Congener Specific Determination of Polychlorinated Biphenyls in Norwegian Human Milk

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INTRODUCTION

Human milk monitoring programs have been performed in many countries for elucidating infants' burden of lipophilic substances from nursing and for comparing levels of environmental pollution by these chemicals in different areas within or between countries. In Norway, human milk surveys have been performed since 1970, thereafter in 1976, 1979, 1982 and 1986[1].
The aim of this study was to determine individual PCB- congeners, especially the non-ortho substituted PCBs, in Norwegian human milk for toxicological assessment. Several non- and mono-ortho PCBs are approximate isostereomers of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), the most toxic dioxin congener, and induce similar toxic effects. The levels of the non- and mono-ortho PCBs are given as toxic equivalencts (TEQs) in relation to TCDD.
In order to compare the results with earlier investigations and determine long-term trends in the PCB levels, the samples were also analysed by packed-column gas chromatography.

METHOD

Sample Collection
Samples were collected at Oslo City Hospital, Norway. 28 mothers (26.2±2.7 years of age) filled out a detailed questionnnaire recording age, height, weight, smoking habits, occupation and nationality. The women were all giving birth to their first child and had lived in the Oslo area during the last years.

Sample Preparation
Extraction using ultrasonic treatment and the clean-up were made according to Skaare et. al.[1].

For the determination of non-ortho substituted PCBs ^{13}C labelled analogues were added. The isolation of the non-ortho PCBs was performed, as described by Haglund et. al.[2], using two 150 x 4.6mm Cosmosil 5-PYE columns.
The mono-ortho and multi-ortho substituted PCBs were analysed using HRGC-ECD and the non-ortho substituted PCBs were analysed using HRGC-HRMS. The HRMS instrument was a VG Autospec high-resolution mass spectrometer.

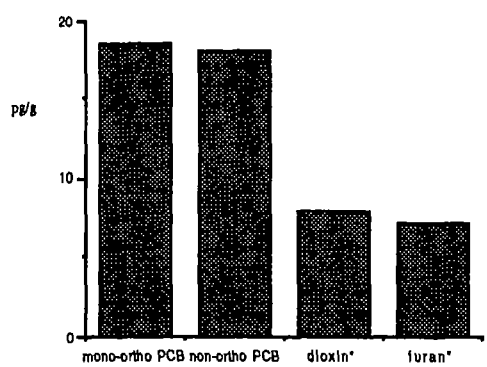
RESULTS AND DISCUSSION

Sum PCBs

The concentrations of 20 PCB congeners determined in 28 individual samples of human milk are presented in Table 1. Sum PCBs refers to the sum of the mean concentrations of all the congeners listed in Table 1. A very correlation, r=0.97, was found between sum PCBs and PCB-153, the most dominating PCB congener, which might therefore be used as an indicator for sum PCBs.
The results obtained in this and other Scandinavian human milk surveys seem to be in the middle or at the lower end of the range of data published from other European countries[3-5].

Non-ortho substituted PCBs

PCB-169 was the dominant non-ortho congener, Table 1. This finding is different from what has been reported in a Swedish and a Canadian human milk survey[6,7] which showed PCB-126 as the dominating non-ortho congener. The sum of non-ortho PCBs was higher in our study as compared to the Swedish[6]. The level of PCB-126 and PCB-169 was higher by 60% and 75%, respectively, in the Norwegian human milk samples as compared to the Swedish human milk.



* Data from Clench-Aas et. al. 1988

Fig. 1 Mean levels, pg/g fat, of non-ortho- and mono-ortho PCBs, PCDDs and PCDFs, expressed as TCDD toxic equivalents (TEQ).

TEQs were calculated using the toxic equivalency factors (TEFs) recently proposed by a Nordic expert group[8]. Among the non-ortho PCBs, PCB-126 contributed most to the TEQs. As the determination of the non-ortho substituted PCBs is very time consuming and expensive it was investigated whether PCB-153 could also be used as an indicator for the levels of non-ortho PCBs. However, no correlation between this congener and the non-ortho substituted PCBs was found (r=-0.1). The concentration of non- and mono-ortho PCBs was further compared with the levels of PCDDs and PCDFs from a Norwegian human milk survey in 1986[9], Fig. 1. In accordance with results obtained in Sweden[10] the non- and mono-ortho PCBs contributed two times more to the dioxin-related toxicity than the PCDDs/PCDFs. This demonstrate the importance to consider the non- and mono-ortho PCBs in human milk assessments.

TABLE 1. Mean, median and range values of PCB congeners in human milk fat, given in ng/g fat weight if not mentioned otherwise.

Congener	IUPAC No	mean	median	range
2,4,4´	28	7.8	22.1	0-24.2
2,2´,5,5´	52	was hidden behind contamination peaks		
2,4,4´.5	74	12.6	10.5	4.2-41.2
2,2´,4,4´,5	99	13.5	13.1	4.6-31
2,2´,4,5,5´	101	1.1	0	0-4.7
2,2´,3,3´,4,4´	128	3.7	2.8	0-14.5
2,2´,3,4,4´,5´	138	86.8	91	74.6-185.9
2,2´,3,4,5,5´	141	0.2	0	0-2.3
2,2´4,4´,5,5´	153	114.4	99.9	49.6- 259.4
2,2´,3,3´,4,4´,5	170	24.7	22.8	11.5- 52.8
2,2´,3,4,´4´,5,5´	180	50.6	46	19.7- 108.3
2,2´,3,3´,4,4´,5,5´	194	4.8	4.9	0- 10
2,2´,3,3´,4,4´,5,5´,6	206	0.4	0	0- 2.5
2,3,3´,4,4´	105	7.7	6.9	0- 16.8
2,3,4,4´,5	114	4.0	3.3	0- 15.2
2, 3´,4, 4´,5	118	26.2	23.7	9.6- 56.7
2,3,3´,4,4´,5	156	11.6	10.3	5.2- 18.9
2,3,3´,4,4´,5´	157	1.6	1.8	0- 4.3
3,3´4,4´	77[a]	45.9	22.1	5.4-273.5
3,3´4,4´,5	126[a]	156	105.4	36-737
3,3´,4,4´,5,5´	169[a]	191.7	114.7	46.4-1353.4
Sum PCBs		371.1	359.3	

a : non-ortho substituted PCBs, given in pg/g

Capillary vs. packed column.
Total PCBs has traditionally been determined by packed column GC using Aroclor 1260 as external PCB standard. To compare the present results with previous human milk surveys, quantitation was performed using both capillary GC and packed column GC. Sum PCBs in Table 1 results in a PCB level which is 62-79% of total PCBs calculated using the packed column GC method.

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