Biological Monitoring of Selected Mono-*ortho*-Chlorobiphenyls in Finland

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1. Introduction

Recent development in the understanding of the differences in toxicity between PCB congeners and isomers has stressed the need for isomer specific analysis of PCBs in different matrices. In the Biomonitoring Laboratory, of the Finnish Institute of Occupational Health we have analyzed PCBs in serum and adipose tissue isomer-specifically since 1983[1,2,3]. We report here our experiences in the biological monitoring of selected mono-*ortho*-chlorobiphenyls.

2. Groups studied

Since 1982 we have analyzed different PCB exposures: environmental (referents), accidental (short occupational exposures) and occupational exposure (condensator manufacture and hazardous waste disposal). The results reported here are from hazardous waste disposal (exposure started in 1985 and continues) and condensator manufacture (exposure ceased in 1983).

3. Methods

All analyses were done using the method by Luotamo *et al*,[1], the accuracy of which was verified by high resolution mass spectrometry[2]. Here we report data on the following isomers: IUPAC #60 (2,3,4,4'-tetraCB), #66 (2,3',4,4'-tetraCB), #74 (2,4,4',5-tetraCB), #105 (2,3,3',4,4'-pentaCB), #118 (2,3',4,4',5-pentaCB), #156 (2,3,3',4,4',5-hexaCB) and #189 (2,3,3',4,4',5,5'-heptaCB). For internal quality control serum from Finnish Red Cross as such and spiked with known amounts the PCB isomers analyzed was used. As external quality assurance we compared our results with Centers for Disease Control, Toxicology Branch[4].

4. Results and Discussion

Out of the mono-*ortho*-chlorinated isomers #60, #66, #118 and especially #74 indicated occupational exposure, while #156 and #189 were more related to environmental exposure.

In condensator manufacture PCB #74 represented approximately 60% of the PCBs in the group with low chlorination (#18, #28, #33, #44, #47, #66, #74 and #101) and nearly 20% was #66 immediately after the exposure (Fig.1). Declining concentrations were seen over the years, after the the condensator manufacture stopped in 1983 (Fig 1).

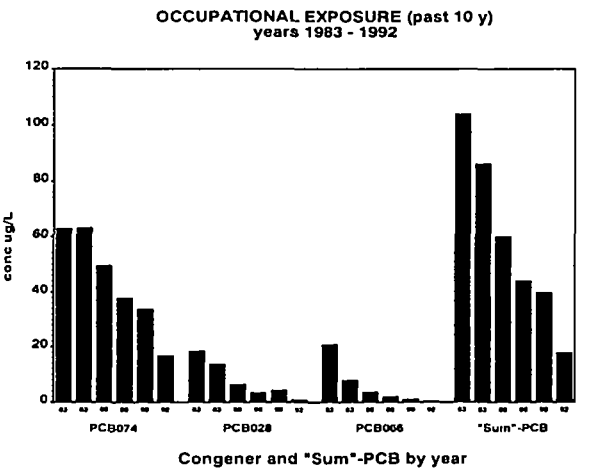

Fig. 1. *The concentrations (μg/L) of lower chlorinated isomers* ("Sum-PCB" = #18 + #28 + #33 + #44 + #47 + #66 + #74 + #101) and of the three most abundant isomers #74, #28 and #66 in sera of one worker in condensator manufacture.

The concentrations of mono-*ortho*-chlorobiphenyls in the serum of workers in the hazardous waste disposal in 1991-1992 are given in Table 1. In the hazardous waste disposal plant increasing concentrations over the years (1985-1991) have been observed at the group level[5]. This was true with the individual mono-*ortho*-chlorobiphenyl isomers. When we divided the hazardous waste disposal plant workers

(N = 252) (Table 1) in two subgroups: those having L-PCBs < 1 μg/L and those having L-PCBs > 1 μg/L (Table 2 and 3); the latter group showed clearly elevated concentrations: for #60 2.2 times, for #66 4.6 times, for #74 3.4 times, and for #118 3.4 times higher than the former group (Table 4).

In the condensator manufacture the mono-*ortho*-chlorobiphenyl concentrations (Table 5) were 7.2, 104, 315, and 2.1 times higher than the highest values observed in the less exposed waste disposal group, respectively.

Table 1. Concentrations (μg/L) of mono-*ortho*-chlorobiphenyls in sera of the workers in hazardous waste disposal (1991-1992) (N = 252, for all isomers, the lowest measured concentrations were < 0.1 μg/L).

Isomer	Mean	Median	Max	S.D.	95 percentile
#60	0.2	0.1	1.5	0.26	0.8
#66	0.1	0.04	1.0	0.12	0.3
#74	0.1	0.03	0.7	0.08	0.2
#105	0.3	0.01	2.4	0.52	1.4
#118	0.5	0.4	5.3	0.63	1.5
#156	0.2	0.01	9.0	0.63	0.7
#189	1.0	0.4	11.1	1.60	4.7

Table 2. Concentrations (μg/L) of mono-*ortho*-chlorobiphenyls in sera from those workers in hazardous waste disposal having L-PCB concentration < 1 μg/L (N = 164, for all isomers, the lowest measured concentrations were < 0.1 μg/L).

Isomer	Mean	Median	Max	S.D.	95 percentile
#60	0.2	0.1	0.7	0.18	0.5
#66	0.04	0.02	0.2	0.04	0.2
#74	0.1	0.04	0.2	0.05	0.1
#105	0.3	0.01	2.2	0.5	1.3
#118	0.5	0.3	1.6	0.5	1.6
#156	0.2	0.01	9.0	0.8	1.0
#189	1.2	0.4	7.3	1.7	4.8

Table 3. Concentrations (μg/L) of mono-*ortho*-chlorobiphenyls in sera from workers in hazardous waste disposal having L-PCB concentration >1 μg/L (N = 88, for all isomers, the lowest measured concentrations were <0.1 μg/L).

Isomer	Mean	Median	Max	S.D.	95 percentile
#60	0.3	0.1	1.5	0.4	1.0
#66	0.2	0.1	1.0	0.2	0.4
#74	0.1	0.04	0.7	0.1	0.4
#105	0.4	0.1	2.4	0.6	1.8
#118	0.7	0.7	5.3	0.8	1.7
#156	0.1	0.01	0.9	0.2	0.5
#189	0.6	0.2	11.1	1.4	1.9

Table 4. Maximal serum concentrations (μg/L) of mono-*ortho*-chlorobiphenyls in the groups with L-PCB <1 μg/L and >1 μg/L among hazardous waste disposal workers .

Isomer	L-PCB $<1\mu$g/L	L-PCB $>1\mu$g/L	ratio
#60	0.7	1.5	2.2
#66	0.2	1.0	4.6
#74	0.2	0.7	3.4
#105	2.2	2.4	1.1
#118	1.6	5.3	3.4
#156	9.0	0.9	0.1
#189	7.3	11.1	1.5

Table 5. Concentrations (μg/L) of mono-*ortho*-chlorobiphenyls in sera from workers in condensator manufacture.

Isomer	N	Mean	Median	Min	Max	S.D.	95 percentile
#60	5	1.6	1.1	0.2	5.1	2.0	5.1
#66	26	2.4	1.0	<0.1	20.8	4.3	7.8
#74	26	17.7	15.1	<0.1	62.9	18.6	62.7
#105	5	1.0	1.0	0.6	1.6	0.4	1.6
#118	5	1.4	0.9	0.3	3.4	1.2	3.4
#156	26	0.3	0.1	<0.1	1.7	0.5	1.2
#189	5	2.5	2.0	1.0	5.5	1.7	5.5

The results indicate, that determination of mono-*ortho*-chlorobiphenyls is important in estimating PCB exposure. However, the role of the mono-*ortho*-chlorobiphenyls in the total exposure asessment of dioxin-like compounds depends on the final values of their individual TEFs, which at present are still being debated.

5. References

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