FOOD INTAKE OF THE BROMINATED FLAME RETARDANTS PBDE:S AND HBCD IN SWEDEN

Ylva Lind, Marie Aune, Samuel Atuma, Wulf Becker*, Rickard Bjerselius, Anders Glynn and Per Ola Darnerud

Swedish National Food Administration, Departments of Research & Development and Nutrition*, P.O. Box 622, SE-751 26 Uppsala, Sweden

Introduction

Due to earlier and present use of chemicals in industry and among consumers, measurable levels of a number of persistent organic pollutants (POPs) can be found in our environment. For the normally exposed person, the exposure via food is the largest single factor for many of the POP substances. A high intake of POPs could represent a health hazard, and its is therefore important to improve the basis for risk assessments of these compounds. In this respect, relevant intake data are necessary.

Recently, the occurrence of brominated flame-retardants (BFRs) in the environment and in human samples has been revealed[1,2]. One group of BFRs that has lately been studied rather extensively is the polybrominated diphenyl ethers (PBDEs). These compounds are used as flame retardants in various electronics, plastics and textiles, are spread in the technosphere and occur in environmental samples[3]. The levels of PBDEs have been increasing in the environment for some time, and in a Swedish time trend study the breast milk levels of PBDEs were shown to increase markedly between 1972 and 1997[4]. In addition, results from our study group show that the levels in milk show a rather wide distribution and that neither maternal age nor computer usage could explain the milk PBDE levels[5]. In a preliminary presentation, the Swedish mean per capita intake of PBDEs via food was estimated to be 51 ng, based on market Basket calculations[6]. Regarding hexabromo cyclododecane (HBCD), another rather frequently used BFR, very little is known about human levels and intake via food. In the present presentation, Swedish PBDE and HBCD intake calculations will be presented.

Materials and methods

The food samples were collected in 1998-99 and only food of animal origin was obtained for BFR analysis. Samples from cow, pig, sheep and chicken were collected at slaughterhouses. Eggs, milk and farmed rainbow trout were obtained from the producers. Samples of wild-caught fish were taken in connection to regular ongoing monitoring programmes. Certain food samples were mixed homogenates and originated from a simultaneously ongoing Market Basket study.

The PBDE analyses were carried out at the Swedish NFA, Uppsala. The five PBDE congeners BDE 47, 99, 100, 153 and 154 (=sumPBDE) were quantified on GC-ECD by use of the respective standards and the internal standard BDE 85. HBCD analyses were performed by an external laboratory (IVL).

The food consumption data used in the intake calculations were derived from the national Swedish dietary survey carried out in 1997-98 (Riksmaten). The methodology used was a precoded 7-d records and data referred to food as consumed. The data was obtained from about 1200 Swedish consumers of both sexes, 18-74 years old. The consumption of data for individual fish species was derived from a food frequency questionnaire included in the survey covering consumption during the previous year.

Separate intake calculations have been made for each of the participating objects, and basal statistics (mean, median, min/max and 95th percentile) of the obtained data have been performed. Age categorisation of the obtained data has also been made.

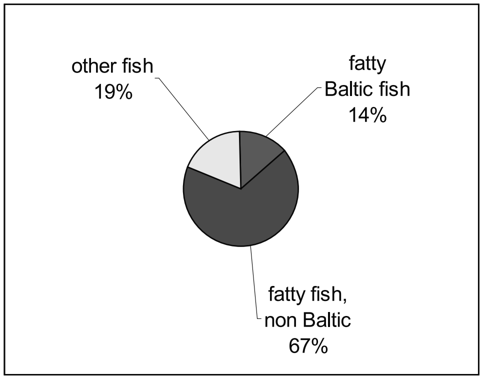

Figure 1. Relative contribution of different fish groups to the total intake of PBDE from fish, based on median values.

Results and Discussion

The intake of sumPBDE in female Swedish objects is shown in Table 1. The data give evidence for a skewed distribution (to the left), by comparing mean-median values and median-min/max values. The most important food group for PBDE intake is fish, which constitute two thirds of the total intake based on median values. Within the fish group, the fatty fishes other than those from the Baltic Sea give most of the total intake from fish (67 %; Fig. 1). If the intake data are age categorised, the median intake increases with age from the youngest age group to the oldest (Table 2), which probably reflects an age-related increased consumption of fatty fish. The intake data for male individuals are quite similar to the female data, and the male total PBDE intake (in ng/kgbw/d) is 0.58 (mean) and 0.43 (median) (data not shown).

The intake data for HBCD is based on a less complete set of food concentration data, and therefore these values must be considered somewhat preliminary. The intake of HBCD in females is given in Table 3. As for PBDE, the HBCD values show that the intake from fish in dominating, making up two thirds of the total intake (based on median values). The age categorised data show that the total intake increases from the age group 21-30 and upwards (female values 2.0 – 2.9 ng/kgbw/d) (Table 4). Based on body weight figures, the male total intake is somewhat lower than the female intake (male mean 2.2 and median 1.9 ng/kgbw/d) (data not shown).

The mean PBDE intake estimation is near a value earlier obtained by use of Market Basket methodology. Also other countries (Canada, Finland) have reported intake figures quite similar to our study (personal communication). An additional feature with our data is the distribution figures, showing the relatively large distribution range and the comparably high maximum intake value. A few subjects have much higher estimated intake values than the rest of the study group, which chiefly can be explained by a high consumption of fish. It should however be noted that we have estimated only the dietary intake, and consequently know very little of other exposure routes and their contribution to the total PBDE exposure.

The estimated intake of HBCD, although preliminary, is suggested to be higher than for PBDE (about three times). We have limited information about PBDE regarding kinetics and toxicology, but even so the knowledge is better than for HBCD. Therefore, much more data should be produced on HBCD, and of course also on possible interactions between different BFRs such as HBCD and PBDE. Another area of missing data is the children and their exposure. We could suppose that the intake per kg body wt. is higher in childhood, and especially during the nursing period. This should be kept in mind when assessing the possible risk with these two compounds, and with other BFRs.

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Table 1. Intake of PBDE (ng/d) from different food groups, females age 17-74

	N	*Mean*	*Median*	*Min - max*	*95th percentile*
All fish	629	30.2	17.1	0.0-654	87.5
Fatty Baltic fish	629	9.37	2.02	0.0-551	43.5
Other fatty fish	629	18.8	9.90	0.0-598	64.1
Other fish	629	4.87	2.79	0.0-48.9	12.5
Meats, chicken	626	2.38	2.28	0.0-8.15	4.74
Diary products	626	3.38	3.15	0.0-12.4	6.75
Vegetable fats	626	1.60	1.26	0.0-12.1	4.17
Other fats	626	2.76	2.51	0.0-11.6	6.02
Egg	626	0.52	0.31	0.0-3.77	1.88
Total intake					
ng/d	621	40.8	28.1	1.28-666	96.4
ng/kgbw/d	621	0.63	0.43	0.02-11.7	1.42

Table 2. Total intake of PBDE (ng/d; ng/kg bw/d) in different age categories, females age 17-74

Age	15-20 N=24	21-30 N=111	31-40 N=139	41-50 N=149	51-60 N=104	61-70 N=73	71-80 N=21
ng/d							
Mean	24.4	30.7	34.8	41.8	52.8	53.7	42.6
Median	19.6	22.6	27.4	27.9	32.8	34.8	35.7
Min - max	6.86-104	3.96-190	4.25-385	1.28-636	11.2-666	10.4-380	7.95-100

ng/kgbw/d							
Mean	0.40	0.49	0.54	0.62	0.84	0.80	0.63
Median	0.34	0.34	0.41	0.42	0.50	0.50	0.54
Min - max	0.11-1.79	0.07-3.46	0.06-6.42	0.02-8.71	0.17-11.7	0.16-6.67	0.10-1.60

Table 3. Intake of HBCD (ng/d) from different food groups, females age 17-74

	N	Mean	Median	Min - max	95th percentile
Fish	629	114	94	0-922	285
Meats, chicken	622	13.3	12.4	0-49.1	26.5
Diary products	622	23.3	21.6	0-85.0	46.2
Egg	622	11.6	7.0	0-84.0	42.0
Total intake					
ng/d	622	162	141	21.8-1076	332
ng/kgbw/d	622	2.50	2.15	0.29-21.5	5.14

Table 4. Total intake of HBCD (ng/d; ng/kg bw/d) in different age categories, females age 17-74

Age	15-20 N=24	21-30 N=111	31-40 N=140	41-50 N=149	51-60 N=104	61-70 N=73	71-80 N=21
ng/d							
Meanl	142	130	154	168	174	192	200
Median	125	114	142	140	151	165	168
Min - max	32.3-370	26.2-385	21.8-875	22.0-710	38.9-1076	49.2-898	22.1-697
ng/kgbw/d							
Mean	2.32	2.05	2.35	2.55	2.76	2.88	2.92
Median	2.06	1.83	2.14	2.15	2.32	2.33	2.24
Min - max	0.48-6.16	0.44-6.38	0.32-11.8	0.39-11.6	0.58-21.5	0.73-13.1	0.29-9.19