HUM II

PCDD/F in house dust

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Summary

The levels of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/F) were determined in house dust samples collected from 12 residential houses located in different areas of Germany. Nine houses were located in an urban and industrial area, one house in a rural area. Two house dust samples were collected from an old farm building, in which large amounts of wood preservatives containing pentachlorophenol (PCP) had been used several years ago. All dust samples were collected from the dust bags of household vacuum cleaners and passed through a sieve (mesh: 2.0 mm). Particles < 2.0 mm were used for analysis.

The average level of PCDD/F in 'normal' house dust was 101 ng I-TEq/kg (range: 7.83 - 332 ng I-TEq/kg). The upper limit was estimated to be about 200 ng I-TEq/kg. The predominant congeners and chlorohomologues were OctaCDD followed by HeptaCDD, HeptaCDF and OctaCDF. The house dust samples collected from a PCP-treated old farm house were found to contain 1.39 and 11.8 µg I-TEq/kg. The chlorohomologues patterns were typical for PCP contaminated with PCDD/F.

The study shows that the levels of PCDD/F in house dust may be used as indicators of indoor contamination by PCDD/F. The results of this study may be used as reference values for further investigations.

Introduction

In the last years levels of contaminants in house dust samples have been used as indicators for indoor exposure. Elevated concentrations of contaminants in house dust can result from dust brought into the house from outside and from indoor sources.

For the identification of such elevated concentrations knowledge of background concentrations of non-exposed dwellings or public buildings (kindergartens, schools and others) is required. Such reference data are available for metals and metalloids, pentachlorophenol, lindane and pyrothroids [1, 2, 4, 5, 9], but not for PCDD/F yet.

Material and methods

Dust

House dust collected by conventional vacuum cleaners was used for this study. First large particles and objects were removed from the dust. Then the dust was passed through a sieve of 2.0 mm mesh width. The fraction < 2.0 mm was used for analysis.

Non-exposed dwellings

10 dwellings (4 in one-family- and 6 in apartment-houses) with no known exposure of PCDD/F were chosen for this study. Nine of them were located in an urban and industrial area (Ruhr-District) and one in a rural area (Bavaria). The occupiers were asked for information about state of dwellings, furniture, panelling of ceiling, floor and walls, heating system, habits of ventilation and cleaning, fires, smoking, domestic animals and about location and surrounding of the houses using a standardized questionaire. Additionally data about age, origin and character of the dust samples were collected. A contamination of the dwellings by biocides or special chemicals used during construction or for cleaning were not determined. The samples were collected in autumn 1994.

PCP-contaminated building

This building consists of a renovated, historical half-timbered dwelling house and a barn which is nowadays used as studio and office. For preservation of the wooden structural components large amounts of PCP-containing wood-preservatives have been used in the past, especially in the barn. The levels of PCP in the dust collected in the dwelling house in 1994 was 23 mg/kg. Dust from the barn showed concentrations of 250 mg PCP/kg and 32 mg Lindane/kg.

Analytical method

A scheme of the analytical procedure is shown in table 1 [1].

Table 1: Scheme of analysis

- Sample:	10 - 30 g (< 2.0 mm)
- Addition of $^{13}C_{12}$-standards:	all 17 congeners with 2,3,7,8-chlorosubstitution pattern
- Extraction:	24 h Soxhlet-extraction with Toluene / 2-Methoxyethanol (90+10)
- Clean-Up:	Shaking out with conc. H_2SO_4, column chromatography: modificated silicagels, activated alumina and activated charcoal
- Addition of recovery-standard:	1,2,3,4-$^{13}C_{12}$-TetraCDD
- Capillary gas chromatography:	HP 5890 Series II with Gerstel cold injection system; DB-5 column, 60 m, 0.25 mm i. d., 0.1 μm film thickness
- High resolution mass spectrometry:	VG AutoSpec, R=10,000
- Detection limit for each congener	0.5 - 2.0 ng/kg

[1] Analysis of the 2 samples from the PCP-treated house were done by 'Forschungs- und Materialprüfungsanstalt Baden-Württemberg (FMPA)', Pfaffenwaldring 2, 70569 Stuttgart. A similar method was used.

Results and discussion

Non-exposed dwellings

The PCDD/F-burden of the examined house dust samples was in the range of 7.83 - 332 ng I-TEq/kg (mean ($\bar{x}$): 101 ng I-TEq/kg; median ($\tilde{x}$): 85.4 ng I-TEq/kg). Descriptive statistical data of the examined dust samples are summarized in table 2 and shown in figure 1.

Table 2: PCDD/F-levels of the examined house dust samples. Concentrations in ng/kg.

[ng/kg]	Non-exposed dwellings (n=10)				PCP-contaminated builiding	
Parameter	Minimum	Maximum	Median	Mean	House	Barn
Σ TetraCDD	4.7	24	13	14.3	20	50
Σ PentaCDD	10	250	97	107	40	120
Σ HexaCDD	19	1100	350	442	2900	25000
Σ HeptaCDD	140	16000	4250	6060	46000	620000
OctaCDD	640	63000	11500	20400	190000	3100000
Σ TetraCDF	17	470	165	184	550	1600
Σ PentaCDF	21	1300	225	387	1100	3500
Σ HexaCDF	20	1900	260	489	11000	50000
Σ HeptaCDF	110	6600	525	1160	39000	390000
OctaCDF	58	6300	410	966	21000	480000
Σ PCDD	812	80700	16600	27200	241000	3770000
Σ PCDF	280	16200	1890	3190	72200	926000
Σ PCDD/F	1090	96900	18800	30400	313000	4690000
NATO/CCMS-TEq	7.83	332	85.41	101	1390	11800

In all samples a typical PCDD/F-pattern was found. The levels of PCDD increase strongly with regard to the grade of chlorination. The mean levels of TetraCDDs are 14.3 ng/kg (range: 4.7 - 24, $\tilde{x}$: 13 ng/kg), the concentrations of OctaCDD are about 1,000-fold higher (range: 0.64 - 63; $\bar{x}$: 20; $\tilde{x}$: 11.5 µg/kg). In all samples OctaCDD is the main component. The pattern of the PCDF-homologues are different. In most samples Tetra- through OctaCDFs are found in similar concentrations. In some samples Hepta- and OctaCDF, in other samples Penta- and HexaCDFs are the dominant homologues.

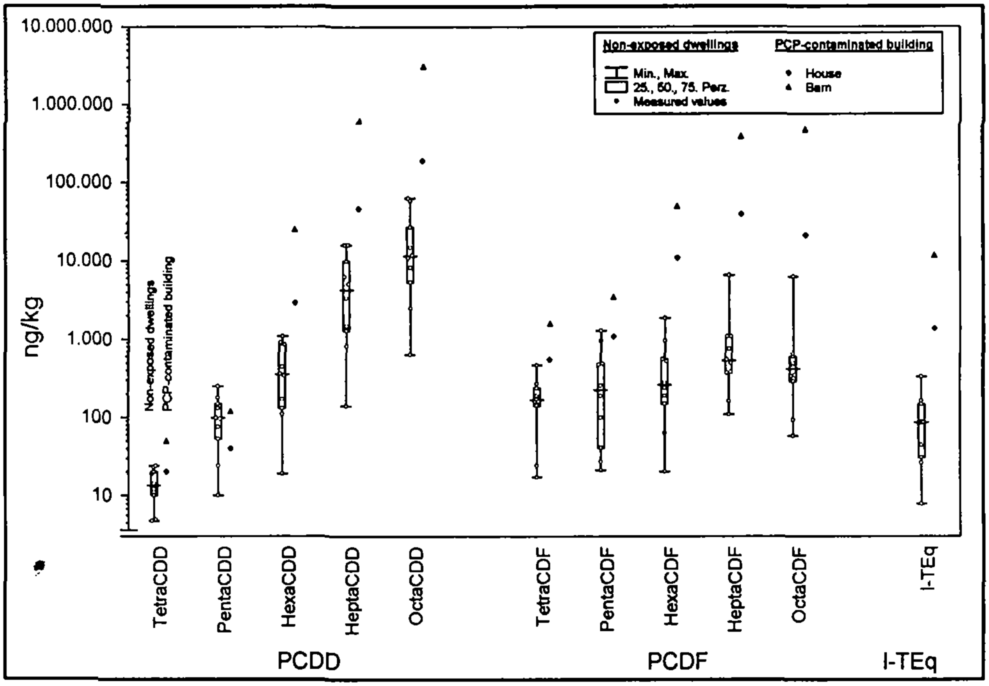
The data show that house dust is relatively high contaminated by PCDD/F. In comparison to the PCDD/F-levels found in soil of urban areas, containing PCDD/F-concentrations up to 20 ng I-TEq/kg house dust contamination is 5- to 10-fold higher. Additionaly we observed differences between the homologue-patterns found in house dust and in soil or outdoor dust. These facts indicate that in first priority indoor sources may be responsible for the house dust contaminations. Important sources may be textiles [3] (clothes, carpets, upholstery etc.), leather goods and PCP-treated furniture. Additionally scaled off skin cells and hair from humans and animals as well as cigarette smoke and other primary or secondary sources are to be mentioned. Outdoor dust or soil brought inside does not seem to be important.

Based on our data the upper level of background exposure (95. percentile) of house dust can be estimated to be about 200 ng I-TEq/kg.

PCP-contaminated building

The samples collected in the two parts of the PCP-contaminated building showed the typical PCDD/F-pattern of technical PCP [7] which is also known from other studies about the contamination of indoor air [6]. The PCDD/F-concentrations were 1.39 and 11.8 µg I-TEq/kg, the levels of OctaCDD were 0.19 or 3.1 mg/kg (see table 2 and figure 1).

Figure 1: Levels of PCDD/F-homologues of the examined house dust samples



Estimation of exposure

It has been assumed that more than 90% of the PCDD/F-exposure by humans takes place via food. As measured by a food duplicate study the actual daily dietary PCDD/F-intake by adults in Germany is 0.72 pg I-TEq/(kg · d) (range 0.18 - 1.7 pg I-TEq/(kg · d) [8]. Assumpting that the daily house dust intake is in the range of 5 to 100 mg/d adults with a body weight of 70 kg or children with a body weight of 15 kg will ingest the PCDD/F-doses shown in table 3. In comparison to the PCDD/F-intake via food the PCDD/F-intake by house dust is only relevant in specially polluted dwellings.

Table 3: Estimation of the PCDD/F-intake via uptake of house dust

	Daily ingested amount of house dust	PCDD/F-dose [pg I-TEq / ($kg_{body\ weight}$ · d)]	
	[mg/d]	Adults (70 kg)	Children (15 kg)
House dust from "non-exposed" dwellings {$\bar{x}$ = 101 ng I-TEq/kg}	5	0.0072	0.034
	10	0.014	0.067
	50	0.072	0.34
	100	0.14	0.67
House dust from a PCP-contaminated building (barn) {11.8 µg I-TEq/kg}	5	0.84	3.9
	10	1.7	7.9
	50	8.4	39
	100	17	79

Conclusion

The levels of contaminants in house dust are very variable and influenced by many parameters. Nevertheless they can be used as indicators for indoor pollution. Specific PCDD/F-contaminations of dwellings can be identified by house dust analysis. Due to the PCDD/F-source typical congener patterns will be found.

House dust of non-exposed dwellings had a mean PCDD/F-burden of approximately 100 ng I-TEq/kg. Based on our small data basis the upper limit of background exposure seems to be in the range of 200 ng I-TEq/kg.

In house dust samples of a contaminated building up to 100-fold higher I-TEq-levels were found. Even a daily intake of 5 mg of this dust leads to a PCDD/F-exposure of 0.84 pg I-TEq/(kg · d) {70 kg body weight}. This is in the same range as the PCDD/F-intake via food which is 0.72 pg I-TEq/(kg · d) [8].

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Acknowledgement

We thank cand. biol. Inga Weiß who collected the house dust samples of the non-exposed dwellings and helped to analyze them.