LEVELS OF DIOXIN AND DIBENZOFURAN CONGENERS IN FOOD AND BLOOD FROM CAMBODIA

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Introduction

Cambodia has little industry, and therefore has small amounts of the synthetic dioxins and dibenzofurans. Our previous reports of Cambodian blood dioxin levels are among the lowest levels found worldwide, although parts of this country were sprayed with Agent Orange, a phenoxyherbicide contaminated with 2,3,7,8-TCDD, during the Vietnam War[1-2]. In this paper, we present the first report to date on dioxin and dibenzofuran levels in food samples from Cambodia compared with Cambodian blood from the same area.

Methods and Materials

Convenience samples of blood were collected near the Vietnam-Cambodian border in the spring of 2000. Food was purchased from a Phnom Penh market, and is believed to be of local origin. Blood was analyzed in Hamburg and food in Muenster, Germany, both WHO-certified for dioxin analysis. High-resolution gas chromatography-mass spectrometry was used, and has been previously described elsewhere[3-6].

Reported data is presented as measured levels and total PCDD/PCDF 1998 dioxin Toxic Equivalents (TEQ), on a whole weight basis (as purchased and consumed). Only fish and meat were collected, as dairy products are not common in Cambodia. Fruits and vegetables have previously been found to be very low in dioxin content [7-9].

Results and Discussion

Results of food and blood analyses are shown in Table 1 and Table 2, respectively. No elevation of TCDD is noted for these samples. Blood dioxin and dibenzofuran levels are relatively low compared to those found in more industrialized countries.

This data again demonstrates low dioxin and dibenzofuran levels in persons living in remote areas away from heavy industry. This contrasts findings of elevated dioxin levels in Arctic areas, where airborne levels of dioxins from industrial countries including the USA, have been reported[11]. These blood findings are similar to those we previously reported from rural China, northern Vietnam, Thailand, Russian Siberia, and other less industrialized regions [1, 11].

Further research is needed to collect samples closer to where Agent Orange spraying occurred. This task is difficult and dangerous given the presence of unexploded ordnance and land mines. However, to date, no elevation of TCDD levels has been found in Cambodian blood or food.

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Table 1.
Measured Levels and Dioxin Toxic Equivalents of of Dioxins and Dibenzofurans in Food from Phnom Penh, Cambodia, 2000*

Congeners	1998 WHO TEFs	Chicken Breast & Bone	Pork Liver	Hind Shank Beef	Bacon	Shrimp	Fish
2,3,7,8-TCDD	1	0.01	0.01	0.001	0.01	0.02	0.02
1,2,3,7,8-PeCDD	1	0.02	0.01	0.001	ND(.013)	0.12	0.07
1,2,3,4,7,8-HxCDD	0.1	0.01	0.02	0	0.01	0.05	0.03
1,2,3,6,7,8-HxCDD	0.1	0.01	0.02	0.002	0.01	0.06	0.05
1,2,3,7,8,9-HxCDD	0.1	0.004	0.01	0.001	ND(.005)	0.06	0.02
1,2,3,4,6,7,8-HpCDD	0.01	0.04	0.09	0.04	0.12	0.09	0.05
OCDD	0.0001	0.12	0.65	0.25	0.93	0.17	0.18
2,3,7,8-TCDF	0.1	0.01	0.02	0.004	0.01	0.02	0.1
1,2,3,7,8-PeCDF	0.05	0.004	0.001	0	ND(.005)	0.003	0.03
2,3,4,7,8-PeCDF	0.5	0.002	0.04	0.001	0.01	0.003	0.03
1,2,3,4,7,8-PeCDF	0.1	0.002	0.03	0.001	0.02	0.001	0.003
1,2,3,6,7,8-HxCDF	0.1	0.001	0.03	0.001	0.01	0.001	0.004
2,3,4,6,7,8-HxCDF	0.1	0.001	0.01	0.001	0.01	0.002	0.003
1,2,3,7,8,9-HxCDF	0.1	ND(.001)	ND(.001)	0	ND(.005)	0	0.003
1,2,3,4,6,7,8-HpCDF	0.01	0.01	0.04	0.003	0.04	0.004	0.01
1,2,3,4,7,8,9-HpCDF	0.01	0.001	0.004	0	0.01	0	0.001
OCDF	0.0001	0.01	0.01	0.01	0.04	0.01	0.01
Total PCDD		0.214	0.81	0.295	1.1	0.57	0.42
PCDD TEQ		0.033	0.026	0.003	0.02	0.158	0.1
Total PCDF		0.042	0.1855	0.021	0.155	0.044	0.194
PCDF TEQ		0.002	0.03	0.001	0.011	0.005	0.019
Total PCDD/PCDF		0.289	0.996	0.319	1.275	0.772	0.714
PCDD/PCDF TEQs		0.035	0.056	0.004	0.031	0.163	0.119
% Fat		3.5	3.4	0.19	25	0.47	5.6

* Samples represented as parts per trillion (ppt), whole-wight basis

1998 WHO Dioxin Toxic Equivalency Factors used to calculate TEQs

Table 2.
Dioxin and Dibenzofuran Measured Levels and Total International Dioxin Toxic Equivalents in a Human Pooled Sample and Individual Samples of Cambodian Blood, Year 2000

		Sample Number							
Congeners	I-TEF	1*	2	3	4	5	6	7	8
2.3.7.8-Tetra-CDD	1	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)	1.1	ND(1.0)	1.3	ND(1.0)
1.2.3.7.8-Penta-CDD	0.5	ND(1.0)	2	1.2	2.3	1.3	1.7	3.3	2.7
1.2.3.4.7.8-Hexa-CDD	0.1	ND(1.0)	ND(1.3)	1.2	1.2	ND(1.0)	ND(1.1)	1.8	1.3
1.2.3.6.7.8-Hexa-CDD	0.1	1.2	2.3	2.5	4	2.1	3.5	3.5	3.4
1.2.3.7.8.9-Hexa-CDD	0.1	ND(1.0)	ND(1.0)	1.1	2.3	ND(1.0)	1.5	1.4	1.1
1.2.3.4.6.7.8-Hepta-CDD	0.01	6.8	6.2	13.4	20.2	12.8	7.9	7.4	8
OCDD	0.001	72.1	39.9	82.2	114.3	89.6	51.3	59	75.4
2.3.7.8-Tetra-CDF	0.1	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
1.2.3.7.8-Penta-CDF	0.05	ND(1.1)	ND(1.4)	<2.1	ND(1.2)	ND(1.2)	ND(1.0)	ND(1.0)	ND(1.1)
2.3.4.7.8-Penta-CDF	0.5	1	1.4	2.4	2.1	1.6	1.3	4.3	3.3
1.2.3.4.7.8-Hexa-CDF	0.1	1.6	1.3	4.1	1.9	1.7	1.5	5.7	3.4
1.2.3.6.7.8-Hexa-CDF	0.1	1.2	1.1	3	1.3	1.1	1.3	5.9	2.4
1.2.3.7.8.9-Hexa-CDF	0.1	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)	ND(1.0)
2.3.4.6.7.8-Hexa-CDF	0.1	1.4	1.1	1.8	1.5	1.1	1	2	1.1
1.2.3.4.6.7.8-Hepta-CDF	0.01	7	2.2	5.4	5.1	2.9	4.7	10.8	4.8
1.2.3.4.7.8.9-Hepta-CDF	0.01	ND(1.4)	ND(1.8)	ND(2.2)	ND(2.1)	ND(1.4)	ND(2.3)	ND(2.2)	ND(2.2)
OCDF	0.001	<5.0	<5.0)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Total PCDD		80.1	50.3	101.7	144.4	106.9	65.9	77.7	92
PCDD TEQ		0.26	1.33	1.31	2.21	2.21	1.49	3.73	2.1
Total PCDF		15.7	10.6	21.3	15.4	12	13.2	32.2	18.5
PCDF TEQ		1.09	1.18	2.29	1.68	1.34	1.16	3.73	2.46
Total PCDD/PCDF		95.7	60.9	123	159.8	118.9	79.1	109.9	110.5
PCDD/PCDF TEQ		1.35	2.51	3.6	3.89	3.55	2.65	7.46	4.56

*Phnom Penh Pooled N=50

International Toxic Equivalents used to calculate TEQs

ND=not detected, detection limit in (). Values with < contribute with 50%

pg/g (ppt), lipid basis