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BROMINATED CHEMICALS: UK DIETARY INTAKES

Summary

In order to allow an estimate of dietary intakes of brominated fire retardants and related compounds by UK consumers, nineteen composite food group samples collected for the 2003 and 2004 Total Diet Studies (TDS) have been analysed for a range of brominated compounds. Based on the results, estimated dietary exposure to brominated compounds does not have implications for health.

Key Facts

- This work was carried out following an increasing number of reports of brominated flame retardants (BFRs) and other brominated compounds being found in fish and other foods.
- Polybrominated diphenyl ethers (PBDEs), brominated dioxins and furans (collectively referred to simply as brominated dioxins) and polybrominated biphenyls (PBBs) were analysed in 19 composite samples of food groups collected during the 2003 Total Diet Survey. Hexabromocyclododecanes (HBCDs) and tetrabromobisphenol A (TBBP-A) were analysed in 2004 TDS samples.
- PBDE 209 was the most abundant PBDE congener, followed by PBDE 47. These and PBDEs 49, 66, 99, 100, 153 and 183 were detected in most of the food groups. Other PBDEs, brominated dioxins, PBBs and HBCDs were detected less frequently. TBBP-A was not found above the limit of detection in any food group.
- The estimated average adult dietary intakes from the whole diet in 2003 or 2004 were <5.9 ng/kg bodyweight/day for total PBDEs, <5.9 ng/kg bodyweight/day for total HBCDs, <1.6 ng/kg bodyweight/day for TBBP-A, and <0.4 pg TEQ/kg bodyweight/day for brominated dioxins.
- The Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment concluded that the concentrations of PBDEs, HBCD and TBBP-A detected in this and the survey for brominated chemicals in farmed and wild fish and shellfish do not raise toxicological concerns.

Background

The source and nature of the compounds measured in this investigation were discussed in a recent report on brominated compounds in fish.¹

Fish have been the most frequent food group to be studied for contamination by brominated fire retardants and related compounds. This Total Diet investigation was carried out to provide the basis for an estimate of overall dietary exposure. It was also intended to identify any other food groups that also contain brominated chemical contaminants and to indicate which of those contribute most significantly to exposure.

Methodology

The Total Diet Study provides a model of the typical UK diet. It is described more fully in Food Survey Information Sheet No 38/03.² Composite samples of all of the food group sub-samples purchased from various locations in the UK in 2003 were tested, with the exception of the beverages food group. In the case of HBCDs and TBBP-A, because there was insufficient sample in most the 2003 food groups to obtain results of good quality, these compounds were re-measured in samples from the 2004 Total Diet Study.

Analysis

All analyses were carried out by the Central Science Laboratory (CSL). Samples were analysed for brominated dioxins, PBBs and PBDEs using the same methodology³ and to the same analytical quality assurance criteria⁴ as dioxins and PCBs. HBCDs and TBBP-A were analysed by using high performance liquid chromatography – mass spectrometry (HPLC-MS/MS). Full details of the analytical methodology can be found in the contractor's final report for the survey.⁵ Table 1 lists the compounds measured. The ranges of brominated dioxins and PBB congeners were limited by the availability of appropriate internal standards. CSL has UKAS accreditation to ISO 17025 for analysis of PBDEs (except PBDE 209) and achieved similar UKAS accreditation for brominated dioxins and PBBs in the course of the survey.

Results

The results are shown in Tables 2 (brominated dioxins and furans), 3 (PBBs), 4a and 4b (PBDEs) and 5 (HBCDs). All results for TBBP-A were below the limit of detection

(generally 0.36 microgram/kg whole weight). Uncertainty data is provided in the final report from the contractor.⁵ Brand names are not available for this survey as composite samples, each comprising a mixture of different branded foods, were analysed.⁶

Brominated dioxins were not detected in any samples, but at least one brominated furan was detected in every food group, with the tri-, tetra-, penta- and hepta- congeners being detected most frequently. The highest absolute totals were found in sugars and preserves, oils and fats, nuts, fish and carcass meat. Dioxin-like PBBs were rarely detected. For dioxins and PBBs together, the highest total TEQs (based on the TEFs for the chlorinated dioxin and PCB analogues where possible)⁷ were found in offal, sugars and preserves, nuts, carcass meats and meat products. Non dioxin-like, ortho-substituted PBBs were also rarely found.

PBDEs were detected in all food groups. Meat products contained the highest total, dominated by PBDE 209 (deca-BDE). PBDE209 was also the PBDE congener of the highest concentration in all but two food groups (canned vegetables and fish). PBDEs 47, 99 and 153 were the next most significant. These and PBDEs 49, 66, 100 and 183 were detected in most of the food groups. In general, the less brominated congeners such as PBDE 47 were most abundant in fish, whilst the more brominated congeners were more abundant in meat.

In the 2004 Total Diet samples, alpha-HBCD was detected in half of the food groups, being highest in fruit, vegetables and meat. Beta- and gamma-HBCD were found less frequently, at lower levels and only in fruit and vegetables.

TBBP-A was not found above the limit of detection in any samples.

Dietary Exposure

Dietary intakes by consumers of different age groups were estimated using food consumption data from various dietary surveys.⁸⁻¹¹ Estimated dietary intakes by adults are presented in Table 6 for brominated dioxins and dioxin-like PBBs, Table 7 for PBDEs and Table 8 for HBCDs and TBBP-A. Estimated total dietary intakes by all age groups are presented in Table 9 for brominated dioxins and dioxin-like PBBs, Table 10 for tribromodioxins, Tables 11a-11f for PBDEs and Table 12 for HBCDs and TBBP-A.

The estimated average upper bound dietary intakes of brominated chemicals by adults from the whole diet in 2003 were 5.8 ng/kg bodyweight per day for total PBDEs, 5.9 ng/kg bodyweight/day for total HBCDs, 1.6 ng/kg bodyweight/day for TBBP-A, and 0.4 pg TEQ/kg bodyweight/day for brominated dioxins. The estimated dietary intakes of the tribromodioxins and dioxin-like PBBs were negligible (pg/kg bodyweight on a fresh weight basis).

Interpretation

The estimated total adult dietary intake of brominated dioxins was comparable with that found in Japan (1.4 pg TEQ/kg bodyweight/day).¹² PBDEs (excluding PBDEs 17, 28 and 209) were also included in the Japanese survey, and the estimated total adult dietary intake (1.1 ng/kg bodyweight/day) is similar to that of the same congeners in the Agency's survey (1.4 ng/kg bodyweight/day). PBBs, HBCDs and TBBP-A were not analysed in the Japanese survey. The intakes of total PBDEs (PBDEs 47, 49, 100, 153 and 154) are comparable with the figure of 2.2 ng/kg bodyweight/day estimated by other UK workers and based on analysis of duplicate diets.¹³ The intakes are also consistent with those found in surveys in Spain, Sweden, Canada and the Netherlands.¹⁴⁻¹⁷ The Dutch survey also included the only dietary intake estimates for total HCBs and TBBP-A – the only examples of which the Agency is aware. The total adult dietary intakes (4.3 and 0.04 ng/kg bodyweight/day, converted to upper bound values), were lower than those found in the Agency's survey.

The independent expert Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT) has previously concluded that, because only limited toxicological data are available, no Tolerable Daily Intakes (TDIs) can be set for either PBDEs or HBCDs.¹⁸ However, the COT did recommend a TDI for TBBP-A of 1 mg/kg bodyweight/day,¹⁹ and the estimated upper bound dietary intakes of TBBP-A are all well within this figure.

The COT recently reviewed the results of the survey for brominated compounds in fish,¹ which included the estimated exposure from the rest of the diet using the data from this Total Diet study.⁵ The COT concluded that the concentrations of PBDEs, HBCD and

TBBP-A detected in this and the survey for brominated chemicals in farmed and wild fish and shellfish do not raise toxicological concerns.

Summary of Units

ppb	parts per billion, equivalent to one microgram per kilogram (kg)
kg	a kilogram (kg) is one thousand grams (g)
µg	microgram, one millionth of a gram
ng	a nanogram is one thousand millionth of a gram
ng/kg bw/day	nanograms per kilogram of bodyweight per day; equivalent to parts per million million (parts per trillion) by weight.
pg TEQ/kg bw/day	picograms of Toxic Equivalents per kilogram; equivalent to parts per thousand million million (parts per quadrillion) by weight.
pg WHO-TEQ/kg bw/day	picograms of WHO Toxic Equivalents per kilogram; equivalent to parts per thousand million million (parts per quadrillion) by weight.

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Table 1 Brominated compounds measured in the survey

Dioxin/furan congeners	TEF*	Polybrominated diphenyl ethers
2,3,7-TriBDD	-	Tri-BDE
2,3,7,8-TetraBDD	1	17 (2,2',4)
1,2,3,7,8-PentaBDD	1	28 (2,4,4')
1,2,3,4,7,8-/1,2,3,6,7,8-HexaBDD	0.1	Tetra-BDE
1,2,3,7,8,9-HexaBDD	0.1	47 (2,2',4,4')
2,3,8-TriBDF	-	49 (2,2,4',5')
2,3,7,8-TetraBDF	0.1	66 (2,3',4,4')
1,2,3,7,8-PentaBDF	0.05	71 (2,3',4',6)
2,3,4,7,8-PentaBDF	0.5	77 (3,3',4,4')
1,2,3,4,7,8-HexaBDF	0.1	Penta-BDE
1,2,3,4,6,7,8-HeptaBDF	0.01	85 (2,2',3,4,4')
		99 (2,2',4,4',5)
Polybrominated biphenyls		100 (2,2',4,4',6)
PBB 77 (3,3',4,4')	0.0001	119 (2,3',4,4',6)
PBB 126 (3,3',4,4',5)	0.1	126 (3,3',4,4',5)
PBB 169 (3,3',4,4',5,5')	0.01	Hexa-BDE
PBB 15 (4,4')	-	138 (2,2',3,4,4',5')
PBB 49 (2,2',4,5')	-	153 (2,2',4,4',5,5')
PBB 52 (2,2',5,5')	-	154 (2,2',4,4',5,6')
PBB 80 (3,3',5,5')	-	Hepta-BDE
PBB 101 (2,2',4,5,5')	-	183 (2,2',3,4,4',5',6)
PBB 153 (2,2',4,4',5,5')	-	Deca-BDE
PBB 209 (2,2',3,3',4,4',5,5',6,6')	-	209 (2,2',3,3',4,4',5,5',6,6')
* TEFs quoted are the WHO-TEFs that apply to the chlorinated analogues		Hexabromocyclododecane enantiomers
		Alpha-HBCD
		Beta-HBCD
		Gamma-HBCD

Tetrabromo-bisphenol A (TBBP-A)

Table 2 Brominated dioxins and furans in Total Diet Food Groups

	237-TriBDD	2378-TBDD	12378-PeBDD	123478-+123678-HxBDD	123789-HxBDD	238-TriBDF	2378-TBDF	12378-PeBDF	23478-PeBDF	123478-HxBDF	1234678-HpDF
bread	<0.002	<0.001	<0.003	<0.007	<0.004	0.005	<i>0.003</i>	<0.004	<0.003	<0.004	0.14
canned vegetables	<0.002	<0.001	<0.004	<0.006	<0.005	<i>0.002</i>	<0.002	<0.002	<0.003	<0.003	0.03
carcass meats	<0.005	<0.004	<0.01	<0.02	<0.02	<0.01	<0.006	<0.01	0.02	<0.01	0.27
dairy products	<0.009	<0.007	<0.02	<0.03	<0.03	<i>0.01</i>	<0.01	<0.01	0.02	<0.02	<0.03
eggs	<0.005	<0.004	<0.01	<0.02	<0.02	<0.006	0.009	<0.01	<0.01	<0.02	0.11
fish	<0.01	<0.006	<0.02	<0.02	<0.01	<0.01	0.02	<0.03	<0.01	<0.02	0.29
fresh fruit	<0.001	<0.001	<0.002	<0.004	<0.003	0.001	<0.001	0.003	0.003	<0.002	0.02
fruit products	<0.005	<0.003	<0.005	<0.01	<0.01	<i>0.02</i>	<0.003	<i>0.02</i>	0.01	<0.01	<0.02
green vegetables	<0.0004	<0.0003	<0.001	<0.001	<0.001	0.002	<i>0.0005</i>	0.001	0.001	0.004	0.01
meat products	<0.005	<0.002	<0.01	<0.03	<0.02	<0.02	<0.007	<0.009	0.02	<0.02	0.31
milk	<0.005	<0.004	<0.008	<0.02	<0.02	<i>0.01</i>	<0.005	<0.007	<0.02	<0.02	0.13
miscellaneous cereals	<0.003	<0.002	<0.006	<0.01	<0.006	<0.009	<i>0.006</i>	0.008	<i>0.008</i>	<0.007	<0.07
nuts	<0.01	<0.005	<0.02	<0.04	<0.02	<0.03	<0.01	<0.01	0.02	<0.03	0.4
offal	<0.004	<0.006	<0.02	<0.02	<0.009	<0.01	<0.006	0.02	0.05	<0.01	<0.11
oils and fats	<0.02	<0.02	<0.08	<0.13	<0.07	<0.08	<0.03	<0.03	<0.07	<0.08	0.67
other vegetables	<0.001	<0.001	<0.003	<0.005	<0.004	<i>0.004</i>	<0.002	<i>0.005</i>	<0.004	<0.004	<0.02
potatoes	<0.002	<0.001	<0.004	<0.001	<0.006	<i>0.002</i>	<i>0.002</i>	<0.005	<0.004	<0.003	<0.01
poultry	<0.005	<0.003	<0.01	<0.02	<0.008	<0.01	0.008	<0.006	<0.01	<0.01	0.19
sugars and preserves	<0.004	<0.003	<0.009	<0.02	<0.006	0.07	<i>0.02</i>	0.02	0.02	0.08	0.54

1. All results expressed as ng/kg on a fresh weight basis
2. Figures in italics are indicative values, i.e. approximate due to interferences in the analysis.

Table 3 Polybrominated biphenyls in Total Diet Food Groups

(all results expressed on a fresh weight basis)

	Non-ortho, ng/kg			Ortho, microgram/kg						
	PBB 77	PBB 126	PBB 169	PBB-15	PBB-49	PBB-52	PBB-80	PBB-101	PBB-153	PBB-209
bread	<0.004	<0.001	<0.002	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.001	<0.005
canned vegetables	<0.003	<0.001	<0.002	<0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.002
carcase meats	<0.01	0.008	<0.007	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005
dairy products	<0.01	<0.009	<0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.06
Eggs	<0.009	<0.005	<0.009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.0009	<0.02
fish	0.02	<0.01	<0.01	<0.0008	<0.0008	0.002	<0.0008	0.0008	0.002	<0.013
fresh fruit	<0.002	<0.001	<0.002	<0.0002	<0.0000	<0.0000	<0.0000	<0.0000	<0.0001	0.005
					4	4	4	4	4	
fruit products	<0.006	<0.005	<0.005	<0.0003	0.0001	0.0001	0.0001	0.0001	<0.0003	<0.003
green vegetables	<0.001	<0.001	<0.001	0.0002	<0.0000	<0.0000	<0.0000	<0.0000	<0.0000	<0.0005
					4	4	4	4	4	
meat products	<0.01	0.007	<0.009	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.005
milk	<0.008	<0.005	<0.008	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.007
miscellaneous cereals	<0.008	<0.003	<0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.011
nuts	<0.02	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
offal	0.01	0.02	<0.007	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	<0.005
oils and fats	<0.07	<0.03	<0.06	<0.008	<0.008	<0.008	<0.008	<0.008	<0.008	0.11
other vegetables	<0.002	<0.001	<0.002	0.001	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.02
potatoes	<0.003	<0.002	<0.003	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.01
poultry	<0.01	<0.006	<0.007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.01
sugars and preserves	0.01	0.007	<0.007	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.07

1. All results expressed on a fresh weight basis

Table 4a Polybrominated diphenyl ethers in Total Diet Food Groups, PBDE 17 - 99

	PBDE-17	PBDE-28	PBDE-47	PBDE-49	PBDE-66	PBDE-71	PBDE-77	PBDE-85	PBDE-99
bread	<0.0003	<0.001	0.01	0.002	0.001	<0.0003	<0.0003	0.0005	0.01
canned vegetables	<0.0001	0.0001	0.003	0	0.0002	<0.0001	<0.0001	<0.0001	0.003
carcase meats	<0.001	<0.001	0.02	<0.001	<0.001	<0.001	<0.001	<0.001	0.02
dairy products	<0.002	<0.002	0.06	0.002	0.003	<0.002	<0.002	0.002	0.07
Eggs	<0.0009	<0.0009	0.02	0.002	0.0009	<0.0009	<0.0009	<0.0009	0.02
fish	0.002	0.02	0.26	0.07	0.02	<0.0008	<0.0008	<0.0008	0.06
fresh fruit	<0.00004	<0.0001	0.002	0.0002	0.0002	<0.00004	<0.00004	<0.0001	0.002
fruit products	0.0002	0.0005	0.01	0.001	0.001	<0.0001	0.0001	<0.0005	0.01
green vegetables	<0.00004	0.0001	0.002	0.0002	0.0001	<0.00004	<0.00004	<0.00004	0.002
meat products	<0.002	<i>0.01</i>	0.08	0.004	0.004	<0.002	<0.002	0.004	0.09
milk	<0.0002	<0.0002	0.007	0	0.0006	<0.0002	<0.0002	0.0002	0.008
miscellaneous cereals	<0.0006	<0.001	0.01	0.001	0.001	<0.0006	<0.0006	<0.0006	0.01
nuts	<0.005	<0.005	<0.02	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01
offal	<0.0006	<0.001	0.02	0.001	0.001	<0.0006	<0.0006	0.0006	0.02
oils and fats	<0.008	<0.008	0.08	0.008	0.008	<0.008	<0.008	<0.008	0.08
other vegetables	0.0006	0.003	0.03	0.01	0.01	0.0006	0.0008	0.004	0.06
potatoes	<0.0002	<0.0002	0.004	0.0005	0.0005	<0.0002	<0.0002	<0.0002	0.004
poultry	<0.0007	<i>0.0007</i>	0.05	0.002	0.001	<0.0007	<0.0007	0.002	0.08
sugars and preserves	<0.001	0.007	0.06	0.006	0.007	<0.001	<0.001	0.002	0.05

1. All results expressed as microgram/kg on a fresh weight basis

2. Figures in italics are indicative values.

Table 4b Polybrominated diphenyl ethers in Total Diet Food Groups, PBDE 100 - 209

	PBDE-100	PBDE-119	PBDE-126	PBDE153	PBDE138	PBDE 154	PBDE-183	PBDE-209
bread	0.001	<0.0003	<0.0003	0.002	<0.0008	<i>0.0008</i>	0.001	0.06
canned vegetables	0.0003	<0.0001	<0.0001	<i>0.0006</i>	<0.0001	<0.0002	0.0002	<0.009
carcase meats	0.004	<0.001	<0.001	0.007	<0.001	0.002	0.004	0.26
dairy products	0.007	<0.002	<0.002	0.02	<0.002	0.003	<0.002	0.11
Eggs	0.004	<0.0009	<0.0009	0.007	<0.0009	0.002	0.003	0.08
fish	0.05	0.003	<0.0008	0.01	<0.0008	0.02	0.0008	0.09
fresh fruit	0.0002	<0.00004	<0.00004	<i>0.0003</i>	<0.0001	<i>0.0001</i>	0.0002	0.02
fruit products	0.001	<0.0001	<0.0001	0.002	<0.0002	<0.0003	0.0006	0.04
green vegetables	0.0003	<0.00004	<0.00004	0.0002	<0.00004	<i>0.0001</i>	0.0003	0.03
meat products	0.01	<0.002	<0.002	0.02	0.004	0.009	0.01	3.64
milk	0.0008	<0.0002	<0.0002	0.002	<0.0002	<0.0004	<0.0002	0.02
miscellaneous cereals	0.001	<0.0006	<0.0006	0.001	<0.0006	<0.0006	<0.0006	0.04
nuts	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.11
offal	0.004	<0.0006	<0.0006	0.007	<0.0006	0.002	0.004	0.04
oils and fats	0.008	<0.008	<0.008	0.02	<0.008	<0.008	0.02	0.29
other vegetables	0.005	0.0008	<0.0003	0.01	0.002	0.003	0.001	0.08
potatoes	0.0005	<0.0002	<0.0002	0.0007	<0.0002	<0.0002	0.0007	0.02
poultry	0.01	<0.0007	<0.0007	0.01	0.0007	0.004	0.003	0.21
sugars and preserves	0.006	0.001	<0.001	0.008	<0.001	0.002	0.004	0.39

1. All results expressed as microgram/kg on a fresh weight basis
2. Figures in italics are indicative values.

Table 5 Hexabromocyclododecanes in Total Diet Food Groups

	Alpha-HBCD	Beta-HBCD	Gamma-HBCD
bread	<0.06	<0.03	<0.04
canned vegetables	0.13	<0.02	0.09
carcase meats	0.15	<0.04	<0.06
dairy products	<0.12	<0.05	<0.07
Eggs	<0.19	<0.08	<0.11
fish	<i>0.24</i>	<0.05	<0.07
fresh fruit	<i>0.29</i>	0.32	<0.14
fruit products	0.1	0.06	0.12
green vegetables	0.21	0.09	<0.06
meat products	0.11	<0.04	<0.05
milk	<0.28	<0.12	<0.16
miscellaneous cereals	<0.06	<0.03	<0.04
nuts	0.17	<0.07	<0.09
offal	<0.11	<0.06	<0.06
oils and fats	<0.16	<0.07	<0.09
other vegetables	<0.25	<0.11	<0.15
potatoes	0.06	0.03	<i>0.02</i>
poultry	<0.09	<0.04	<0.05
sugars and preserves	0.06	0.03	0.07

1. All results expressed as microgram/kg on a fresh weight basis
2. Figures in italics are indicative values.

Table 6: Estimated upper bound adult dietary intakes (pg TEQ/kg bodyweight/day) of brominated (Br) dioxins and dioxin-like PBBs from the whole diet in 2003

Food group	Br-dioxins	Dioxin-like PBBs	Total	Br-dioxins	Dioxin-like PBBs	Total
	Average			High level		
bread	0.02	<0.01	0.02	0.04	<0.01	0.04
canned vegetables	0.01	<0.01	<0.01	0.03	<0.01	0.03
carcase meats	0.03	<0.01	0.03	0.1	<0.01	0.1
dairy products	0.04	<0.01	0.04	0.1	<0.01	0.1
Eggs	0.01	<0.01	0.01	0.04	<0.01	0.04
fish	0.04	<0.01	0.04	0.1	<0.01	0.1
fresh fruit	0.01	<0.01	0.01	0.04	<0.01	0.04
fruit products	0.03	<0.01	0.03	0.1	<0.01	0.1
green vegetables	<0.01	<0.01	<0.01	0.01	<0.01	0.01
meat products	0.04	<0.01	0.04	0.1	<0.01	0.1
milk	0.1	<0.01	0.1	0.3	0.01	0.3
miscellaneous cereals	0.04	<0.01	0.04	0.1	<0.01	0.1
nuts	0.01	<0.01	0.01	0.05	<0.01	0.05
offal	0.02	<0.01	0.02	0.05	<0.01	0.05
oils and fats	0.03	<0.01	0.03	0.1	<0.01	0.1
other vegetables	0.01	<0.01	<0.01	0.03	<0.01	0.03
potatoes	0.02	<0.01	0.02	0.05	<0.01	0.05
poultry	0.03	<0.01	0.03	0.1	<0.01	0.1
sugars and preserves	0.02	<0.01	0.02	0.07	<0.01	0.07
Total	0.4	0.01	0.4	0.8	0.02	0.8

Notes: The intakes of brominated dioxins and dioxin-like PBBs by the average and high level consumer for all foods combined are not equal to the sum of the intakes from the individual foods. These values are derived from a distribution of the individual consumers' consumption patterns with regards to the individual foods.

Table 7: Estimated upper bound adult dietary intakes (ng/kg bodyweight/day) of selected polybrominated diphenyl ethers (PBDEs)

Food group	PBDE 47	PBDE 99	PBDE 100	PBDE 153	PBDE 209	Sum PBDEs*	PBDE 47	PBDE 99	PBDE 100	PBDE 153	PBDE 209	Sum PBDEs*
	Average						High level					
bread	0.02	0.02	0.002	0.003	0.1	0.2	0.05	0.04	0.003	0.005	0.2	0.3
canned vegetables	<0.001	<0.001	<0.001	<0.001	0.008	0.02	0.08	0.06	0.008	0.008	0.3	0.5
carcase meats	0.03	0.02	0.003	0.008	0.3	0.4	0.07	0.07	0.01	0.02	0.8	1.1
dairy products	0.06	0.07	0.007	0.02	0.1	0.3	0.02	0.02	0.003	0.007	0.04	0.1
Eggs	0.008	0.01	0.002	0.003	0.04	0.07	0.3	0.3	0.04	0.08	12	13
fish	0.19	0.04	0.04	0.007	0.06	0.4	0.2	0.3	0.03	0.05	0.7	1.2
fresh fruit	0.005	<0.001	<0.001	<0.001	0.05	0.06	0.6	0.1	0.11	0.02	0.2	1.3
fruit products	0.02	0.02	0.002	0.003	0.06	0.1	0.05	0.05	0.005	0.02	0.2	0.4
green vegetables	<0.001	<0.001	<0.001	<0.001	0.01	0.01	0.03	0.04	0.007	0.01	0.1	0.2
meat products	0.08	0.09	0.01	0.02	3.7	4.0	0.1	<0.001	0.01	0.01	0.7	1.0
milk	0.03	0.03	0.003	0.007	0.08	0.1	0.002	0.002	<0.001	<0.001	0.04	0.05
miscellaneous cereals	0.03	0.03	0.003	0.003	0.1	0.2	0.02	0.02	0.002	0.003	0.09	0.1
nuts	<0.001	<0.001	<0.001	<0.001	0.02	0.04	0.09	0.2	0.02	0.03	0.2	0.7
offal	0.005	0.005	0.002	0.002	0.01	0.03	0.007	0.007	0.002	0.002	0.03	0.06
oils and fats	0.02	0.02	0.002	0.005	0.05	0.1	0.02	0.01	0.002	0.002	0.2	0.2
other vegetables	0.03	0.06	0.005	0.01	0.08	0.2	0.08	0.06	0.008	0.01	0.2	0.4
potatoes	0.007	0.007	0.002	0.002	0.04	0.06	0.07	0.08	0.008	0.02	0.2	0.4
poultry	0.05	0.09	0.01	0.02	0.2	0.4	0.2	0.2	0.02	0.05	0.4	1.0
sugars and preserves	0.03	<0.001	0.003	0.003	0.2	0.3	0.02	0.01	0.005	0.005	0.1	0.2
Total	0.5	0.5	0.08	0.1	4.5	5.9	1.0	0.8	0.2	0.2	13	15

Notes: The intakes of PBDEs by the average and high level consumer for all foods combined are not equal to the sum of the intakes from the individual foods.
 * Sum of all the PBDEs analysed.

Table 8: Estimated upper bound adult dietary intakes (ng/kg bodyweight/day) of hexabromocyclododecanes (HBCDs) and tetrabromobisphenol A (TBBP-A) from the whole diet in 2004

Food group	Alpha-HBCD	Beta-HBCD	Gamma-HBCD	Sum HBCDs*	TBBP-A	Alpha-HBCD	Beta-HBCD	Gamma-HBCD	Sum HBCDs*	TBBP-A
	Average					High level				
bread	0.1	0.05	0.07	0.2	0.07	0.2	0.1	0.2	0.5	0.2
canned vegetables	0.1	0.02	0.08	0.2	0.03	0.4	0.06	0.3	0.7	0.1
carcase meats	0.2	0.05	0.07	0.3	0.08	0.5	0.1	0.2	0.8	0.2
dairy products	0.1	0.05	0.08	0.3	0.09	0.4	0.2	0.2	0.8	0.3
Eggs	0.09	0.04	0.05	0.2	0.06	0.3	0.1	0.2	0.6	0.2
fish	0.2	0.04	0.05	0.3	0.06	0.5	0.1	0.2	0.8	0.2
fresh fruit	0.5	0.6	0.3	1.4	0.08	1.8	2.0	0.9	4.7	0.3
fruit products	0.2	0.1	0.2	0.4	0.08	0.6	0.4	0.7	1.7	0.3
green vegetables	0.09	0.04	0.03	0.2	0.03	0.3	0.1	0.09	0.5	0.1
meat products	0.1	0.04	0.05	0.2	0.07	0.4	0.1	0.2	0.7	0.2
milk	1.0	0.4	0.6	2.0	0.7	2.7	1.2	1.6	5.5	1.9
miscellaneous cereals	0.1	0.07	0.1	0.3	0.1	0.4	0.2	0.2	0.8	0.2
nuts	0.03	0.01	0.02	0.06	0.02	0.2	0.06	0.08	0.3	0.1
offal	0.03	0.02	0.02	0.07	0.02	0.1	0.06	0.06	0.2	0.07
oils and fats	0.03	0.01	0.02	0.06	0.02	0.1	0.05	0.06	0.2	0.07
other vegetables	0.2	0.1	0.1	0.5	0.2	0.8	0.3	0.5	1.6	0.6
potatoes	0.1	0.06	0.04	0.2	0.04	0.3	0.1	0.09	0.5	0.09
poultry	0.1	0.04	0.05	0.2	0.08	0.3	0.1	0.2	0.6	0.2
sugars and preserves	0.03	0.02	0.04	0.08	0.02	0.1	0.05	0.1	0.3	0.05
Total	2.9	1.5	1.6	5.9	1.6	5.5	3.3	3.1	12	3.1

Notes: The intake of HBCDs and TBBP-A by the average and high level consumer for all foods combined is not equal to the sum of the intakes from the individual foods. These values are derived from a distribution of the individual consumers' consumption patterns with regards to the individual foods.

* Sum of alpha-, beta- and gamma-HBCDs.

Table 9: Estimated total dietary intakes (pg TEQ/kg bodyweight/day) by all age groups of brominated dioxins and dioxin-like PBBs from the whole diet in 2003

Age group	Average						High level					
	Upper bound			Lower bound			Upper bound			Lower bound		
	Br-Dioxins	PBBs	Br-DX +PBBs	Br-Dioxins	PBBs	Br-DX +PBBs	Br-Dioxins	PBBs	Br-DX +PBBs	Br-Dioxins	PBBs	Br-DX +PBBs
Senior citizens - living at home	0.4	<0.01	0.4	0.07	0.001	0.1	0.6	0.01	0.6	0.1	0.003	0.1
Senior citizens - in old peoples' homes	0.5	0.01	0.5	0.09	0.001	0.1	0.8	0.02	0.81	0.2	0.003	0.2
Adults	0.4	<0.01	0.4	0.09	0.002	0.1	0.8	0.02	0.8	0.2	0.01	0.2
Schoolchildren:												
4-6 years	1.0	0.02	1.0	0.2	0.003	0.2	1.7	0.03	1.7	0.3	0.007	0.3
7-10 years	0.7	0.02	0.7	0.2	0.003	0.2	1.2	0.03	1.2	0.3	0.005	0.3
11-14 years	0.5	0.01	0.5	0.1	0.002	0.1	0.9	0.02	0.9	0.2	0.005	0.2
15-18 years	0.4	<0.01	0.4	0.08	0.002	0.1	0.7	0.01	0.7	0.2	0.004	0.2
Toddlers:												
1.5-2.5 years	1.6	0.03	1.6	0.2	0.004	0.2	3.0	0.06	3.0	0.5	0.01	0.5
2.5-3.5 years	1.3	0.03	1.3	0.2	0.004	0.2	2.3	0.05	2.3	0.4	0.009	0.4
3.5-4.5 years	1.1	0.02	1.1	0.2	0.003	0.2	1.9	0.04	1.9	0.4	0.008	0.4

Note: Combined dietary intakes of br-dioxins and dioxin-like PBBs may not equal the sum of the separate intakes due to rounding.

Table 10: Estimated total dietary intakes (pg/kg bodyweight/day) by all age groups of tribromo dioxins (2,3,7-triBDD and 2,3,8-triBDF) from the whole diet in 2003

Age group	Average				High level			
	Upper bound		Lower bound		Upper bound		Lower bound	
	2,3,7-triBDD	2,3,8-triBDF	2,3,7-triBDD*	2,3,8-triBDF	2,3,7-triBDD	2,3,8-triBDF	2,3,7-triBDD*	2,3,8-triBDF
Senior citizens - living at home	0.1	0.2	0	0.1	0.1	0.3	0	0.2
Senior citizens - in old peoples' homes	0.1	0.2	0	0.2	0.1	0.4	0	0.3
Adults	0.1	0.2	0	0.1	0.1	0.4	0	0.3
Schoolchildren:								
4-6 years	0.2	0.5	0	0.4	0.3	0.9	0	0.7
7-10 years	0.1	0.4	0	0.3	0.2	0.7	0	0.5
11-14 years	0.09	0.3	0	0.2	0.2	0.5	0	0.4
15-18 years	0.07	0.2	0	0.1	0.1	0.4	0	0.3
Toddlers:								
1.5-2.5 years	0.3	0.8	0	0.6	0.5	1.4	0	1.3
2.5-3.5 years	0.2	0.7	0	0.5	0.4	1.2	0	1.1
3.5-4.5 years	0.2	0.6	0	0.4	0.3	1.0	0	0.8

Note: * 2,3,7-triBDD was not detected in any of the food groups.

Table 11a: Estimated total dietary intakes (ng/kg bodyweight/day) by all age groups of polybrominated diphenyl ethers (PBDEs 17, 28 and 47) from the whole diet in 2003

Age group	Average						High level					
	Upper bound			Lower bound			Upper bound			Lower bound		
	PBDE 17	PBDE 28	PBDE 47	PBDE 17	PBDE 28	PBDE 47	PBDE 17	PBDE 28	PBDE 47	PBDE 17	PBDE 28	PBDE 47
Senior citizens - living at home	0.01	0.03	0.4	0.001	0.02	0.4	0.02	0.05	0.8	0.003	0.04	0.8
Senior citizens - in old peoples' homes	0.01	0.03	0.5	0.001	0.02	0.5	0.02	0.05	0.8	0.004	0.04	0.8
Adults	0.01	0.03	0.5	0.002	0.02	0.5	0.02	0.06	1.0	0.01	0.05	1.0
Schoolchildren:												
4-6 years	0.03	0.06	1.0	0.002	0.04	1.0	0.04	0.1	1.7	0.006	0.08	1.7
7-10 years	0.02	0.05	0.8	0.002	0.03	0.8	0.03	0.09	1.3	0.005	0.06	1.3
11-14 years	0.01	0.04	0.5	0.001	0.02	0.5	0.03	0.07	1.0	0.003	0.06	1.0
15-18 years	0.01	0.03	0.4	0.001	0.02	0.4	0.02	0.05	0.7	0.003	0.04	0.7
Toddlers:												
1.5-2.5 years	0.03	0.07	1.2	0.003	0.04	1.2	0.06	0.1	2.2	0.009	0.1	2.2
2.5-3.5 years	0.03	0.07	1.1	0.002	0.04	1.1	0.05	0.1	2.0	0.008	0.1	2.0
3.5-4.5 years	0.03	0.07	1.0	0.002	0.04	1.0	0.04	0.1	1.8	0.007	0.09	1.8

Table 11b: Estimated total dietary intakes (ng/kg bodyweight/day) by all age groups of polybrominated diphenyl ethers (PBDEs 49, 66 and 71) from the whole diet in 2003

Age group	Average						High level					
	Upper bound			Lower bound			Upper bound			Lower bound		
	PBDE 49	PBDE 66	PBDE 71	PBDE 49	PBDE 66	PBDE 71	PBDE 49	PBDE 66	PBDE 71	PBDE 49	PBDE 66	PBDE 71
Senior citizens - living at home	0.06	0.04	0.009	0.06	0.03	<0.001	0.1	0.07	0.02	0.1	0.07	0.002
Senior citizens - in old peoples' homes	0.06	0.04	0.01	0.06	0.04	0.001	0.1	0.09	0.02	0.1	0.09	0.002
Adults	0.07	0.04	0.01	0.07	0.04	<0.001	0.2	0.08	0.02	0.2	0.08	0.002
Schoolchildren:												
4-6 years	0.1	0.08	0.02	0.1	0.08	0.001	0.2	0.14	0.04	0.2	0.1	0.002
7-10 years	0.08	0.06	0.02	0.08	0.06	0.001	0.2	0.10	0.03	0.2	0.1	0.002
11-14 years	0.06	0.04	0.01	0.06	0.04	<0.001	0.1	0.09	0.02	0.1	0.08	0.001
15-18 years	0.05	0.04	0.01	0.05	0.03	<0.001	0.1	0.07	0.02	0.1	0.06	0.001
Toddlers:												
1.5-2.5 years	0.1	0.1	0.03	0.1	0.1	0.001	0.4	0.2	0.06	0.4	0.2	0.003
2.5-3.5 years	0.1	0.09	0.03	0.1	0.09	0.001	0.4	0.2	0.05	0.3	0.2	0.003
3.5-4.5 years	0.1	0.09	0.03	0.1	0.08	0.001	0.3	0.1	0.04	0.3	0.1	0.003

Table 11c: Estimated total dietary intakes (ng/kg bodyweight/day) by all age groups of polybrominated diphenyl ethers (PBDEs 77, 85 and 99) from the whole diet in 2003

Age group	Average						High level					
	Upper bound			Lower bound			Upper bound			Lower bound		
	PBDE 77	PBDE 85	PBDE 99	PBDE 77	PBDE 85	PBDE 99	PBDE 77	PBDE 85	PBDE 99	PBDE 77	PBDE 85	PBDE 99
Senior citizens - living at home	0.009	0.02	0.4	0.001	0.01	0.4	0.02	0.03	0.6	0.003	0.02	0.6
Senior citizens - in old peoples' homes	0.01	0.02	0.4	0.001	0.01	0.4	0.02	0.04	0.8	0.003	0.03	0.8
Adults	0.01	0.02	0.5	0.002	0.03	0.5	0.02	0.04	0.8	0.003	0.03	0.8
Schoolchildren:												
4-6 years	0.03	0.04	0.9	0.001	0.03	0.9	0.04	0.06	1.6	0.003	0.05	1.6
7-10 years	0.02	0.03	0.7	0.001	0.02	0.7	0.03	0.05	1.2	0.002	0.04	1.2
11-14 years	0.01	0.02	0.5	0.001	0.02	0.5	0.02	0.04	0.9	0.002	0.03	0.9
15-18 years	0.01	0.02	0.4	0.001	0.01	0.4	0.02	0.03	0.7	0.002	0.02	0.70
Toddlers:												
1.5-2.5 years	0.03	0.04	1.1	0.001	0.03	1.1	0.06	0.08	2.1	0.005	0.06	2.1
2.5-3.5 years	0.03	0.04	1.0	0.001	0.03	1.0	0.05	0.08	2.0	0.005	0.06	2.0
3.5-4.5 years	0.03	0.04	1.0	0.001	0.03	1.0	0.04	0.07	1.7	0.005	0.05	1.7

Table 11d: Estimated total dietary intakes (ng/kg bodyweight/day) by all age groups of polybrominated diphenyl ethers (PBDEs 100, 119 and 126) from the whole diet in 2003

Age group	Average						High level					
	Upper bound			Lower bound			Upper bound			Lower bound		
	PBDE 100	PBDE 119	PBDE 126	PBDE 100	PBDE 119	PBDE 126*	PBDE 100	PBDE 119	PBDE 126	PBDE 100	PBDE 119	PBDE 126*
Senior citizens - living at home	0.06	0.01	0.009	0.06	0.002	0	0.1	0.02	0.02	0.1	0.005	0
Senior citizens - in old peoples' homes	0.07	0.01	0.01	0.07	0.003	0	0.1	0.02	0.02	0.1	0.006	0
Adults	0.08	0.01	0.01	0.08	0.003	0	0.2	0.02	0.02	0.2	0.007	0
Schoolchildren:												
4-6 years	0.1	0.03	0.02	0.1	0.004	0	0.3	0.05	0.04	0.3	0.01	0
7-10 years	0.1	0.02	0.02	0.1	0.003	0	0.2	0.03	0.03	0.2	0.008	0
11-14 years	0.08	0.01	0.01	0.08	0.003	0	0.1	0.03	0.02	0.1	0.007	0
15-18 years	0.06	0.01	0.01	0.06	0.002	0	0.1	0.02	0.02	0.1	0.005	0
Toddlers:												
1.5-2.5 years	0.2	0.03	0.03	0.2	0.005	0	0.3	0.06	0.06	0.3	0.01	0
2.5-3.5 years	0.1	0.03	0.03	0.1	0.005	0	0.3	0.05	0.05	0.3	0.01	0
3.5-4.5 years	0.1	0.03	0.03	0.1	0.005	0	0.3	0.04	0.04	0.3	0.01	0

Note: * PBDE 126 was not detected in any of the food groups.

Table 11e: Estimated total dietary intakes (ng/kg bodyweight/day) by all age groups of polybrominated diphenyl ethers (PBDEs 138, 153 and 154) from the whole diet in 2003

Age group	Average						High level					
	Upper bound			Lower bound			Upper bound			Lower bound		
	PBDE 138	PBDE 153	PBDE 154	PBDE 100	PBDE 119	PBDE 126	PBDE 100	PBDE 119	PBDE 126	PBDE 100	PBDE 119	PBDE 126
Senior citizens - living at home	0.01	0.07	0.03	0.004	0.07	0.03	0.02	0.1	0.05	0.01	0.1	0.05
Senior citizens - in old peoples' homes	0.02	0.09	0.03	0.004	0.09	0.03	0.03	0.2	0.06	0.01	0.2	0.05
Adults	0.02	0.1	0.04	0.005	0.1	0.03	0.03	0.2	0.07	0.01	0.2	0.06
Schoolchildren:												
4-6 years	0.03	0.2	0.07	0.009	0.2	0.06	0.05	0.4	0.1	0.02	0.4	0.1
7-10 years	0.03	0.2	0.05	0.007	0.2	0.04	0.04	0.3	0.09	0.02	0.3	0.08
11-14 years	0.02	0.1	0.04	0.006	0.1	0.03	0.03	0.2	0.07	0.02	0.2	0.06
15-18 years	0.01	0.08	0.03	0.005	0.08	0.03	0.03	0.2	0.05	0.01	0.2	0.05
Toddlers:												
1.5-2.5 years	0.04	0.2	0.08	0.01	0.2	0.06	0.07	0.5	0.2	0.03	0.5	0.1
2.5-3.5 years	0.04	0.2	0.07	0.01	0.2	0.06	0.06	0.4	0.1	0.03	0.4	0.1
3.5-4.5 years	0.03	0.2	0.07	0.01	0.2	0.06	0.06	0.4	0.1	0.03	0.4	0.1

Table 11f: Estimated total dietary intakes (ng/kg bodyweight/day) by all age groups of polybrominated diphenyl ethers (PBDEs 183, 209 and sumPBDEs) from the whole diet in 2003

Age group	Average						High level					
	Upper bound			Lower bound			Upper bound			Lower bound		
	PBDE 183	PBDE 209	Sum PBDEs*	PBDE 183	PBDE 209	Sum PBDEs*	PBDE 183	PBDE 209	Sum PBDEs*	PBDE 183	PBDE 209	Sum PBDEs*
Senior citizens - living at home	0.02	3.3	4.4	0.02	3.3	4.4	0.04	8.8	10	0.04	8.8	10
Senior citizens - in old peoples' homes	0.03	3.6	4.9	0.02	3.6	4.8	0.05	7.8	9.6	0.04	7.8	9.5
Adults	0.03	4.5	5.9	0.03	4.5	5.8	0.06	13	15	0.06	13	15
Schoolchildren:												
4-6 years	0.06	8.5	11	0.05	8.5	11	0.1	22	26	0.09	22	26
7-10 years	0.05	6.8	9.0	0.04	6.8	8.9	0.09	16	19	0.08	16	19
11-14 years	0.04	5.3	6.8	0.03	5.3	6.7	0.07	14	16	0.06	14	16
15-18 years	0.03	4.4	5.6	0.03	4.4	5.5	0.06	11	13	0.05	11	13
Toddlers:												
1.5-2.5 years	0.07	10	13	0.05	9.9	13	0.1	30	34	0.1	30	34
2.5-3.5 years	0.07	9.6	13	0.05	9.5	12	0.1	28	33	0.1	28	33
3.5-4.5 years	0.06	9.6	12	0.05	9.6	12	0.1	25	29	0.1	25	29

Note: * Sum of all the PBDE congeners analysed. SumPBDE intakes may not equal the sum of the separate intakes due to rounding.

Table 12: Estimated upper bound total dietary intakes (ng/kg bodyweight/day) by all age groups of hexabromocyclododecanes (HBCDs and tetrabromobisphenol A (TBBP-A) from the whole diet in 2004

Age group	Average					High level				
	Alpha HBCD	Beta HBCD	Gamma HBCD	Sum HBCDs	TBBP-A	Alpha HBCD	Beta HBCD	Gamma HBCD	Sum HBCDs	TBBP-A
Senior citizens - living at home	2.4	1.2	1.3	5.0	1.4	4.5	2.4	2.5	9.3	2.6
Senior citizens - in old peoples' homes	3.0	1.4	1.7	6.1	1.9	5.2	2.5	3.0	11	3.4
Adults	2.9	1.5	1.6	5.9	1.6	5.5	3.3	3.1	12	3.1
Schoolchildren:										
4-6 years	6.5	3.3	3.8	14	3.7	12	6.1	7.1	25	7.7
7-10 years	4.5	2.3	2.6	9.4	2.5	8.2	4.5	4.8	18	4.7
11-14 years	2.9	1.4	1.7	6.0	1.7	5.8	3.0	3.5	12	3.4
15-18 years	2.3	1.1	1.3	4.7	1.3	4.3	2.3	2.6	9.2	2.6
Toddlers:										
1.5-2.5 years	12	5.7	6.7	24	7.0	24	11	14	50	15
2.5-3.5 years	9.2	4.5	5.4	19	5.4	18	9.2	11	38	12
3.5-4.5 years	7.8	3.8	4.5	16	4.6	15	7.3	8.4	30	8.9

Note: * Sum of alpha-, beta- and gamma-HBCDs. SumHBCD intakes may not equal the sum of the separate intakes due to rounding.