9	2.3	6	28.0
1,2,3,7,8,9-HxCDD	0.1	1.5	ND(1.9)	1	ND(1.1)	1.7	1.9	3.6
1,2,3,4,6,7,8-HpCDD	0.01	5.3	ND(7.1)	3	4.2	ND(4.0)	17.1	31
OCDD	0.0001	71.5	0.108	39.8	37.9	32.1	203	246
2,3,7,8-TCDF	0.1	ND(1.8)	ND(2.6)	ND(1.1)	ND(1.5)	ND(1.4)	ND(1.3)	ND(1)
1,2,3,7,8-PnCDF	0.05	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.1)	ND(1)
2,3,4,7,8-PnCDF	0.5	1.6	ND(1.0)	1.6	2.4	3	3.5	13
1,2,3,4,7,8-HxCDF	0.1	2.2	ND(1.9)	1.4	2.8	2.8	3.5	6.7
1,2,3,6,7,8-HxCDF	0.1	1	ND(1.1)	1.4	1.9	2.1	2.2	5.4
2,3,4,6,7,8-HxCDF	0.1	ND(1.1)	ND(4.5)	ND(2.8)	ND(1.1)	ND(1.6)	ND(2.9)	ND(1)
1,2,3,7,8,9-HxCDF	0.1	ND(1.8)	ND(2.6)	ND(1.1)	ND(1.6)	ND(1.5)	1.8	1.5
1,2,3,4,6,7,8-HpCDF	0.01	ND(3.4)	ND(4.9)	ND(2.0)	ND(2.9)	ND(2.8)	10.1	ND(4)
1,2,3,4,7,8,9-HpCDF	0.01	ND(1.5)	ND(3.2)	ND(1.5)	ND(2.2)	ND(2.6)	ND(5.7)	ND(3)
OCDF	0.0001	ND(13)	ND(19)	ND(7.8)	ND(11)	ND(11)	ND(12)	ND(10)
TeCB 81	0.0001	ND(95)	ND(2.7)	ND(1.1)	2	3	2	ND(50)
TeCB 77	0.0001	ND(1.8)	ND(137)	ND(56)	ND(81)	ND(77)	ND(58)	ND(6)
PnCB 126	0.1	ND(38)	ND(55)	ND(23)	ND(32)	ND(31)	31	71
HxCB 169	0.01	8	10	11	17	15	13	90
"0" limit of detection								
PCDD TEQ	0.36	0.29	0.34	3.74	4.00	5.18	12.24	
PCDF TEQ	1.12	0.00	1.08	1.67	1.99	2.60	7.86	
PCDD/F TEQ	1.48	0.29	1.42	5.41	5.99	7.78	20.10	
Non-ortho PCB TEQ	0.08	0.10	0.11	0.09	0.15	3.23	8.00	
Total TEQ	1.56	0.39	1.53	5.49	6.14	11.01	28.10	
½ of limit of detection								
PCDD TEQ	1.54	2.11	1.86	3.88	4.11	5.35	12.24	
PCDF TEQ	1.41	1.05	1.37	1.93	2.27	2.87	8.02	
PCDD/F TEQ	2.94	3.16	3.23	5.81	6.38	8.21	20.27	
Non-ortho PCB TEQ	1.98	2.86	1.26	1.69	1.70	3.23	8.00	
Total TEQ	4.93	6.02	4.49	7.50	8.08	11.45	28.27	

ND – Not detected, detection limit in parentheses.

LS1, LS3, LS6, LS8, and LS9 – individual blood samples collected in Agent Orange sprayed Sepone Village. Laos Pool 1 – pooled blood sample collected in Vientiane, Laos, N=50.

Germany – pooled blood, N=13; Fürst and Pöpke, 2002.

Table 2. Levels of dioxin, dibenzofuran, and polychlorinated biphenyl congeners in Laotian milk from Sepone and comparison to German milk samples.

Compound Name	LS2	Laos Milk, 2001			German Milk, 2001 ^a
		LS5	LS12		
WHO-TEF					
2,3,7,8-TCDD	1	0.06	0.24	0.35	1.6
1,2,3,7,8-PnCDD	1	0.13	0.22	0.42	4.1
1,2,3,4,7,8-HxCDD	0.1	0.12	ND(0.23)	ND(0.2)	2.8
1,2,3,6,7,8-HxCDD	0.1	0.20	0.57	0.74	12.9
1,2,3,7,8,9-HxCDD	0.1	0.29	0.39	ND(0.2)	2.4
1,2,3,4,6,7,8-HpCDD	0.01	0.60	1.42	1.88	14.5
OCDD	0.0001	9.01	18.71	20.27	86.8
2,3,7,8-TCDF	0.1	0.10	0.23	0.17	0.34
1,2,3,7,8-PnCDF	0.05	0.10	0.28	ND(0.18)	0.24
2,3,4,7,8-PnCDF	0.5	0.17	0.35	0.56	11.1
1,2,3,4,7,8-HxCDF	0.1	0.22	0.48	ND(1.15)	2.8
1,2,3,6,7,8-HxCDF	0.1	0.13	0.23	ND(0.80)	2.4
2,3,4,6,7,8-HxCDF	0.1	0.06	0.17	ND(0.70)	0.07
1,2,3,7,8,9-HxCDF	0.1	ND(0.04)	ND(0.11)	ND(0.81)	1.1
1,2,3,4,6,7,8-HpCDF	0.01	0.06	ND(0.06)	ND(0.16)	3.7
1,2,3,4,7,8,9-HpCDF	0.01	ND(0.07)	ND(0.25)	ND(0.53)	0.1
OCDF	0.0001	ND(0.32)	ND(0.87)	ND(1.40)	1.2
TeCB 81	0.0001	0.25	0.29	0.45	N.A.
TeCB 77	0.0001	0.68	ND(0.11)	ND(0.15)	N.A.
PnCB 126	0.1	1.88	3.52	4.33	84.1
HxCB 169	0.01	0.72	1.35	2.61	30.5
PCDD TEQ		0.25	0.57	0.86	7.66
PCDF TEQ		0.14	0.30	0.30	6.27
PCDD/F TEQ		0.39	0.87	1.16	13.93
Non-ortho PCB TEQ		0.20	0.37	0.46	8.72
Total TEQ		0.59	1.23	1.62	22.65

Data presented in pg/g of lipid or parts per trillion (ppt).

ND – Not detected, detection limit in parentheses, half of the limit of detection used in calculation of TEQs.

NA– not analyzed.

LS2, LS5, LS12 – breast milk samples collected in Agent Orange sprayed Sepone Village, Laos

^a Mean levels of 69 individual blood samples collected in North Rhine-Westphalia/Germany; Fürst and Pöpke, 2002.