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Polychlorinated Dibenzo-*p*-Dioxins and Dibenzofurans in Lake Sediments from Chinese Schistosomiasis Areas

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Lake D is located in the south of China. The total area of the lake is about 3,000 km^2. The dimension of the lakeland varies greatly with changing of seasons. It is an important source of grain and freshwater fish in China. However schistosomiasis japonica prevailed in this region for a long time, sodium pentachlorophenate(Na-PCP) has been sprayed since the 1960s to control the spreading of snailborne schistosomiasis. Being contaminants of technical Na-PCP, PCDD/Fs may enter the environment and contribute to human exposure after the treatment. The low water solubilities and high adsorption to sediment of PCDD/Fs do not rule out their movement in the environment. Schecter et al. (1994) compared PCDD/Fs levels in blood and milk in agricultural workers and others following Na-PCP exposure in another schistosomiasis area in China, high levels of PCDD/Fs in exposed persons are evident. But the investigation concerning the contamination of Lake D has not been carried out before this study.

MATERIALS AND METHODS

The samples were taken from eight different locations distributed over the whole lakeland in March 1995 before spraying Na-PCP that year. Sample 1 and Sample 2 were collected in the areas that were covered with water only in the rainy season and exposed directly to the air in the dry season, while other samples are all from sediments under water.

Samples are air dried and sieved(ϕ 2 mm) to eliminate any solid objects. Ten grams of sieved samples are spiked respectively with 3.5 ng each of eight ^{13}C-labelled 2,3,7,8,-substituted PCDD/Fs congeners(2,3,7,8-TCDD, 1,2,3,7,8-P_5CDD, 1,2,3,6,7,8-H_6CDD, OCDD, 2,3,7,8-TCDF, 2,3,4,7,8-P_5CDF, 1,2,3,4,7,8-H_6CDF, 1,2,3,4,6,7,8-H_7CDF, Cambridge Isotope Laboratories) except that 7.0 ng of OCDD as internal standard. The

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samples are extracted with toluene for 24 hr in a Soxhlet extractor. The extracts are concentrated to 2 ml using a rotary evaporator. The bulk of the co-extracted organic materials are removed by successively passing the extract through the following series of chromatographic columns: acid silica, acid-base and silver nitrate silica multilayer, and basic alumina. The columns are prepared and the elution procedures are performed according to Lamparski (1989). Just prior to GC-MS analysis, 4 µl of two ^{13}C-labelled recovery standards (1,2,3,7,8-P_5CDD, 1,2,3,4,6,7,8-H_7CDF, Cambridge Isotope Laboratories) of 1.0 ng/µl are added for the quantification of surrogated recovery. One sample blank is analyzed for every eight samples. All analyses are carried out by VG-7070E-HF GC/MS using a 60 m SP-2331 (Supelco) fused-silica column. Quantitation of PCDD/Fs is performed in selected-ion monitoring mode. For each congener, two most abundant molecular cluster ions are measured.

RESULTS AND DISCUSSION

Table 1 shows the concentrations of the 2,3,7,8-substituted PCDD/Fs in Chinese products of Na-PCP(Bao et al. 1995).

Table 1. PCDD/Fs in Chinese PCP-Na(ng/g sample)

PCDDs		PCDFs	
2378-TCDD	4.0	2378-TCDF	3.1
12378-P_5CDD	2.1	12378-P_5CDF	40.9
		23478-P_5CDF	2.4
123478-H_6CDD	244	123478-H_6CDF	76.1
123678-H_6CDD	13.8	123678-H_6CDF	9.4
123789-H_6CDD	2.1	123789-H_6CDF	0.3
		234678-H_6CDF	0.9
1234678-H_7CDD	1702	1234678-H_7CDF	135
		1234789-H_7CDF	18.3
OCDD	12514	OCDF	1647
Total PCDDs	15760	Total PCDFs	2260

The results of the lake sediment analyses, expressed in pg/g of dry weight(d.w.) for the toxic 2,3,7,8-substituted congeners and also in international toxic equivalence factors (I-TEQ) are given in Table 2. The mean recoveries of the samples are in the range from 62 up to 75%.

The fingerprints of the 2,3,7,8-substituted PCDD/F congeners shown in Table 2 are similar to those shown in Table 1. The congeners OCDD, 1,2,3,4,6,7,8-H_7CDD and 1,2,3,4,6,7,8-H_7CDF are dominating.

Table 2. Levels of 2,3,7,8-substituted PCDD/F congeners in the sediments(pg/g d.w.)

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8
2378-TCDD	22.9	623.8	26.3	22.4	39.9	6.7	9.1	4.7
12378-P_5CDD	54.8	183.2	42.8	40.4	122.3	57.5	34.1	79.5
123478-H_6CDD	214.8	131.5	149.7	125.0	26.9	47.6	20.2	14.9
123678-H_6CDD	24.7	ND	ND	79.5	ND	ND	ND	7.6
123789-H_6CDD	ND	27.3	6.1	ND	ND	ND	ND	3.2
1234678-H_7CDD	574.6	524.8	361.2	2506.2	265.2	103.6	112.2	253.0
OCDD	218257	151225	149431	48349	92761	92149	98221	79899
2378-TCDF	19.6	ND	11.4	2.2	ND	ND	3.4	1.1
12378-P_5CDF	1.5	ND	ND	8.2	1.3	ND	ND	2.2
23478-P_5CDF	5.8	ND	1.7	ND	ND	ND	ND	1.2
123478-H_6CDF	9.9	ND	4.1	2.2	2.9	ND	ND	3.7
123678-H_6CDF	5.6	ND	ND	2.2	ND	ND	ND	ND
123789-H_6CDF	ND	ND	ND	ND	ND	ND	ND	ND
234678-H_6CDF	5.9	ND	ND	ND	ND	ND	ND	ND
1234678-H_7CDF	488.6	105.2	196.0	65.4	115.5	20.4	13.7	53.8
1234789-H_7CDF	402.8	35.3	187.0	ND	ND	ND	9.2	ND
OCDF	13215	1371.2	14610	1414.0	852.2	1206	252.9	814.5
Σ I-TEQs	326.9	890.5	237.2	139.5	201.5	134.8	128.3	130.2

ND : not detectable (〈 1.0 pg/g)

The ratios of the PCDF/PCDD in the sediments are relatively lower compared to that of PCDF/PCDD in the products of Na-PCP. This phenomenon can be explained by the suggestion that the sunlight photolysis rates of PCDFs in nature water are enhanced by indirect or sensitized photoreactions of chemicals naturally occurring in water (Dung et al., 1994), and PCDFs are photochemically less stable than PCDDs (Wagenaar et al., 1995).

The high values for toxic equivalents of PCDD/Fs of the sediments suggested that the contamination situation would be more serious if PCDD/Fs were distributed on adjacent areas by flooding events and by transport throughout rivers. Chinese scientists are concerned about dioxin contamination and steps have been taken to replace Na-PCP as molluscacide.

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