DIETARY INTAKE ESTIMATIONS OF PCB AND DIOXINS BASED ON A SWEDISH MARKET BASKET

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Introduction

In most cases, dietary intake of persistent organic pollutants (POPs) is the major source in the total human exposure to these compounds. For example, the food intake of dioxins is estimated to account for at least 90 % of the total exposure.[1] Consequently, in cases where the actual exposure is close to or above the tolerable daily intake (TDI), the presence of POPs in food constitutes a potential health problem. Depending on national or regional food habits and traditions, the actual intake of POPs, and the relative intake from different food groups, may vary considerably. Food of animal origin contains the highest levels of most POPs, and these groups will constitute the major contributors to the POP-intake. For vegetables, on the other hand, studies from e.g. Holland show that they constitute only a small part of the total dioxin (PCDD/DF + dioxin-like PCB) intake from food.[2,3]

The aim of the present study was to estimate the mean Swedish per capita intake of selected POPs derived from background contamination and to compare the result with other intake estimations, e.g. the Swedish market basket study from 1999.[4] Intake estimations of the actual compounds will be used in risk assessments regarding Swedish consumers. In the present paper, results for dioxins (PCDD/DF) and PCB in fish/fish products, meat/meat products, dairy products, egg and fats/oils are presented.

Materials and Methods

Sampling

The basis for sampling was the per capita-consumption data, derived from Swedish producers and trade statistics.[5] Thus, selected food products, representing food categories consumed at minimum 0.5 kg per person and year, were obtained in 2005 at two places of purchase in each of four major Swedish cities, namely Malmoe (Malmö), Gothenburg (Göteborg), Uppsala and Sundsvall (i.e. eight purchase places totally, except for fats/oils which was only bought in Uppsala). The towns are geographically well separated in different regions of Sweden and represent major population areas. The food items were divided into different groups, for example fish/fish products, meat/meat products, cereals etc. and five of these groups, namely fish/fish products, meat/meat products, dairy products, egg and fats/oils were used for POP analyses.

Sample preparation

From each food unit/package, a defined amount (by weight) of the yearly per capita consumption was taken out for homogenate preparation and subsequent analysis. In case of food items where wastage could be supposed, inedible parts such as bone, skin etc. were removed prior to homogenisation. The weighed amount of food samples from every food item within a food group (e.g. meat/meat products) were subsequently mixed and carefully blended. From these homogenates, samples were taken for analyses of the selected POP compounds.

Analysis

The analyses of PCDD/DF and PCB were performed by National Public Health Institute (KTL) in Kuopio, Finland using an accredited method. The samples were quantified by high resolution gas chromatography using a DB-Dioxin capillary column (J&W Scientific: 60 m, 0.25 mm, 0.15 μm) and high resolution mass spectrometry (Hewlett-Packard 6890- VG 70-250 SE) using selective ion recording (resolution 10,000).

Market basket-derived intake estimation
On the basis of the analyses, and if necessary extrapolating non-quantified levels with half the quantification limit (<LOQ=½ LOQ), the *per capita* mean intake was calculated. First, the amount of the respective compound in each food group homogenate was calculated by multiplying the actual concentration in the homogenate with the weight that represents the annual consumption of the product group. This will give the yearly consumption of the actual compound, which subsequently could be expressed on a daily basis by dividing with 365. The total intake figure is also given on a kg weight basis, and in this case the mean weight for the participants in the Swedish consumption study Riksmaten (yr 17-79) was used, i.e. a weight of 73.7 kg (mean of men and women).[6]

Results and Discussion
In Table 1, the levels of PCDD/DF TEQ, PCB TEQ and PCB153 in homogenates of fish, meat, dairy products, eggs and fats/oils are presented on fresh weight basis. Data are presented as city specific and as a mean of eight samples (except for fats/oils). The fats/oils, which generally are not produced locally, were only purchased in Uppsala. During the collection of the products primarily locally produced products were chosen when possible. However, from the limited data presented in Table 1, no clear geographical differences can be observed.

The estimated, market basket-intakes of the studied compounds, based on presented mean occurrence values, are given in Table 2. The data obtained from the market basket study in 1999 are shown as a comparison. Generally, the estimated intakes of PCDD/DF and PCB from the present market basket data seems to be lower than in the earlier study. However, the basis for these estimations is the occurrence data of PCDD/DF and PCB as well as the data on the Swedish per capita consumption for the particular years and both these data sets contain elements of uncertainty. In case of the consumption data, they are based on production and trade statistics, which represents a consumption level which is probably higher than what people actually eat. In addition, these data give only a mean value and do not give information on individual consumption patterns. In case of the analytical methods, levels less that the LOQ will increase the uncertainty. During the market basket study in 1999, several levels were reported below the quantification limit valid at that time. For example, the analyses of fats/oils resulted in levels almost exclusively beneath the LOQ, which will introduce a considerable amount of uncertainty in the intake calculations of these food groups. The observed decrease in estimated intake may therefore be due to an actual reduction of concentrations in the analysed food samples, but can also be the result of decreased quantification limits.

When calculating contribution of the different food groups to the total intake of dioxins (total-TEQ, medium bound) it is shown that fish is a major contributor (49%) to the intake of dioxins for Swedish consumers. Also in the market basket study from 1999[4], fish was found to be the major contributor to the intake of dioxins (33% of the total-TEQ, medium bound). Kiviranta et.al. reported fish as the major contributor to the intake of PCDD/DF TEQ and PCB TEQ in Finland.[7] In our present study, it was also found that meat (15%), dairy products (22%) and fats/oils (13%) are important factors for the intake of dioxins. These results correspond to the results from the previous market basket study.[4]

The estimated market basket-intakes total-TEQ of 0.7 pg/kgbw/day are below the internationally acceptable intake limits (total-TEQ 2 pg/kgbw/day- SCF, 2001) and lower than the estimated intake based on from the data from the market basket study in 1999 (total-TEQ 1.3 pg/kgbw/day).[4] The present study gives evidence for an ongoing decrease in the Swedish intake of dioxins and PCB from food.

Table 1. Levels of *PCDD/DF TEQ*[a], *PCB TEQ*[b] *and PCB 153* in food homogenates of selected Swedish market basket sample groups, based on samples collected in four cities. The levels are presented on fresh weight.

	Fat (%)	PCDD/DF TEQ (pg/g)	PCB TEQ (pg/g)	PCB 153 (ng/g)
FISH (mean)	***8.4***	***0.215***	***0.326***	***1.20***
Uppsala	7.1	0.240	0.328	1.31
	6.1	0.198	0.394	1.57
Sundsvall	10.0	0.469	0.442	1.71
	7.2	0.207	0.297	1.06
Gothenburg	9.3	0.153	0.244	0.802
	8.6	0.162	0.326	1.13
Malmoe	8.8	0.112	0.228	0.901
	10.3	0.180	0.352	1.13
MEAT (mean)	***12.8***	***0.016***	***0.021***	***0.076***
Uppsala	11.9	0.017	0.018	0.059
	11.4	0.013	0.023	0.102
Sundsvall	11.7	0.012	0.027	0.083
	14.8	0.022	0.024	0.083
Gothenburg	11.4	0.016	0.018	0.072
	13.6	0.015	0.018	0.070
Malmoe	13.4	0.013	0.018	0.063
	13.8	0.021	0.023	0.074
DAIRY PROD (mean)	***4.4***	***0.012***	***0.011***	***0.025***
Uppsala	4.3	0.012	0.012	0.026
	5.3	0.016	0.013	0.023
Sundsvall	4.0	0.012	0.007	0.016
	3.3	0.008	0.006	0.014
Gothenburg	3.7	0.008	0.009	0.018
	4.4	0.009	0.010	0.022
Malmoe	4.5	0.014	0.017	0.045
	5.3	0.013	0.017	0.036
EGG (mean)	***8.4***	***0.023***	***0.010***	***0.032***
Uppsala	8.4	0.018	0.007	0.015
	8.5	0.016	0.004	0.013
Sundsvall	9.1	0.018	0.014	0.027
	8.0	0.020	0.007	0.022
Gothenburg	7.1	0.016	0.009	0.024
	8.6	0.029	0.013	0.043
Malmoe	9.1	0.025	0.014	0.076
	8.7	0.038	0.010	0.033
FATS/OILS (mean)	***73.0***	***0.14***	***0.034***	***<0.11***
Uppsala	74.0	0.12	0.033	<0,11
	71.9	0.15	0.035	<0,11

a) PCDD/DF-TEQ (17 congeners)
b) PCB-TEQ (12 congeners)

Table 2. Calculated intakes of PCDD/DF TEQ[a], PCB TEQ[b] and PCB 153 from five food groups (<LOQ=½LOQ). TEQ-based intakes in pg/day and PCB 153 intake in ng/day. A comparison is made with data from the Swedish market basket data in 1999.[4]

	TOTAL[c]	Fish	Meat	Dairy prod.	Egg	Fats/oils
PCDD/DF-TEQ, 2005	24	9.8	3.3	5.6	0.5	5.2
PCDD/DF-TEQ, 1999	51	12.8	9.52	12.8	2.11	13.5
PCB-TEQ, 2005	26	15	4.3	5.4	0.2	1.3
PCB-TEQ, 1999	40	18.2	4.75	5.91	3.73	7.05
PCB 153, 2005	85	55	15	12	0.7	2.1
PCB 153, 1999	139	79.4	22.2	23.1	9.80	4.12

a) PCDD/DF-TEQ (17 congeners)
b) PCB-TEQ (1999: 9 congeners analysed, 2005: 12 congeners analysed)
c) Total=fish+meat+dairy prod.+egg+fats/oils.

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