

PCDDs/Fs Levels in Deer Tissue Samples Following an Accidental Release from a Special Waste Treatment Center: 2001 Results

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Introduction

In early 1997, high levels of PCDDs/Fs and CBs were detected in deer and moose tissues from the Swan Hills area, Alberta, Canada, following an accidental release of these contaminants from a Special Waste Treatment Center in October 1996.¹ Follow-up wild game sampling was conducted in 2000/01 to examine changes in PCDDs/Fs concentrations in the tissues of whitetail deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*) collected in the same geographic location as in 1997 and 1998/99.²

Materials and Methods

Sampling. Field collection was carried out in December 2000 and January 2001. Six whitetail deer and mule deer were collected at distances of 1 - 30 km to the east and west of the Special Waste Treatment Center. Representative muscle, liver and fat samples were taken from each deer. All samples were kept frozen at - 20 °C prior to analysis.

Contaminants Analysis. PCDDs/Fs and CBs determinations for all samples were performed by the Fisheries and Oceans Regional Dioxin Laboratory at the Institute of Ocean Sciences in Sidney, British Columbia, Canada. The methodologies used to process the samples, the criteria used for identification and quantification and the quality assurance quality control protocols were described in detail elsewhere.³ From each sample four aliquots were collected from the carbon-fibre fractionation, the last part of the sample clean-up process. Fraction-IV contained the PCDDs and PCDFs. Analysis of all fractions was conducted by high-resolution gas chromatograph/high-resolution mass spectrometry (GC/HRMS). For all analyses the MS was operated at 10 000 resolution under positive EI conditions and data were acquired in the Single Ion Monitoring Mode (SIM). The concentrations of identified compounds and their minimum detection limits (MDLs) were calculated by the internal standard method using mean relative response factors determined from calibration standard runs, made before and after each batch of samples was run. Detection limits ranged from 0.01 to 0.12 pg/g for PCDDs/Fs.

Results and Discussion

The mean values of Σ PCDDs/Fs congeners and their homologues and Σ TEQ are summarized in Table 1. All 17 PCDDs/Fs congeners were detected in the liver and fat samples

collected in 2001 and liver collected in 1999. Eight of out 17 congeners were not detected in muscle samples (2001), including 2,3,7,8-TCDD, 1,2,3,7,8-PeCDD, 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,7,8,9-HxCDF, 2,3,4,6,7,8-HxCDF and 1,2,3,4,7,8,9-HxCDF. Means of individual PCDDs/Fs congeners accounted for 99.8% of their homologues in the liver samples in the study area and 96% in control areas, 90% in the muscle in the study area and 80% in control areas, and 85% in the fat in the study area.

The concentrations of PCDDs/Fs in the liver collected in 2001 were significantly higher than the samples collected in 1999 in the study area and control areas. The concentration of PCDDs/Fs in the muscle was not significantly different in the samples from the study area (1999 and 2001) and control areas (1999). The concentration of PCDDs/Fs was similar in the muscle and fat. The results indicated that PCDDs/Fs were mainly concentrated in the liver.

The most predominant congener in all the 2001 samples in the study area was 2,3,4,7,8-PeCDF, accounting for 80% of Σ PCDDs/Fs in the liver, 66% in the fat and 50% in the muscle. Also, a major congener contributing to Σ PCDDs/Fs TEQ was 2,3,4,7,8-PeCDF (Table 1). Other prevalent compounds in the liver include 1,2,3,4,7,8-HxCDF, 1,2,3,6,7,8-HxCDF, 1,2,3,7,8,9-HxCDF, 1,2,3,4,6,7,8-HpCDF and 1,2,3,4,7,8,9-HpCDF. In comparison with the 1999 results from the control areas, the most prevalent congeners in the liver were 1,2,3,4,6,7,8-HpCDD (30%) and OCDD (40%). 2,3,4,7,8-PeCDF only accounted for 4% of Σ PCDDs/Fs. Therefore, 2,3,4,7,8-PeCDF may be a marker congener present in the emissions of the special waste treatment facility as has been observed to be the major congener in soil, vegetation, sediment, fish and voles collected near the facility since 1996.

The concentrations of Σ PCDDs/Fs against distance from facility are summarized in Table 2. The highest Σ PCDDs/Fs concentrations were detected in the tissue of the two deer collected at a distance of 0.5 km and 1.0 km from the facility in 2001 and 1.0 km and 4.0 km from the facility in 1999. Similarity to the 1997 results,⁴ the PCDDs/Fs concentrations in all the samples decreased with distance from the facility. The mobility of white-tail and mule deer is restricted to a radius of 4 to 5 km in the winter. This finding suggests that contamination has occurred in the ecosystem in the vicinity of the facility and that PCDDs/Fs have also accumulated in deer.

In summary, overall levels of Σ PCDDs/Fs in the liver declined in 2001 as compared to the 1997 levels (Figure A) but increased as compared to 1999 levels. The Σ PCDDs/Fs levels in the muscle in 1999 and 2001 increased as compared to the 1997 levels (Figure B). The levels of Σ PCDDs/Fs TEQ increased in the liver and muscle in 2001 as compared to those in the 1997 and 1999 studies.

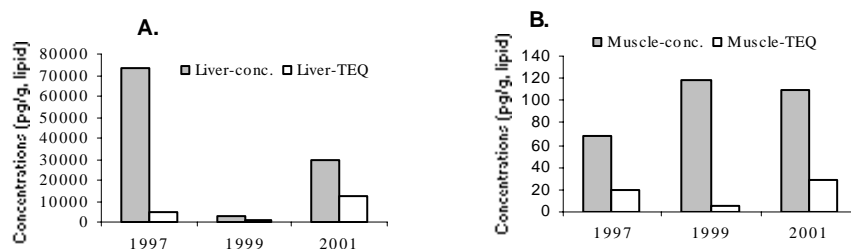


Table 1 Summary of Mean of PCDDs/Fs and Homologues in Deer (pg/g, lipid basis)

Parameter	2001			1999		1999	
	Study Area			Study Area		Control Area	
	(N=6)			(N=9)		(N=10)	
	Liver	Muscle	Fat	Liver	Muscle	Liver	Muscle
Lipid content (%)	3.69	2.53	65	3.00	2.3	3.7	3.5
2,3,7,8-TCDD	5.7	<0.06	0.29	2.2	<0.08	<0.08	<0.08
1,2,3,7,8-PeCDD	31.3	<0.08	0.92	28.9	<0.08	2.16	<0.08
1,2,3,4,7,8-HxCDD	46.1	<0.10	0.76	44.2	<0.10	4.56	<0.10
1,2,3,6,7,8-HxCDD	47.9	<0.10	1.26	79.5	8.92	10.31	6.52
1,2,3,7,8,9-HxCDD	10.3	<0.10	0.31	29.4	<0.10	2.87	<0.10
1,2,3,4,6,7,8-HpCDD	210	3.89	1.81	258	5.82	40.88	7.90
OCDD	285	25.56	3.30	295	81.82	53.87	38.98
2,3,7,8-TCDF	147	7.99	10.77	17.5	1.00	<0.05	<0.05
1,2,3,7,8-PeCDF	8.5	1.42	2.92	4.4	<0.06	<0.06	<0.06
2,3,4,7,8-PxCDF	24155	54.49	76.95	1842	6.68	6.00	<0.06
1,2,3,4,7,8-HxCDF	2576	8.13	9.92	218	0.90	2.95	<0.08
1,2,3,6,7,8-HxCDF	992	1.88	3.05	120	<0.08	2.62	<0.08
1,2,3,7,8,9-HxCDF	1009	<0.08	2.23	96.0	<0.08	1.97	0.27
2,3,4,6,7,8-HxCDF	1.0	<0.08	0.00	0.5	<0.08	<0.08	<0.08
1,2,3,4,6,7,8-HpCDF	386	2.43	1.25	65.6	4.46	5.84	3.80
1,2,3,4,7,8,9-HpCDF	38.6	<0.10	0.06	6.5	<0.10	0.56	<0.10
OCDF	31.6	3.67	0.37	17.8	8.42	3.07	3.82
∑PCDDs/Fs (Ind.)	29980	109	116	3125	118	138	61
∑ TCDD	5.7	0.2	0.3	5.5	5.4	3.7	3.3
∑ PeCDD	31	<0.08	1.0	28.9	<0.08	2.2	<0.08
∑ HxCDD	104	3.4	3.1	154	11	18	9.7
∑ HpCDD	210	7.7	2.5	271	10	43	15
∑ OCDD	285	25.6	3.3	295	82	54	39
∑ TCDF	161	8.0	14	19	1.0	<0.05	<0.05
∑ PeCDF	24206	60.7	94	1853	7.3	6.0	0.1
∑ HxCDF	4578	10.0	17	436	0.9	7.6	0.8
∑ HpCDF	425	2.5	1.4	76	4.5	6.7	5.1
∑ OCDF	32	3.7	0.4	18	8.4	3.1	3.8
∑ PCDDs/Fs (Homo.)	30038	122	137	3155	130	144	77
% of ∑PCDDs/Fs (Ind.) in ∑ PCDDs/Fs (Homo.)	99.8	89.9	84.9	99.0	90.8	95.5	79.9
∑PCDDs/Fs-TEQ ^a	12589	29	42	1002	4.6	7.1	0.84
∑CBs-TEQ ^b	1678	17	37	85	1.9	1.0	0.19
∑TEQ	14267	46	79	1087	7	8	1
% of ∑PCDDs/Fs-TEQ in ∑TEQ	88	63	53	92	71	87	82
% of ∑CBs-TEQ in ∑TEQ	12	37	47	8	29	13	18
% of 2,3,4,7,8-PeCDF in ∑ PCDDs/Fs-TEQ	96	93	91	92	72	42	0
% of 2,3,4,7,8-PeCDF in ∑TEQ	85	59	48	85	51	37	0

a. NATO-CCMS I-TEFs. b. WHO-IPCS I-TEFs.

Table 2 Concentrations of Σ PCDD/Fs in Deer (pg/g) in Study Area and Distance to Facility

Sample ID	Distance to Facility (km)	Liver (wet weight)	Liver (lipid weight)	Muscle (wet weight)	Muscle (lipid weight)	Fat (wet weight)	Fat (lipid weight)
<i>2001 Results</i>							
Sample 1	0.5	381	10459	1.29	145	90	158
Sample 2	1.0	5754	168749	3.49	478	212	390
Sample 3	10	12	306	0.61	10	11	18
Sample 4	20	6.40	181	0.00	0.00	N/A	N/A
Sample 5	28	5.89	116	0.21	5.28	2	2
Sample 6	30	1.75	73	0.30	19	9	13
<i>1999 Results</i>							
Sample 1	1.0	638	17618	1.51	98	N/A	N/A
Sample 2	4.0	286	8157	1.01	102	N/A	N/A
Sample 3	10	0.78	496	3.85	114	N/A	N/A
Sample 4	17	19	507	0.53	47	N/A	N/A
Sample 5	19	10	347	0.40	21	N/A	N/A
Sample 6	19	10	279	0.39	23	N/A	N/A
Sample 7	23	5.17	151	0.51	17	N/A	N/A
Sample 8	24	6.39	223	3.87	65	N/A	N/A
Sample 9	25	11	347	8.20	573	N/A	N/A
<i>1997 Results</i>							
Sample 1	10	459	14340	2.8	122	54	58
Sample 2	20	4955	206442	0.5	83	N/A	N/A
Sample 3	30	23	582	nd	nd	8.9	11

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