PCDD/F AND PCB LEVELS IN HUMAN HAIR

Werner Tirler[1], Giulio Voto[1], Massimo Donegà[1]

[1]Eco-Research, Via Negrelli 13, 39100 Bolzano, Italy

Introduction

Persistent organic pollutants (POP) are ubiquitously present in our environment and accumulate in human body due to their highly lipophilic properties. Once there, they can cause cancer and have adverse effects on the endocrine, immune and nervous system.[1]

Body burden measurements can help to find some correlation between adverse health effects and exposure to those environmental pollutants. Analyses of blood or breast milk are commonly used to evaluate human exposure.[2]

Beside food assumption, also through the outer surface of our body, an adsorption of environmental POPs can be supposed.[3,4,5] Particularly hair with its large specific surface can act like a passive sampler.[6]

Materials and Methods

Hair samples were taken from four persons, three close to age forty, one age twenty, working in the same place. After washing hair with shampoo, scalp hair was collected by routine haircut by study participants. Approximately 5 g of hair were spiked with $^{13}C_{12}$ labelled standards and dissolved in 2 N NaOH.[7] The obtained solution was extracted with toluene. Sulphuric acid pre-treatment and multi step clean up on an automated sample clean up apparatus (Power Prep, FMS) were used to purify the extract. Special pre-cleaned adsorbents for clean up are required in order to get sufficient low method blanks.

Determination of PCDD/F and PCBs were performed by isotopic dilution on a Thermo MAT 95 XP high-resolution gas chromatography and high resolution mass spectrometry (HRGC/HRMS) system using an Agilent DB 5ms GC column (60 m, 0,25 µm film , 0,25 ID).

Blood samples were taken under medical control by a clinical laboratory. Determination of PCDD/F in blood were performed using HRGC/HRMS, described in detail elsewhere.[8]

From one person (called person A) two hair samples, one form 2003 and one from 2006, were analyzed. For this person also data from an earlier study performed in 2001 were available.[5]

Results and Discussion

In Table 1 the PCDD/F results of hair and blood are summarized, in Table 2 only the PCB results in hair. Comparing the results from person A similar or slightly lower results were obtained from the 2003 samples than form the 2001 samples. Differences may also be due to the lower quantification limits of the 2001 study. On the other hand the sample from 2006 shows a quite lower contamination and was more similar to the sample from person B and C.

Lower concentration of POPs can be correlated to a lower environmental exposure, since levels of PCDD/F and PCBs in the environment are declining . Person B, the only cigarette smoker of the group presented significantly higher levels of OCDD and OCDF. Person D, age 20, showed by a factor of ten lower levels of PCDD/F in blood, but comparable levels in hair. So in this study (limited by only four participants) definitively no correlation between hair and blood levels of PCDD/F can be observed. Basing on blood serum analysis younger people generally present significant lower body POP concentrations due to a shorter exposure time and the already mentioned declined environmental levels of this substances. The PCDD/F congener pattern in hair is quite different from what is usually found in blood samples. They are similar to profiles found in environmental samples, like ambient air or spruce needles. So also the lower concentrations found in younger people can be caused by a different lifestyle, by a different hair handling, such as relatively short hair, use of hair cosmetics, frequent washing and so on.

Table 1: PCDD/Fs in Hair and Blood. Results in pg/g

Person	A	A	A	B	C	D		
Hair sampling Time	04_2001*	05_2003	04_2006	04_2005	04_2005	04_2006		WHO-TEF
Hair results								
2378 TCDD	<0,2	0,04	<0,02	<0,02	<0,02	<0,02		1
12378 PCDD	0,3	0,28	0,05	0,05	<0,02	0,05		1
123478 HxCDD	<0,5	0,29	0,10	0,08	0,07	0,07		0.01
123678 HxCDD	<0,5	0,32	0,10	0,24	0,11	0,09		0.01
123789 HxCDD	<0,5	0,22	0,07	0,12	0,05	0,05		0.01
1234678 HpCDD	3,2	2,15	0,75	2,39	0,48	0,53		0.001
OCDD	22,5	11,76	5,00	16,76	3,34	2,32		0.0001
2378 TCDF	0,4	0,26	0,06	0,13	0,07	0,03		0.01
12378 PCDF	0,2	0,23	0,07	0,11	0,06	0,10		0.05
23478 PCDF	0,5	0,52	0,18	0,32	0,11	0,14		0.05
123478 HxCDF	<0,5	0,53	0,13	0,21	0,17	0,13		0.01
123678 HxCDF	<0,5	0,37	0,16	0,20	0,11	0,08		0.01
234678 HxCDF	<0,5	0,63	0,15	0,30	0,15	0,20		0.01
123789 HxCDF	<0,5	0,06	0,05	0,02	0,02	0,02		0.01
1234678 HpCDF	1,3	1,65	0,59	1,62	0,37	0,32		0.01
1234789 HpCDF	<0,5	0,30	0,05	0,13	0,07	0,06		0.01
OCDF	3,2	1,73	0,55	1,42	0,52	0,24		0.0001
WHO-TEQ in hair	0,62* (1,17**)	0,89	0,25	0,38	0,16	0,20		
Blood results in pg WHO-TEQ/g lipid			18,1	19,0	18,5	1,7		

* lowerbound: using zero for the contribution of each non-quantified congener to the TEQ

* * upperbound: using the limit of quantification for the contribution of each non-quantified congener to the TEQ

Table 2: PCBs in Hair. Results in pg/g

Person		A	A	A	B	C	D		
Sampling Time		04_2001	05_2003	04_2006	04_2005	04_2005	04_2006		WHO-TEF
PCB-Iupac number									
77		23,0	22,0	10,0	35,4	4,6	3,1		0,0001
126		3,6	1,6	<1	2,8	1,0	<1		0,1
169		1,3	<1	<1	2,1	<1	<1		0,01
81		<1	<1	<1	<1	<1	<1		0,0001
105		249,0	132,1	79,5	108,4	119,9	29,3		0,0001
114		32,1	35,9	6,5	16,9	10,6	<1		0,0005
118		896,4	698,5	354,3	375,1	383,2	127,6		0,0001
123		9,5	5,2	2,1	2,8	3,5	<1		0,0001
156		247,1	215,5	113,5	247,2	117,2	43,3		0,0005
157		44,6	26,5	5,2	46,8	7,4	5,7		0,0005
167		75,4	68,4	29,8	48,1	30,3	14,7		0,00001
189		21,8	25,9	7,6	31,0	12,7	6,8		0,0001
WHO_TEQ		0,66	0,39	0,17	0,51	0,22	0,10		
28		**	666	198	417	96	36		
52		**	755	96	205	115	268		
101		**	1348	601	387	365	841		
138		**	2050	877	2102	782	374		
153		**	2174	701	822	342	332		
180		**	490	206	623	343	224		

In conclusion the transfer of body accumulated POPs, that rises mainly from food assumption, seems to have just a minor contribution to the total POPs found in hair. Exposure by ambient air is the principal way POPs accumulate in hair. From this point of view, hair is not an alternative to blood or breast milk. For long term exposure and body burden studies they will remain the main reference. Hair shows to be a complimentary matrix, which gives basic information about the short term exposure. [9] This can be particularly useful for occupational health studies and forensics.

References:

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