Fecal excretion rates of PCDDs/PCDFs in two breast-fed infants

Körner, W., Dawidowsky, N. and Hagenmaier, H.
Institute of Organic Chemistry, University of Tübingen, 7400 Tübingen, FRG

Objective

Breast-fed infants take up considerable amounts of PCDDs and PCDFs via mothers' milk. In spite of some indications that not the whole PCDD/PCDF-burden is absorbed by the infants' body, a balance of intake and excretion for the various congeners has been lacking.
We therefore measured the PCDD/PCDF-concentrations in the stool of two breast-fed infants and in the corresponding mother's milk. From these data we could calculate the fecal excretion rates for the different PCDD- and PCDF-congeners.

Introduction

The intake of PCDDs and PCDFs by breast-fed infants in industrialized countries like Germany via mothers' milk at a daily dose of about 130 pg I-TEQ/kg body weight exceeds the acceptable daily intake of 1-10 pg I-TEQ/kg by far. Because of this high intake of PCDDs and PCDFs in addition to other xenobiotics like PCBs there is continuous discussion about possible health risks of breast-feeding for the infants. In calculating the babies' body burden of PCDD/PCDF by breast-feeding it always has been assumed that infants' body incorporates the total amount of PCDD/PCDF ingested by mothers' milk. Some new experimental data indicate that this probably is not the case[1]. The first analysis of a stool sample of a 3-month old breast-fed infant indicates PCDD/PCDF-concentrations on a fat weight basis which are very similar to concentrations in mothers' milk[2].
However, for an accurate risk assessment we need the exact fecal excretion rates for the various congeners. We therefore sampled simultaneously mothers' milk and infants' stool, in total 3 samples each, two of the same mother and baby. In both cases it was the mother's first child. From the measured PCDD/PCDF-concentrations and the daily amounts of milk and excreted stool we could calculate the fecal excretion rates.

Material and methods

Mother's milk and the whole excreted stool was sampled over 4 - 6 days. After freeze-drying all 2,3,7,8-substituted PCDD/F-congeners were added as $^{13}C_{12}$-labeled standards

and a soxhlet-extraction with n-hexane was carried out. A 3-step clean-up followed. Finally analysis with HRGC/HRMS was performed.

Results

The results are shown in table 1 and 2 and can be summarized as follows:

1) The PCDD/PCDF-concentrations in the mothers' milk samples are in the range expected for young women living in Germany.
2) The fat content of the stool was in the range of 6-10%.
3) The daily stool amount shows a 6-fold difference for the two babies (1.6 and 10 g/d).
4) On a fat weight basis the PCDD/PCDF-concentrations in the stool (expressed as I-TEQ) are similar to the corresponding concentrations in milk.
   In the case of a small amount of feces (A) the concentration was nearly twice as high as in the milk, in the case of a large amount of stool only about half the concentration of the milk was found.
5) For all congeners the fecal excretion rates are low (in general below 10%).
   In spite of the higher stool concentrations the excretion rates of the baby with a small amount of stool is significantly lower (0.8 vs. 3.2% of the TEQ-values).
6) The excretion rates of the third and seventh week are similar (0.8 vs. 1.2% of the TEQ-values).
7) The Cl_7- and especially the Cl_8-congeners show the highest excretion rates. 2,3,7,8-Cl_4DF has also a relatively high excretion rate.
8) Those congeners, which contribute most to the I-TEQ-values in human fat, have the lowest excretion rates: 2,3,4,7,8-Cl_5DF, 2,3,7,8-Cl_4DD, 1,2,3,7,8,-Cl_5DD and 1.2,3,6,7,8-Cl_6DD.

Conclusions

Our calculations, based on analytical data, show low fecal excretion rates for all PCDD- and PCDF-congeners in two breast-fed infants. Expressed in I-TEQ, they are only a few percent. Even the absorption of OCDD is quite high (nearly 90% or higher). This is contrary to Jödicke et al[2], who assumed poor absorption of Cl_7- and Cl_8DD/F only considering the concentration ratio of infant's stool and breast milk. The strikingly low excretion rates of those congeners which contribute mainly to the I-TEQ-values in human adipose tissue indicate that above-average intestinal absorption may be one reason for their relative enrichment.

Considering the high absorption rates of PCDD/PCDF in breast-fed infants some questions remain open: In some breast-fed infants who died suddenly, Beck et al[1] found tissue-concentrations of PCDD/PCDF which are lower than expected from average concentrations in breast milk. If our results can be generalized this cannot be explained by high fecal excretion rates. It could be due to strong increase of infants' body and fat mass during nursing.

References

1 Beck H. Belastung des Menschen durch PCDD/PCDF. *Dioxin-Informationsveranstaltung*, Augsburg, 11.-13.11.1991.

2 Jödicke B, Ende M, Helge H, Neubert D. Fecal excretion of PCDDs/PCDFs in a 3-month-old breast-fed infant. *Chemosphere* 1992;24:in press.

Mother/child-pair	A	A	A	A	B	B
Sample	milk	feces	milk	feces	milk	feces
Fat content (%)	3.60	6.97	3.43	6.21	2.86	9.34
Week of nursing	3	3	7	7	8	8
2,3,7,8-TetraCDD	3.93	5.62	2.08	7.34	2.64	1.43
1,2,3,7,8-PentaCDD	16.3	13.2	6.91	11.1	7.29	2.89
1,2,3,4,7,8-HexaCDD	11.6	16.6	4.22	15.2	6.19	7.57
1,2,3,6,7,8-HexaCDD	33.9	51.5	25.1	47.5	28.0	16.1
1,2,3,7,8,9-HexaCDD	13.4	26.8	3.84	18.6	6.95	8.46
1,2,3,4,6,7,8-HeptaCDD	34.9	120	16.7	121	62.3	94.4
OctaCDD	134	1163	96.4	1021	240	799
Sum PCDD	247.5	1396	155.2	1241	353.3	929.4
2,3,7,8-TetraCDF	1.48	16.8	1.44	16.4	3.51	3.77
1,2,3,7,8-PentaCDF	0.32	3.05	0.42	(<7.4)	0.73	(<1.2)
2,3,4,7,8-PentaCDF	5.50	12.5	21.0	18.7	15.8	7.33
1,2,3,4,7,8-HexaCDF	7.90	5.60	4.73	17.1	4.56	5.84
1,2,3,6,7,8-HexaCDF	5.70	10.4	3.80	11.1	4.92	5.03
1,2,3,7,8,9-HexaCDF	0.09	1.05	(<0.54)	n.n.	(<0.38)	(<1.6)
2,3,4,6,7,8-HexaCDF	4.39	10.8	1.01	(<12)	2.49	4.33
1,2,3,4,6,7,8-HeptaCDF	8.30	37.1	7.25	23.5	8.99	8.85
1,2,3,4,7,8,9-HeptaCDF	(<0.03)	(<2.3)	(<0.90)	(<11)	0.28	(<2.0)
OctaCDF	7.53	n.b.	3.78	47.3	4.87	n.b.
Sum PCDF	41.21	97.28	43.45	134.0	46.13	35.15
I-TEQ	23.26	35.31	20.81	37.32	20.83	13.48

Table 1: PCDD/PCDF-concentrations of mothers' milk and corresponding infants' stool samples in pg/g fat

Mother/child-pair	A	A		A	A		B	B	
Sample	milk	feces		milk	feces		milk	feces	
Daily amount (g)	380	1.6	**Excretion**	730	1.7	**Excretion**	660	10	**Excretion**
Week of nursing	3	3	**%**	7	7	**%**	8	8	**%**
2,3,7,8-TetraCDD	53.6	0.63	**1.2**	51.8	0.78	**1.5**	49.5	1.3	**2.7**
1,2,3,7,8-PentaCDD	223	1.5	**0.66**	172	1.2	**0.68**	137	2.7	**2.0**
1,2,3,4,7,8-HexaCDD	158	1.9	1.2	105	1.6	1.5	116	7.1	6.1
1,2,3,6,7,8-HexaCDD	464	5.7	**1.2**	623	5.0	**0.80**	525	15	**2.9**
1,2,3,7,8,9-HexaCDD	183	3.0	1.6	96	2.0	2.1	131	7.9	6.0
1,2,3,4,6,7,8-HeptaCDD	477	13	2.8	416	13	3.1	1170	88	7.5
OctaCDD	1825	130	7.1	2400	108	4.5	4508	746	17
Sum PCDD	3384	156	4.6	3865	131	3.4	6636	868	13.1
2,3,7,8-TetraCDF	20.1	1.9	9.3	35.8	1.7	4.8	66.0	3.5	5.3
1,2,3,7,8-PentaCDF	4.18	0.34	8.2	10.2	n.n.	n.n.	13.9	n.n.	n.n.
2,3,4,7,8-PentaCDF	75.2	1.4	**1.9**	523	2.0	**0.38**	296	6.9	**2.3**
1,2,3,4,7,8-HexaCDF	108	0.62	0.58	118	1.8	1.5	85.8	5.5	6.4
1,2,3,6,7,8-HexaCDF	77.9	1.2	1.5	94.2	1.2	1.2	92.4	4.7	5.1
1,2,3,7,8,9-HexaCDF	1.1	0.12	10	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.
2,3,4,6,7,8-HexaCDF	60.0	1.2	2.0	24.8	n.n.	n.n.	46.9	4.1	8.6
1,2,3,4,6,7,8-HeptaCDF	114	4.1	3.6	180	2.5	1.4	169	8.3	4.9
1,2,3,4,7,8,9-HeptaCDF	n.n.	n.n.	n.n.	n.n.	n.n.	n.n.	5.28	n.n.	n.n.
OctaCDF	103	n.b.	n.b.	94.2	5.0	5.3	91.7	n.b.	n.b.
Sum PCDF	563.2	10.9	1.9	1080	14.2	1.3	867.2	32.8	3.8
I-TEQ	**318.0**	**3.9**	**1.2**	**518**	**3.9**	**0.76**	**391.4**	**12.6**	**3.2**

Table 2: Average daily uptake and excretion (in pg/day) and excretion rates of PCDD and PCDF from 3 corresponding mothers' milk and infants' stool samples