LEVELS OF PCDDs AND PCDFs IN HUMAN FECES

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INTRODUCTION

A series of PCDDs and PCDFs have been identified in sewage sludge from various locals. Unexpectedly levels were nearly the same for sludges obtained from rural and highly urbanized areas, as well as in small septic systems only receiving wastes from a few families (1,2). It has been assumed that household detergents may contribute to these levels, however extensive programs designed to study this question have shown that detergents are not an important source (3). Another possible source of PCDDs and PCDFs found in sewage sludge could be human feces.

In 1984 it was first reported that samples of human adipose tissue contain background levels of a variety of 2,3,7,8-substituted PCDDs and PCDFs (4). Pioneering findings in Umeå and Ottawa (Ryan) followed a multitude of studies examining PCDDs and PCDFs in human adipose tissue, milk, and blood.

Human feces have not been the subject of complete analyses for PCDDs and PCDFs. Wendling et al (5) reported on the methodology for the analysis of 2,3,7,8-tetraCDD only in human feces. They also reported a level of 0.6-0.7 pg/g dry weight of this congener in a pool from laboratory workers. No other congeners were reported. The objecting of the study described here was to assist in an understanding of PCDD/F eliminated in human feces as well as to explore human waste as a source of PCDD/Fs in sewage sludge.

EXPERIMENTAL

Four feces samples (20-25 g) were collected from the same subject over four consequtive days. The person (58 years, 93 kg) resides in Umeå and consumes fish, meat and cheese, but not milk or butter.

A laboratory blank was analyzed in parallel. The results are shown in Table 1. From the dried and homogenized feces an amount of 5-10 g was spiked with relevant ^{13}C-labelled compounds and Soxhlet extracted with 150 ml toluene for 12 hours and the water content was measured. The extract was concentrated, the residue dissolved in 20 ml n-hexane and then transferred to a column consisting of silica (30 mm x 25 mm), H_2SO_4-silica (30 mm x 25 mm) and KOH-silica (30 mm x 25 mm). The column was eluted with 300 ml n-hexane. This new extract was concentrated and cleaned-up on a two column system (Alox, Carbopak C). The extract was analyzed using HRGC/HRMS, a VG 70-250S system operating at a resolution of 8 000. The recoveries were found to be in the range 62 - 119%.

DISCUSSION

A series of 2,3,7,8-substituted PCDDs and PCDFs were found in all samples. No other major PCDDs or PCDFs were found, but a few minor peaks were found in the samples and also in the blank. The differences between the individual samples were quite small in spite of the fact that no restrictions were put on the food intake. There is a good correlation between the individual congeners found in these samples and in other samples of human fat. The value for 2,3,7,8-tetraCDD is very similar to the value earlier reported (5). There is also good correlation between the specific profiles and patterns found in these samples and in other samples of human fat. In Figure 1 a histogram is given for the normalized mean values in these samples together with the mean values for blood lipida found in a cohort of unexposed people in Sweden with normal fish consumption. Consequently, it is seen that the stool-fat is very similar with respect to these contaminants to the normal pool of body fat in blood and adipose.

The TEQ value was 3.9 pg/g dry weight. Assuming a 50% metabolism (as suggested by Wendling et al (5)) and a stool weight of 100 g/day, the daily dose could be calculated to 7-8 pg TEQ/kg b.w. day. The ADI value in the Nordic countries is 5 pg TEQ/kg b.w. day (7), and this is therefore exceeded. The pattern is dominated by octaCDD and 1,2,3,4,6,7,8-heptaCDD. The daily excretion of these is around 12 000 pg. The octa- and heptaCDD levels are very low in most fish and other aquatic food samples. They are sometimes found in fatty meat and dairy products, but it seems highly unlikely that these sources can account for the levels found in the body and excreted. The major source for the human exposure of octa- and hepta-CDD is hence presently unknown.

The isomeric patterns found in feces are quite different from the patterns found in sewage sludge. The feces contain mainly the 2,3,7,8-substituted congeners, but these congeners are normally low in sewage sludge (1). Consequently feces cannot explain the levels of PCDDs and PCDFs found in sewage sludge. It has recently been found that hepta- and octa CDDs can be formed in novo from pentachlorophenol in sewage sludge (8).

Analyses of feces could be a new and non-invasive indicator of human exposure.

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Table 1. Levels of PCDDs and PCDFs in feces (pg/g dry weight)

	Day 1	Day 2	Day 3	Day 4	Blank
2,3,7,8-TCDF	0.91	1.3	1	1	0.45
SUM TCDF	3.6	4.7	4.2	3.7	1.4
2,3,7,8-TCDD	0.49	0.62	0.61	1.5	0.055
SUM TCDD	1.1	3.3	0.9	2.6	ND(0.17)
1,2,3,7,8-PeCDF	0.23	0.14	0.13	0.15	0.053
2,3,4,7,8-PeCDF	3.3	2.2	2.4	2.7	0.078
SUM PeCDF	3.8	2.3	2.6	2.9	ND(0.27)
1,2,3,7,8-PeCDD	3.2	0.63	0.72	0.84	0.091
SUM PeCDD	5.4	1	1.2	1.1	ND(0.79)
1,2,3,4,7,8-HxCDF	1.2	1.1	1,1	1.2	ND(0.023)
1,2,3,6,7,8-HxCDF	0.79	0.65	0.67	0.8	ND(0.018)
1,2,3,7,8,9-HxCDF	ND(0.026)	ND(0.052)	ND(0.029)	ND(0.029)	ND(0.034)
2,3,4,6,7,8-HxCDF	0.5	0.26	0.36	0.61	ND(0.044)
SUM HxCDF	2.9	2.7	2.7	3.4	ND(0.31)
1,2,3,4,7,8-HxCDD	0.41	0.27	ND(0.048)	0.38	ND(0.05)
1,2,3,6,7,8-HxCDD	3.1	2.4	2.9	3	ND(0.033)
1,2,3,7,8,9-HxCDD	0.69	2	0.98	1.2	ND(0.042)
SUM HxCDD	3.7	5.3	5.4	6.1	ND(0.28)
1,2,3,4,6,7,8-HpCDF	2.7	2.5	2.6	3.1	ND(0.037)
1,2,3,4,7,8,9-HpCDF	0.11	0.17	ND(0.044)	0.19	ND(0.054)
SUM HpCDF	4.1	6.3	3.8	8.2	ND(0.018)
1,2,3,4,6,7,8-HpCDD	12	13	14	17	ND(0.061)
SUM HpCDD	16	18	19	22	ND(0.12)
OCDF	3.1	6.8	7.8	10	ND(0.061)
OCDD	130	80	94	100	0.41
I-TEF	4.8	3.1	3.1	4.4	0.2

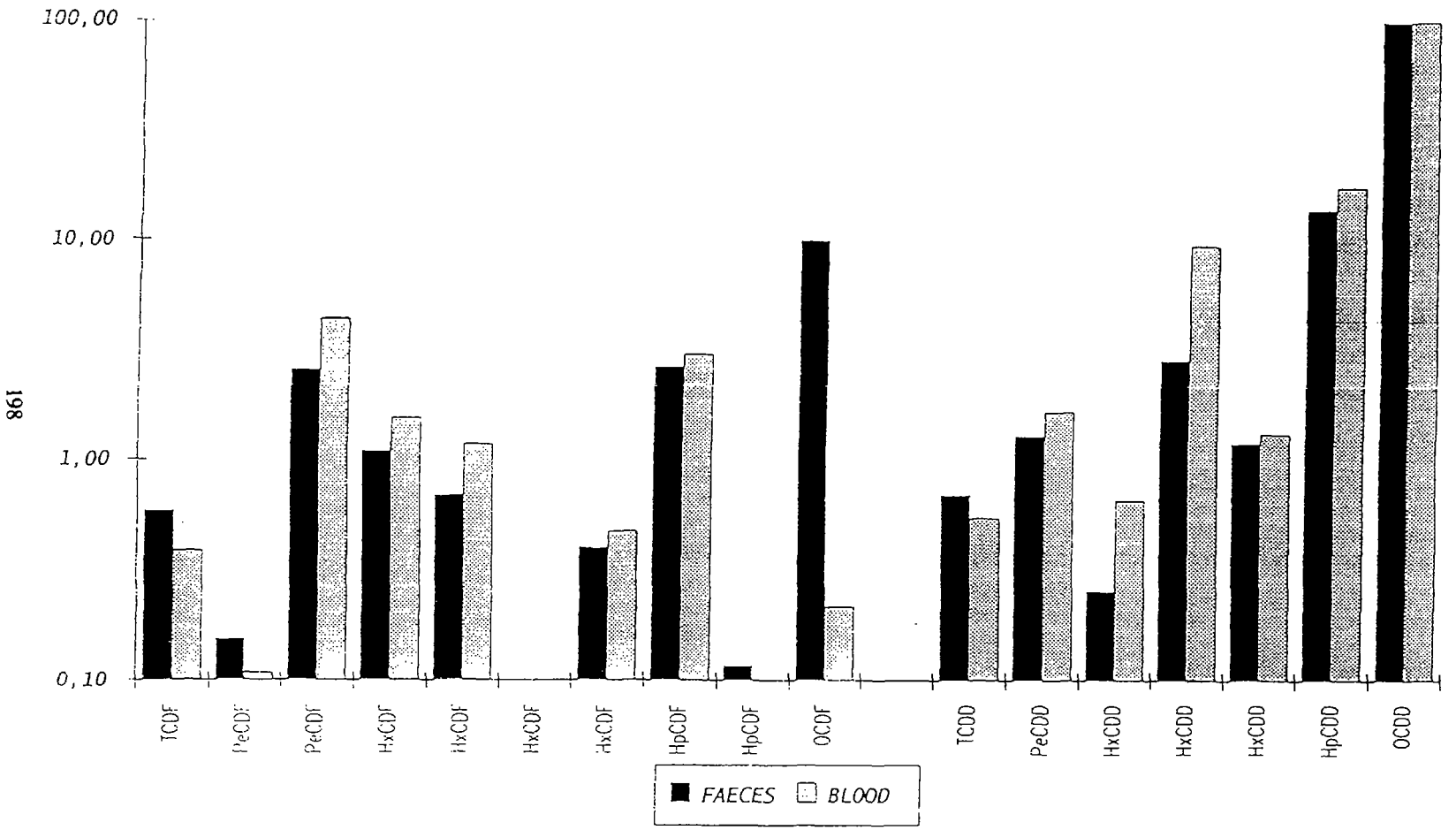

Figure 1. Histogram of normalized levels of PCDDs and PCDFs found in human feces and blood.