POLYCHLORINATED DIOXINS AND DIBENZOFURANS IN ENVIRONMENTAL SAMPLES FROM CHINA

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1. Introduction

Despite being one of the world's largest nations, there is relatively little environmental information on polychlorinated dioxins (PCDDs) and dibenzofurans (PCDFs) in China. Agricultural handbooks published in China suggest applications of herbicides such as 2,4,5-T and pentachlorophenol, but it is difficult to verify application sites and rates of these compounds. The fact that China has no formal regulations on PCDDs and PCDFs also minimizes the need to analyze and to keep records on these chemicals. This paper attempts to begin documentaion of the presence of the compounds in some environmental soil, sediment, municipal wastewater and industrial wastewater samples from a variety of sources. Although attempts were made to sample locations that are significant such as the Yangtze River or the most likely sources of contamination such as paper mills and a pentachlorophenol production plant, the selection of sites and sample matrix is not entirely environmentally or scientifically logical due to the lack of background information and difficult access to some of the more ideal sites.

2. Samples

The samples were collected around October of 1995 from locations in central and northern China.They were shipped to the United States without preservation and cooling. Table 1. is a list of the samples and their sources.

3. Sample Preparation and Analysis

The samples were analyzed according to U.S.EPA Method 1613A (Revision A, dated October 1992). 10 gm of sediment or soil was extracted for each solid sample. For water samples, an aliquot of approximately 1 liter was analyzed.

4. Results

The analytical results together with the calculated toxic equivalent concentrations (TEQ) are presented in Table 2 and Table 3.

5. Discussion

With the exception of a few samples, the ranges of TEQ calculated from PCDDs and PCDFs in the wastewater and sediment samples are within the ranges of those found in other industrial countries. The total TEQ for most of the river sediment samples were actually lower than other Asian regions such as Japan [1,2]. The only higher samples are Nos. SD05, SD09 and WW07. Samples SD05 and WW07 were collected in a wastewater treatment plant which receives part of its wastewater from several industries, including a nearby paper mill. Sample SD09 was sampled from just down stream of Hefei city which discharges industrial wastewater directly into the Nanfei River. As one of the major rivers in China, the Yangtze River flows through many provinces and cities; and it is interesting to note that the four Yangtze sediment samples collected from three different provinces had similar concentrations and profiles.

Although the soil sample collected from the pentachlorophenol plant was expected to contain PCDDs and PCDFs, the levels of the compounds in Sample No. SO01 were much higher than anticipated. Further studies involving extensive sampling of various matrixes such as soil, water, air and wall surfaces in and around the plant will be needed to assess the extent of contamination. Because the PCP plant is so close to a river and a housing development, risk assessment studies should be conducted to evaluate its effects on the surrounding environment and local residents. It is not clear why the levels of PCDDs and PCDFs in our soil sample are higher than those in the Na-PCP produced by the same plant as reported by L. Li [3]. The PCDD and PCDF profiles of the two studies are also not exactly the same. One possible explanation for the differences in levels and profiles is that the our soil sample was obtained from an area which appeared to be highly contaminated with production wastes while the Na-PCP sample analyzed by L. Li was a purified commercial grade product.

6. References

1) Ohsaki, Y., T. Matsueda and K.Youichi (1994): Levels and features of PCDD's, PCDF's and Co-PCB's in River and Coastal Sediments. 14th International Symposium on Chlorinated Dioxins, PCB and Related Compounds, Kyoto, Japan.

2) Yamamoto, T.(1994): Multivariate statistical analysis of PCDD's and PCDF's in Japanese aquatic sediments. 14th International Symposium on Chlorinated Dioxins, PCB and Related Compounds, Kyoto, Japan.

3) Li, L., Y. Chan, C. Chiu, G. Poole, W. Miles, and K. Jiang, (1994): PCDD/F's in Sediment Samples from Chinese schistosomiasis areas and potential human health effects. 14th International Symposium on Chlorinated Dioxins, PCB and Related Compounds, Kyoto, Japan.

Table 1: Sample Description

ID	Matrix	Location
WW01	Mun. wastewater	No. 3 Harbor, Bengu, Anhui
WW02	Chemical wastewater	Bengu, Anhui
WW03	Paper mill wastewater	Bengu, Anhui
WW04	Chemical wastewater	Beida Gou, Jilin City, Jilin
WW05	Chemical wastewater	Xian, Jilin City. Jilin
WW06	Paper mill wastewater	Jilin City, Jilin
WW07	Mun. wasterwater	Gaobei Dian Wastewater Treatment Plant, Beijing
SO01	Soil from PCP plant	Tianjin
SD01	Sediment	No. 3 Harbor, Bengu, Anhui
SD02	Chemical wastewater	Bengu, Anhui ,discharge sediment
SD03	Chemical wastewater	Beida Gou, Jilin City, Jilin discharge sediment
SD04	Plant sediment	Baoding Wastewater Treatment Plant, Heibei
SD05	Plant sediment	Gaobei Dian Wastewater Treatment Plant, Beijing
SD06	Lake sediment	Hongze Lake, Jiangsu
SD07	Canal sediment	Grand Canal, Xuzhou, Jiangsu
SD08	River sediment	Fu River, Chengdu, Sichuan
SD09	River sediment	Nanfei River, Hefei, Anhui
SD10	Lake sediment	Dongting Lake. Yueyang, Hunan
SD11	River sediment	Han River, Wuhan, Heibei
SD12	Lake sediment	Poyang Lake, Hu Kou, Jiangxi
SD13	River sediment	Yangtze R., Jiujiang, Jiangxi
SD14	River sediment	Yangtze R., Wuhu, Anhui
SD15	River sediment	Yangtze R., Nanjiang, Jiangsu
SD16	River sediment	Yangtze R., Zhenjiang, Jiangsu
SD17	River sediment	Huangpu R., Dian Shan, Shanghai
SD18	River sediment	Huangpu R., Wusong Kou, Shanghai
SD19	River sediment	Huaihe R., Yangzhou, Jiangsu

Table 2: Concentration of PCDD and PCDF in Wastewater Samples (pg/L)

	WW02	WW03	WW04	WW05	WW06	WW07
2,3,7,8-TCDD	ND	ND	ND	ND	ND	ND
Total TCDD	ND	ND	ND	ND	ND	18
1,2,3,7,8-PeCDD	ND	ND	ND	ND	ND	ND
Total PeCDD	ND	ND	ND	ND	ND	ND
1,2,3,4,7,8-HxCDD	ND	ND	ND	ND	ND	ND
1,2,3,6,7,8-HxCDD	ND	ND	ND	ND	ND	ND
1,2,3,7,8,9-HxCDD	ND	ND	ND	ND	ND	ND
Total HxCDD	ND	ND	ND	ND	ND	26
1,2,3,4,6,7,8-HpCDF	11	8.1	14	ND	3.4	37
Total HpCDD	11	8.1	27	ND	6.6	37
OCDD	89	48	140	66	25	270
2,3,7,8-TCDF	ND	ND	15	ND	ND	450
Total TCDF	ND	ND	26	ND	ND	1100
1,2,3,7,8-PeCDF	ND	ND	6.7	ND	ND	52
2.3.4.7.8-PeCDF	4.7	ND	ND	ND	ND	44
Total PeCDF	4.7	ND	8.9	ND	ND	160
1,2,3,4,7,8-HxCDF	ND	ND	7	ND	ND	58
1,2,3,6,7,8-HxCDF	ND	ND	ND	ND	ND	16
2,3,4,6,7,8-HxCDF	ND	ND	5.4	5.5	5.2	13
1,2,3,7,8,9-HxCDF	ND	ND	ND	ND	ND	ND
Total HxCDF	ND	ND	8.1	5.5	5.2	96
1,2,3,4,6,7,8-HpCDF	7.7	ND	ND	ND	ND	42
1,2,3,4,7,8,9-HpCDF	ND	ND	ND	ND	ND	25
Total HpCDF	7.7	ND	ND	ND	ND	112
OCDF	66	15	56	46	15	270
TEQ	2.6	0.14	3.4	0.11	0.59	78

Table 3: Concentration Of Sediment And Soil Samples (pg/g, d.w.)

	SD01	SD02	SD03	SD04	SD05	SD06	SD07	SD08	SD09	SD10	SD11	SD12	SD13	SD14	SD15	SD16	SD17	SD18	SD19	SO01
2,3,7,8-TCDD	ND	ND	ND	ND	ND	ND	ND	ND	1.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9,000
Total TCDD	5.4	8.4	9.6	ND	12	0.79	1.5	2.1	6.3	0.44	ND	0.77	0.93	0.92	1.2	1.1	2	ND	4.2	70,000
1,2,3,7,8-PeCDD	ND	ND	ND	ND	ND	ND	ND	ND	3	ND	ND	0.21	ND	ND	ND	ND	ND	ND	ND	130,000
Total PeCDD	ND	1.8	3.6	ND	ND	ND	ND	1.8	4.2	ND	ND	0.72	0.67	0.59	0.84	0.76	0.89	0.49	4.9	420,000
1,2,3,4,7,8-HxCDD	ND	ND	1.3	ND	ND	ND	ND	1.1	2.7	0.44	ND	0.77	0.19	0.15	0.28	0.27	ND	ND	2.9	440,000
1,2,3,6,7,8-HxCDD	ND	ND	1.8	ND	1.6	ND	ND	1	4.8	0.26	ND	0.73	0.15	0.13	0.28	0.28	ND	ND	0.74	780,000
1,2,3,7,8,9-HxCDD	ND	ND	2	ND	0.88	ND	ND	0.53	2.7	ND	ND	1	0.18	0.17	0.43	0.3	ND	ND	ND	610,000
Total HxCDD	4.2	2.4	17	ND	11	1.5	ND	12	27	3.3	ND	11	1.8	1.8	4.5	2.6	4.1	3.1	6	3,600,000
1,2,3,4,6,7,8-HpCDI	4	1.6	6.1	2.3	8.1	2.4	1.4	9	18	5.2	ND	23	2.5	3	8.1	10	3.1	4.2	13	12,000,000
Total HpCDD	7.1	2.8	11	2.3	14	5.4	2.5	16	30	11	0.66	54	5.5	7.3	20	22	9.4	12	28	15,000,000
OCDD	40	8.5	12	40	85	33	7.6	38	80	250	8.7	824	121	135	388	394	35	128	403	110,000,000
2,3,7,8-TCDF	2.7	1.4	58	10	180	0.71	4.2	0.54	31	ND	ND	0.17	0.31	0.22	0.25	0.35	1.6	2.1	3.6	4,400
Total TCDF	24	19	561	28	435	6.4	14	9.6	171	0.59	ND	2.4	3.7	1.8	3.7	3.4	8.4	11	23	140,000
1,2,3,7,8-PeCDF	1.4	ND	9.7	2.8	17	0.32	3.6	0.39	16	ND	ND	0.14	0.13	0.14	0.16	0.15	0.68	0.98	3.2	22,000
2.3.4.7.8-PeCDF	1.6	0.82	6.5	2.4	13	ND	1.8	0.67	12	ND	ND	0.14	0.17	0.15	0.26	0.16	0.49	ND	4.1	59,000
Total PeCDF	11	0.82	66	11	51	2.6	8.8	3	123	ND	ND	1	1.3	1.2	1.3	1.3	1.8	4.1	12	820,000
1,2,3,4,7,8-HxCDF	1.9	0.61	12	2.8	17	0.5	4.3	1.1	41	0.21	ND	0.23	0.57	0.42	0.45	0.6	ND	0.94	3.1	1,100,000
1,2,3,6,7,8-HxCDF	0.86	0.38	2	0.91	4.4	0.38	0.98	0.73	21	ND	ND	0.16	0.18	0.17	0.17	0.19	0.3	ND	0.92	140,000
2,3,4,6,7,8-HxCDF	1.2	0.9	1.5	1.5	3.7	0.64	0.83	1.2	13	0.37	0.27	0.26	0.32	0.31	0.27	0.32	0.37	0.4	ND	82,000
1,2,3,7,8,9-HxCDF	ND	ND	2.7	0.8	3.1	ND	1.1	0.35	10	ND	ND	ND	0.12	0.12	0.13	0.16	ND	ND	0.83	170,000
Total HxCDF	7	2.6	27	7.6	36	3.4	8.7	8	194	0.63	0.27	1.2	3.2	2.4	2.2	3	0.9	2.6	9	3,200,000
1,2,3,4,6,7,8-HpCDI	3.9	1.6	10	3.3	12	1.8	2.5	4.9	157	ND	0.49	0.99	2.2	1.6	1.5	2.6	0.81	1.9	3.5	3,100,000
1,2,3,4,7,8,9-HpCDI	1	ND	2.5	1.2	8.2	ND	1.1	0.69	53	ND	ND	0.13	0.61	0.47	0.35	0.66	ND	0.49	0.71	690,000
Total HpCDF	6.9	1.6	20	6.1	22	1.8	5.6	7.2	308	ND	0.49	1.8	6.3	4.2	3.5	6.8	1.3	4	8.3	5,500,000
OCDF	23	3.1	224	11	70	7.2	9.8	6.2	3001	1.9	3.4	3.4	18	16	8.7	27	1.5	13	17	38,000,000
TEQ	1.6	0.78	12	3.1	28	0.32	2.2	1.5	27	0.37	0.04	2.3	0.49	0.45	0.86	0.89	0.42	0.6	4	740,000