

Concentration of PCDDs/PCDFs and coplanar PCBs in human skin lipids obtained from underwear

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Introduction

Many scientists have determined the concentrations of PCDDs, PCDFs and Co-PCBs in several human samples including adipose tissue¹⁾, blood²⁾ and breast milk³⁾. It is well known that human milk is the most effective excretion route, however, little is known about the other excretion route of PCDDs, PCDFs and Co-PCB from human body. Especially, information concerning with the excretion of PCDDs, PCDFs and Co-PCBs via skin surface has been lacking. Ohgami *et al.* reported the levels of PCBs and PCQs in skin surface lipids of patients with Yusho.⁴⁾ We previously analyzed the levels of PCDDs, PCDFs and Co-PCB in human face skin lipids⁵⁾ and showed that the concentration of TEQ in skin lipids correlated with that in the blood. Such investigations provide very important information for the elimination of these lipophilic chemicals from the human body. In this study, We therefore examined the levels of those chemicals in lipids extracted from underwear worn by 4 volunteers for consecutive 3 days, and compared these findings with blood levels.

Methods

Collection of skin lipids: To collect the skin lipids from human body (upper half of the body), 4 male volunteers (40-48 years old) wore underwear for consecutive 3 days without taking a bath or changing underwear. The underwear were made of cotton, and previously purified by extraction with acetone using a soxhlet extractor. After being worn for 3 days, the underwear was extracted with acetone using a soxhlet extractor for 24 hours. The extract was concentrated and re-extracted with hexane by adding water. Each extract was then concentrated to dryness, and the lipid weight was determined gravimetrically. The method of collecting facial skin lipids was described in our previous report.⁵⁾

Purification of samples: Ten kinds of ¹³C-labeled PCDDs/PCDFs and three kinds of ¹³C-labeled Co-PCBs were added as internal standards for checking recoveries of PCDDs/PCDFs and Co-PCBs throughout the whole analytical procedure. The extract was cleaned up on a AgNO₃-silica gel column and charcoal column.

GC/MS analysis: The PCDDs/PCDFs and Co-PCBs were analyzed by the HRGC/HRMS technique using a Finnigan MAT-95 mass spectrometer (Finnigan MAT-95, Germany) directly interfaced with a HP Model 5890 II gas chromatograph. All target compounds were measured with an SP-2331 capillary column (0.32 mm x 60m; film thickness, 0.25 μm). The mass resolution (5 % valley) was 7000 to 8000.

Results and discussion

The total amounts of lipid obtained from underwear which was worn for 3 consecutive days, ranged from 0.74 to 1.27g (average: 1.09g). Concentrations of PCDDs, PCDFs and Co-PCBs in the skin lipids from underwear and those from face, and blood were determined and the results are summarized in Table 1 on a lipid basis.

The 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD) toxic equivalent (TEQ) values of PCDDs and PCDFs were calculated according to I-TEF and those of the Co-PCBs were calculated using the data reported by WHO.⁶⁾

The respective average TEQ concentrations of PCDDs, PCDFs and Co-PCBs were 9.1, 8.4, and 14.4 pg/g for skin lipids obtained from underwear, 9.4, 9.0, and 13.0 pg/g for face skin lipids and 15.1, 13.6, and 14.0 pg/g for blood samples, respectively. The average TEQ concentration was quite similar between skin lipids collected from face and those from underwear. However, the average concentration of TEQ in blood was 35% higher than that of skin lipids from their source.

Table 1 Concentration of PCDDs, PCDFs and Co-PCB in human lipid and blood samples (pg/g lipid basis)

Congener	Skin lipids*					Skin lipids**	Blood
	No-1	No-2	No-3	No-4	Average		
2,3,7,8-TCDD	1.4	1.1	1.2	1.8	1.4	1.9	4.6
1,2,3,7,8-PeCDD	5.3	5.8	5.9	7.0	6.0	7.2	9.9
1,2,3,4,7,8-HxCDD	2.0	1.3	2.6	2.3	2.1	2.5	2.9
1,2,3,6,7,8-HxCDD	9.7	13.4	10.7	17.4	12.8	16.3	36.7
1,2,3,7,8,9-HxCDD	11.2	6.7	7.2	2.9	7.0	2.5	2.1
1,2,3,4,6,7,8-HpCDD	107.1	106.6	38.0	112.2	91.0	54.2	40.3
OCDD	1545.1	2514.9	584.0	1775.9	1605.0	1233.1	1021.9
2,3,7,8-TCDF	5.1	5.4	3.6	7.8	5.5	4.6	2.2
1,2,3,7,8-PeCDF	8.0	4.8	4.2	9.8	6.7	5.7	2.3
2,3,4,7,8-PeCDF	10.5	8.7	9.7	13.4	10.6	11.6	22.3
1,2,3,4,7,8-HxCDF	5.8	6.3	7.1	11.0	7.5	6.7	7.9
1,2,3,6,7,8-HxCDF	5.5	2.4	6.7	10.7	6.3	5.5	7.6
1,2,3,7,8,9-HxCDF	3.0	0.8	0.4	1.1	1.3	3.5	1.8
2,3,4,6,7,8-HxCDF	5.1	2.3	2.1	5.5	3.7	7.2	3.0
1,2,3,4,6,7,8-HpCDF	38.4	20.6	12.5	38.9	27.6	15.6	8.7
1,2,3,4,7,8,9-HpCDF	1.5	0.8	0.0	1.8	1.0	1.2	0.0
OCDF	42.4	27.8	19.1	44.5	33.4	43.0	11.2
3,3',4,4'-TeCB	367.1	245.1	261.8	145.6	254.9	125.1	19.2
3,3',4,4',5-PeCB	183.5	122.5	113.2	135.1	138.6	125.0	133.2
3,3',4,4',5,5'-HxCB	25.9	40.0	51.1	36.6	38.4	40.8	71.2
Total PCDD	1681.9	2649.9	649.6	1919.4	1725.2	1317.7	1118.2
Total PCDF	125.4	79.8	65.3	144.5	103.8	104.4	67.1
Total PCDD/PCDF	1807.3	2729.8	714.9	2064.0	1829.0	1422.1	1185.3
Total Coplanar PCB	576.5	407.6	426.2	317.3	431.9	290.9	223.6
Total PCDD-TEQ	9.0	9.7	7.2	10.5	9.1	9.4	15.1
Total PCDF-TEQ	8.5	6.5	7.2	11.3	8.4	9.0	13.6
Total Coplanar PCB-TEQ	18.8	12.8	12.0	14.0	14.4	13.0	14.0
TEQ(International)	36.3	29.0	26.3	35.7	31.8	31.4	42.8

*:Obtained from underwear(upper half of human body)

** :Obtained from face

HUM (po)

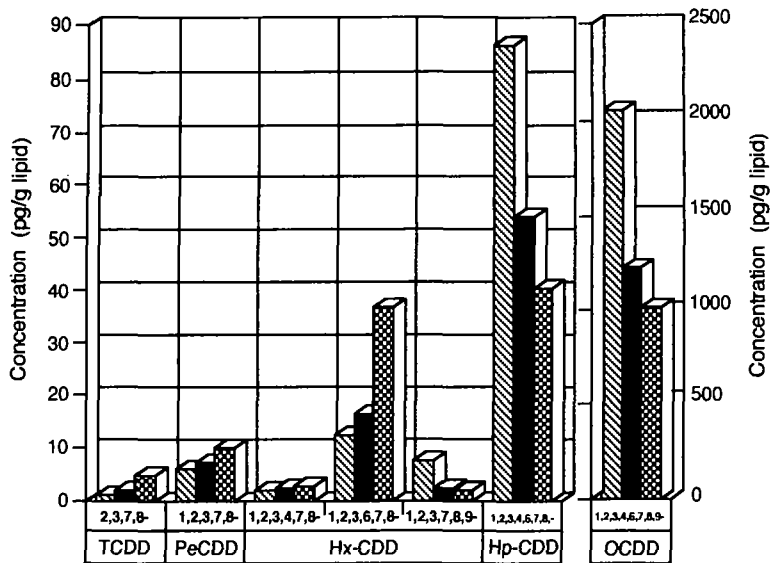


Fig.1 Congener pattern of PCDDs In skin lipids and blood

:Skin lipids from underwear :Skin lipids from face
 :Blood

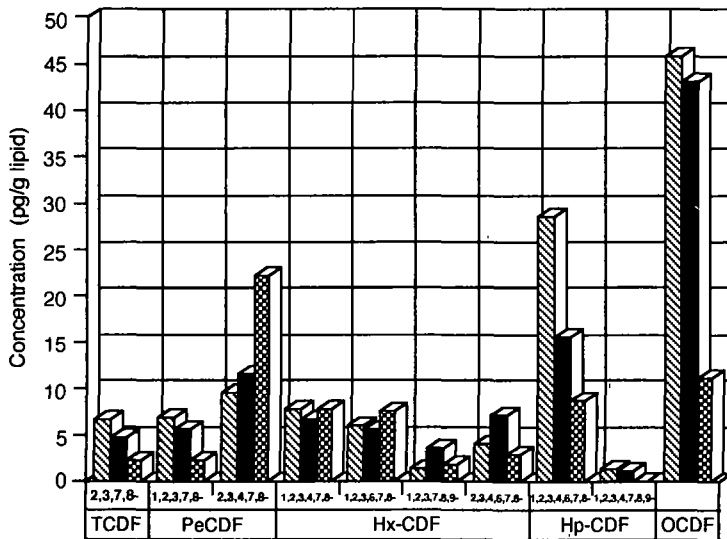


Fig.2 Congener pattern of PCDFs In skin lipids and blood

:Skin lipids from underwear :Skin lipids from face
 :Blood

We have already demonstrated that the concentration of TEQ in face skin lipids correlated with that in blood. Compared to this study, PCDDs, PCDFs and Co-PCBs concentration in skin lipids from underwear was similar to those found in skin lipids obtained from the face. This indicated that the area of the body sample did not affect the levels of PCDDs, PCDFs and Co-PCBs in the skin lipids.

Fig. 1 shows the congener pattern of PCDDs for both skin lipids and blood. As shown in this figure, OCDD was the predominant congener among PCDDs in skin surface lipids and blood. However, the levels seemed to be different between skin lipids (2053 pg/g for underwear) and blood (1021 pg/g). In PCDFs, OCDF indicated the highest level in the skin lipids but not in the blood sample, Pe-CDF was the most abundant congener (Fig. 2).

The greatest concentration was seen in 3,3',4,4',5-PCB, the most toxic congener in CO-PCBs for blood. However, 3,3',4,4'-tech levels in skin lipids (underwear) and face skin lipids were 6.5 and 13.2 times higher than those found in the blood, respectively. In our previous study on lipid excretion from the body, the daily excretion levels of skin surface lipid ranged from 0.5 to 1 g.⁷⁾ On the basis of this result, daily excretion value via skin was estimated to range from 15 to 30 TEE pg.

Conclusions

Levels of PCDDs, PCDFs and coplanar PCBs in human skin surface lipids obtained from different areas *i.e.* face and the upper half of the body were measured. The average TEQ concentrations of face skin surface lipids, those from underwear and those from blood were 31.4, 31.8 and 42.8 TEQ pg /g on a lipid basis, respectively. The sampling area of the body sample did not affect the levels of PCDDs, PCDFs and Co-PCBs in the skin lipids. It is suggested that the skin lipid play an important role in excreting lipophilic chemicals.

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