

PCDDs/Fs Levels in Deer Tissue Samples Following an Accidental Release from a Special Waste Treatment Center: 2003 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 2002/03 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, 1998/99 and 2000/01.^{1,2,3,4}

Materials and Methods

Sampling. Field collection was carried out in December 2002 and February 2003. Seven 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.⁵ 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. The information from 1999 and 2001 is presented in Table 1 for comparison of the results in 2003. In the 2003 study, fifteen of out 17 PCDDs/Fs congeners were detected in the liver and fat samples. Five of out 17 congeners were detected in muscle samples, including 2,3,7,8-TCDF, OCDD, 1,2,3,4,6,7,8-HpCDD, 2,3,4,7,8-PeCDF, and 1,2,3,4,7,8-HxCDF. Means of individual PCDDs/Fs congeners accounted for 99.3% of their homologues in the liver samples, 88% in the muscle and 89% in the fat.

The concentrations of PCDDs/Fs in the liver, muscle and fat samples collected in 2003 decreased compared with those samples collected in 1999 and 2001 in the study area. The concentration of PCDDs/Fs in the liver samples in the 2003 study area was still higher than those samples in the control area (1999). The concentration of PCDDs/Fs in muscle tissue taken from the study area in 2003 was similar to the results of samples taken in the control area.

The most predominant congener in the liver and fat samples was 2,3,4,7,8-PeCDF, accounting for 28% of Σ PCDDs/Fs. The most predominant congener in the muscle samples was OCDD, accounting for 72% of Σ PCDDs/Fs. Also, a major congener contributing to Σ PCDDs/Fs TEQ was 2,3,4,7,8-PeCDF (Table 2). The TEQ value of 2,3,4,7,8-PeCDF accounted for 78% of Σ PCDDs/Fs TEQ in the livers, 42% in the muscles and 67% in the fats. The pattern distribution is consistent with those in the study area in 1999 and 2001. In comparison, the 1999 results from the control area indicated that 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. The TEQ of 2,3,4,7,8-PeCDF accounted for 42% of Σ PCDDs/Fs TEQ. Therefore, 2,3,4,7,8-PeCDF may be a marker congener present in the emissions of the special waste treatment facility. This has also been the major congener observed in soil, vegetation, sediment, fish and voles collected near the facility since 1996.

In 2003 the highest Σ PCDDs/Fs concentrations were detected in the liver tissue of the two deer collected at a distance of 2.5 km and 8.0 km from the facility. Similar to the 1997 results,⁶ 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 samples declined in 2003 as compared to those levels in 1997, 1999, and 2001 (Figure A). The Σ PCDDs/Fs levels in the muscle samples in 2003 declined as compared to those levels in 1999 and 2001 (Figure B). Overall levels of Σ PCDDs/Fs-TEQ in the liver samples declined in 2003 as compared to those levels in 1997, 1999, and 2001 (Figure C). Overall levels of Σ PCDDs/Fs-TEQ in the muscle samples declined in 2003 as compared to those levels in 1997, 1999, and 2001 (Figure D).

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

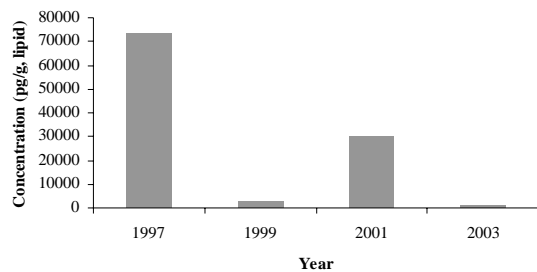
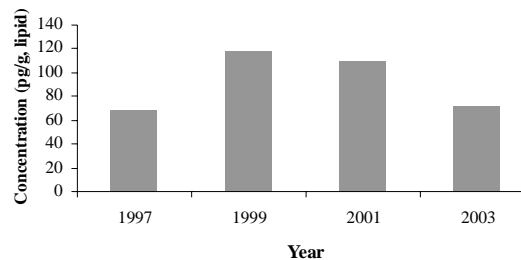
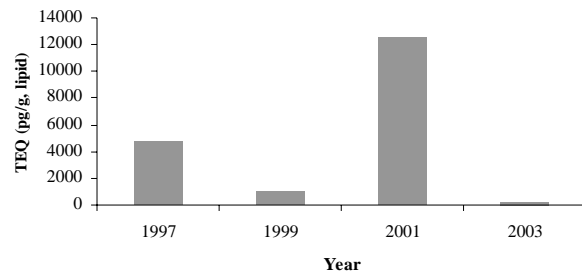
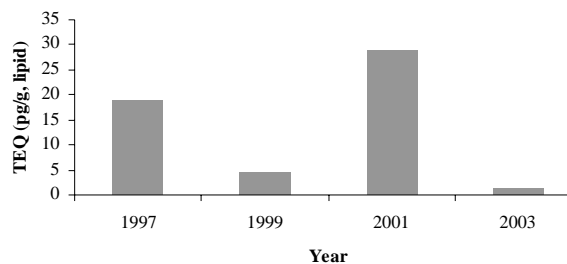
Parameter	2003 (N=7)			2001 (N=6)			1999 (N=9)		1999 (N=10)	
	Liver	Muscle	Fat	Liver	Muscle	Fat	Liver	Muscle	Liver	Muscle
	<u>Study Area</u>			<u>Study Area</u>			<u>Study Area</u>		<u>Reference Area</u>	
Lipid content (%)	4.07	0.88	63	3.69	2.53	65	3.00	2.3	3.7	3.5
2,3,7,8-TCDD	2.96	<0.12	0.18	5.7	<0.06	0.29	2.2	<0.08	<0.08	<0.08
1,2,3,7,8-PeCDD	28.18	<0.11	1.51	31.3	<0.08	0.92	28.9	<0.08	2.16	<0.08
1,2,3,4,7,8-HxCDD	40.84	<0.14	1.74	46.1	<0.10	0.76	44.2	<0.10	4.56	<0.10
1,2,3,6,7,8-HxCDD	55.12	<0.14	2.77	47.9	<0.10	1.26	79.5	8.92	10.31	6.52
1,2,3,7,8,9-HxCDD	21.58	<0.14	0.13	10.3	<0.10	0.31	29.4	<0.10	2.87	<0.10
1,2,3,4,6,7,8-HpCDD	257.4	14.69	3.39	210	3.89	1.81	258	5.82	40.88	7.90
OCDD	225.2	52.09	4.50	285	25.56	3.30	295	81.82	53.87	38.98
2,3,7,8-TCDF	6.63	2.73	1.22	147	7.99	10.77	17.5	1.00	<0.05	<0.05
1,2,3,7,8-PeCDF	<0.11	<0.10	0.16	8.5	1.42	2.92	4.4	<0.06	<0.06	<0.06
2,3,4,7,8-PxCDF	376.2	0.91	7.58	24155	54.49	76.95	1842	6.68	6.00	<0.06
1,2,3,4,7,8-HxCDF	84.00	1.67	1.83	2576	8.13	9.92	218	0.90	2.95	<0.08
1,2,3,6,7,8-HxCDF	69.30	<0.09	0.65	992	1.88	3.05	120	<0.08	2.62	<0.08
1,2,3,7,8,9-HxCDF	52.92	<0.09	0.31	1009	<0.08	2.23	96.0	<0.08	1.97	0.27
2,3,4,6,7,8-HxCDF	<0.08	<0.09	<0.18	1.0	<0.08	0.00	0.5	<0.08	<0.08	<0.08
1,2,3,4,6,7,8-HpCDF	79.25	<0.13	0.34	386	2.43	1.25	65.6	4.46	5.84	3.80
1,2,3,4,7,8,9-HpCDF	3.72	<0.13	<0.35	38.6	<0.10	0.06	6.5	<0.10	0.56	<0.10
OCDF	9.82	<0.19	0.08	31.6	3.67	0.37	17.8	8.42	3.07	3.82
ΣPCDDs/Fs (Ind.)	1313	72	26	29980	109	116	3125	118	138	61

Σ TCDD	3.84	<0.11	0.36	5.7	0.2	0.3	5.5	5.4	3.7	3.3
Σ PeCDD	28.18	<0.11	1.91	31	<0.08	1.0	28.9	<0.08	2.2	<0.08
Σ HxCDD	261.1	24.62	3.89	104	3.4	3.1	154	11	18	9.7
Σ HpCDD	120.9	<0.16	5.49	210	7.7	2.5	271	10	43	15
Σ OCDD	225.2	52.09	4.50	285	25.6	3.3	295	82	54	39
Σ TCDF	6.63	2.73	1.31	161	8.0	14	19	1.0	<0.05	<0.05
Σ PeCDF	376.8	0.91	8.78	24206	60.7	94	1853	7.3	6.0	0.1
Σ HxCDF	206.8	1.67	2.97	4578	10.0	17	436	0.9	7.6	0.8
Σ HpCDF	83.00	<0.13	0.36	425	2.5	1.4	76	4.5	6.7	5.1
Σ OCDF	9.82	<0.19	0.08	32	3.7	0.4	18	8.4	3.1	3.8
Σ PCDDs/Fs (Homo.)	1322	82	30	30038	122	137	3155	130	144	77
% of Σ PCDDs/Fs (Ind.) in Σ PCDDs/Fs (Homo.)	99.3	87.9	89.0	99.8	89.9	84.9	99.0	90.8	95.5	79.9

Table 2 Summary of Mean of PCDDs/Fs TEQ in Deer (pg/g, lipid basis)

Parameter	2003 (N=7)			2001 (N=6)			1999 (N=9)		1999 (N=10)	
	Liver	Muscle	Fat	Liver	Muscle	Fat	Liver	Muscle	Liver	Muscle
	<i>Study Area</i>			<i>Study Area</i>			<i>Study Area</i>		<i>Reference Area</i>	
Lipid content (%)	4.07	0.88	63	3.69	2.53	65	3.00	2.3	3.7	3.5
Σ PCDDs/Fs-TEQ ^a	241.8	1.09	5.65	12589	29	42	1002	4.6	7.1	0.84
% of 2,3,4,7,8-PeCDF in Σ PCDDs/Fs-TEQ	78	42	67	96	93	91	92	72	42	0

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

A. PCDD/F Concentrations in Livers**B. PCDD/F Concentration in Muscles****C. PCDD/F TEQ in Livers****D. PCDD/F TEQ in Muscles**

Acknowledgements

The contribution of those who assisted with the analytical work at the Fisheries and Oceans Regional Dioxin Laboratory and who assisted with sample collection in Alberta Environment, Dennis Prince Associates and local communities is gratefully acknowledged.

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