TNO Built Environment and Geosciences

Nederlandse Organisatie voor
toegepast-natuurwetenschappelijk
onderzoek / Netherlands Organisation
for Applied Scientific Research

Laan van Westenenk 501
P.O. Box 342
7300 AH Apeldoorn
The Netherlands

www.tno.nl

P +31 55 549 34 93
F +31 55 541 98 37

TNO-report

2006-A-R0095/B version 2

Man-Made Chemicals in Food Products

Date	July 2006
Authors	Ruud J.B. Peters
Order no.	034.64205
Dossier no.	52006030
Keywords	food products brominated flame retardants phthalates artificial musks alkylphenols organochlorine pesticides PCB organotin compounds perfluorinated compounds
Intended for	Mr. G. Watson WWF-UK Panda House, Weyside Park Godalming, Surrey GU7 1XR United Kingdom

Summary

Nowadays a large number of man-made chemicals are being used. As a consequence their widespread presence in the environment is becoming increasingly well documented. Many of these compounds have also been found in human blood indicating that humans are exposed to these chemicals. This exposure may be through different routes. One is the use of these chemicals as additives in consumer products such as carpets, curtains, toys and electronic equipment. The presence of these chemicals in house dust indicates the potential for human exposure. Another route for human exposure to such compounds is through food products. Since many of these compounds have a lipophilic nature they may bio-accumulated in the food chain especially in foods with a high fat content.

The objective of this study was to determine the presence and concentrations of a number of man-made chemicals in 27 food products that many of us use daily. The compound groups of interest were organochlorine pesticides, polychlorinated biphenyls, brominated flame retardants, phthalates, alkylphenols, artificial musks, perfluorinated compounds and organotin compounds. The results show that many of these compounds are present in food in a concentration range of 0.1 to 10 ng/g with the exception of phthalates for which typical concentrations are two orders of magnitude higher.

Organochlorine pesticides were found in the 19 of the 27 samples. The main organochlorine pesticides found in food are p,p'-DDE, a metabolite of DDT, and HCB in concentrations up to 5.6 ng/g for the individual pesticides. Polychlorinated biphenyls were found in all of the 26 samples analysed with predominance for PCB-18, -28 and -52. The sum of the indicator-PCBs ranged from 0.16 to 13 ng/g with total-PCBs concentrations up to 32 ng/g. The highest concentrations were found in fish. Brominated flame retardants were found in 19 of the 26 samples with predominance for the tetra- and penta-PBDEs, especially BDE-47, -32 and -99. Total PBDE concentrations ranged from 0.15 to 1.3 ng/g with the highest concentration found in meat and not in fish as in other studies. BDE-209, HBCD and TBBPA were not found in any of the samples.

The perfluorinated compounds PFOS and PFOSA were found in one of the five samples analysed, a fish sample, in concentrations of 1.3 and 0.2 ng/g. The predominant phthalates in food were DEHP, DBP and BBP. Phthalates were found in 16 of the 21 samples analysed, DEHP in concentrations ranging from 20 to 3300 ng/g and one exceptional high concentration of 24,000 ng/g in a sample of olive oil. DBP was found in a range of 76 to 780 ng/g and BBP in concentrations from 2 to 340 ng/g. DINP was found in about half of the samples in concentrations up to 660 ng/g. Alkylphenols were detected in 2 of the 21 samples analysed, in both cases nonylphenol in a concentrations around 5 ng/g.

Artificial polycyclic musks, HHCB and AHTN, were found in two of the four samples analysed in concentrations up to 0.56 ng/g for HHCB. As in other matrices the AHTN concentrations are about half those of HHCB. The older nitro-musks MK and MX were not found. Finally, organotin compounds were found in three of the four samples. Apart from TBT and its metabolites DBT and MBT, two samples also contained octyltin compounds.

Table 1 Summary of concentration ranges of some chemicals detected in analysed food items.

Chemical	Found in	Lowest	Highest	2nd highest
HCB	16 out of 27 analysed	0.1 ng/g (sausages, olive oil, frankfurters, cottage cheese, salami, jamon curado)	0.83 ng/g (reindeer meat)	0.7 ng/g (pickled herring)
p, p' DDE	16 out of 27 analysed	0.17 ng/g (pork chops, jamon curado)	5.6 ng/g (pickled herring)	1.6 ng/g (Manchego cheese)
Total PCBs	26 out of 26 analysed	0.16 ng/g (eggs)	31.0 ng/g (pickled herring)	6.8 ng/g (smoked salmon)
Total PBDEs	19 out of 26 analysed	0.15 ng/g (honey)	1.3 ng/g (minced beef)	1.15 ng/g (Scottish cheddar)
DEHP	16 out of 21 analysed	20 ng/g (frankfurters)	24 000 ng/g (olive oil)	3300 ng/g (jamon curado)
DBP	9 out of 21 analysed	76 ng/g (Cacioatta cheese)	780 ng/g (cottage cheese)	760 ng/g (chicken)
BBP	12 out of 21 analysed	2 ng/g (bacon)	340 ng/g (olive oil)	50 ng/g (Manchego cheese)
AHTN (musk)	2 out of 4 analysed	0.18 ng/g (tuna)	0.29 ng/g (pickled herring)	-
HHCB (musk)	2 out of 4 analysed	0.27 ng/g (tuna)	0.56 ng/g (pickled herring)	-
MBT (organotin)	2 out of 4 analysed	0.5 ng/g (fish fingers)	9.0 ng/g (tuna)	-
DBT (organotin)	2 out of 4 analysed	0.6 ng/g (pickled herring)	1.1 ng/g (tuna)	-
TBT (organotin)	2 out of 4 analysed	0.2 ng/g (tuna)	0.8 ng/g (pickled herring)	-

Table of contents

1. Introduction

Nowadays a large number of man-made chemicals are being used. As a consequence their widespread presence in the environment is becoming increasingly well documented[1,2]. Many of these compounds have also been found in human blood indicating that humans are exposed to these chemicals[3,4,5,6,7]. This exposure may be through different routes. One is the use of these chemicals as additives in consumer products such as carpets, curtains, toys and electronic equipment. The presence of these chemicals in house dust [8,9,10] indicates the potential for human exposure. Another route for human exposure to such compounds is through food products. Since many of these compounds have a lipophilic nature they may bio-accumulated in the food chain especially in foods with a high fat content.

The objective of this study was to determine the presence and concentrations of a number of man-made chemicals in typical food products that many of us use daily. The chemicals considered in this study are; brominated flame retardants, phthalates, artificial musks, alkylphenols, organochlorine pesticides, PCBs, organotin compounds and perfluorinated compounds.

---

1 Peters RJB. *Hazardous Chemicals in Precipitation.* TNO report R2003/198, May **2003**.

2 Vethaak AD, Rijs GBJ, Schrap SM, Ruiter H, Gerritsen A, Lahr J. *Estrogens and xeno-estrogens in the aquatic environment of the Netherlands.* RIZA/RIKZ-report 2002.001, February **2002**.

3 CDC report: *National Report on Human Exposure to Environmental Chemicals*. CDC, Atlanta, Georgia, March **2001**.

4 CDC report: *National Report on Human Exposure to Environmental Chemicals*. CDC, Atlanta, Georgia, January **2003**.

5 WWF-UK *National Biomonitoring Survey*, November **2003**.

6 WWF Detox campaign: *Chemical Check Up: An analysis of chemicals in the blood of Members of the European Parliament*. April **2004**.

7 Peters RJB. *Man-made chemicals in Human Blood*, TNO report R 2004/493, November **2004**.

8 Santillo D, Labunska I, Davidson H, Johnston P, Strutt M, Knowles O. *Consuming Chemicals.* Greenpeace Research laboratories Technical Note 01/2003 (GRL-TN-01-2003) **2003**.

9 Peters RJB, *The Determination of Hazardous Chemicals in House Dust from Belgium homes and offices*. TNO report R2004/087, April **2004**.

10 Peters RJB, *The Determination of Hazardous Chemicals in House Dust from Brazilian homes*. TNO report R2004/159, April **2004**.

2. Samples and Chemical Parameters

2.1 Samples

The samples, 27 in total, were received from different countries within the European Union. An overview of the received samples is given in table 2. Samples were received frozen and were stored at -18°C until analysis.

2.2 Chemical parameters

The chemical parameters determined in this study are listed in table 3, including the abbreviations that are used throughout the text and in the result tables in the text and appendix. Note that not all parameters are determined in all samples. Which parameters are determined in the food products is indicated in table 2.

Table 2 Lists of all received samples, their origin and the parameters that are determined in each sample.

Food Product	Purchased in	TNO-code	OCPs	PCBs	BFRs	PFCs	Phthalates	Organotins	Musks	Alkylphenols
Butter	UK	52006030-01	√	√	√		√			√
Cheese	UK	52006030-02	√	√	√		√			√
Bacon	UK	52006030-03	√	√	√		√			√
Sausages	UK	52006030-04	√	√	√		√			√
Eggs	UK	52006030-05	√	√	√		√			√
Milk	UK	52006030-06	√	√	√		√			√
Olive oil	UK	52006030-07	√	√	√		√			√
Chicken breast	UK	52006030-08	√	√	√		√			√
Fish fingers	UK	52006030-09	√	√	√	√		√	√	
Salmon	UK	52006030-10	√	√	√	√		√	√	
Tuna	UK	52006030-13	√	√	√	√		√	√	
Honey	UK	52006030-11	√	√	√					
Brown bread	UK	52006030-14	√	√	√	√				
Orange Juice	UK	52006030-12	√				√			√
Scottish Cheese	UK	52006030-25	√	√	√		√			√
Frankfurters	Finland	52006030-15	√	√	√		√			√
Reindeer beef	Finland	52006030-16	√	√	√		√			√
Minced beef	Sweden	52006030-18	√	√	√		√			√
Pickled herring	Sweden	52006030-17	√	√	√	√		√	√	
Pork chops	Poland	52006030-19	√	√	√		√			√
Cottage cheese	Poland	52006030-20	√	√	√		√			√
Salami	Italy	52006030-21	√	√	√		√			√
Cheese	Italy	52006030-22	√	√	√		√			√
Ham	Spain	52006030-23	√	√	√		√			√
Cheese	Spain	52006030-24	√	√	√		√			√
Hard Cheese	Greece	52006110-05	√	√	√		√			√
Steak	Greece	52006110-06	√	√	√		√			√

Table 3 Lists of all individual parameters determined in the samples and their abbreviations used in the text and tables.

Organochlorine pesticides (OCPs):	**Phthalates:**
α-HCH (alpha-hexachlorocyclohexane)	di-methyl phthalate (DMP)
β-HCH	di-ethyl phthalate (DEP)
γ-HCH (lindane)	di-isobutyl phthalate (DiBP)
HCB	di-butyl phthalate (DBP)
α-chlordane (cis-)	bezylbutyl phthalate (BBP)
β-chlordane (trans-)	di-(2-ethylhexyl) phthalate (DEHP)
o,p'-DDT	di-isononyl phthalate (DiNP)
p,p'-DDT	di-isodecyl phthalate (DiDP)
o,p'-DDD	
p,p'-DDD	
o,p'-DDE	
p,p'-DDE	

Polychlorinated biphenyls (PCBs):		**Brominated flame retardants (BFRs):**	
PCB-18	PCB-118	***Polybrominated diphenylethers:***	
PCB-28/31	PCB-123	BDE-17	BDE-138
PCB-22	PCB-138/158	BDE-28	BDE-153
PCB-41	PCB-141	BDE-32	BDE-154
PCB-44	PCB-149	BDE-35	BDE-156
PCB-49	PCB-151	BDE-37	BDE-166
PCB-52	PCB-153/168	BDE-47	BDE-181
PCB-54	PCB-156	BDE-49/71	BDE-183
PCB-56/60	PCB-157	BDE-66	BDE-184
PCB-64	PCB-167	BDE-75	BDE-190
PCB-70	PCB-170	BDE-77	BDE-191
PCB-74	PCB-177	BDE-85	BDE-196
PCB-87	PCB-180	BDE-99	BDE-197
PCB-90	PCB-183	BDE-100	BDE-206
PCB-99	PCB-187	BDE-119	BDE-207
PCB-101	PCB-188	BDE-126	BDE-209
PCB-104	PCB-189		
PCB-105	PCB-194	***Other BFRs:***	
PCB-110	PCB-199	tetrabromobisphenol-A (TBBPA)	
PCB-114	PCB-203	hexabromocyclododecane (HBCD)	

Table 3 Lists of all individual parameters determined in the samples and their abbreviations used in the text and tables (continued).

Perfluorinated chemicals (PFCs):	**Artficial musks:**
perfluorooctanoic acid (PFOA)	galaxolide (HHCB)
perfluorooctane sulphonate (PFOS)	tonalide (AHTN)
perfluorooctane sulfonamide (PFOSA)	musk xylene (MX)
perfluorononanoic acid (PFNA)	musk ketone (MK)
perfluorodecanoic acid (PFDA)	
perfluoroundecanoic acid (PFUnA)	
perfluorododecanoic acid (PFDoA)	
perfluorotetradecanoic acid (PFTrDA)	

Alkylphenols (AP):	**Organotin compounds:**
nonylphenol isomers (NP)	mono-butyltin (MBT)
octylphenol isomers (OP)	di-butyltin (DBT)
	tri-butyltin (TBT)
	mono-octyltin (MOT)
	di-octyltin (DOT)

3. Materials and methods

3.1 Sample analysis

3.1.1 Pre-treatment of samples

Solid food samples were thawed, cut into small pieces and homogenised with a blender. Milk was acidified with formic acid and the solid part containing the proteins and fat was separated from the liquid phase. Both parts were stored for analysis. Orange juice centrifuged and vacuum filtrated and the solid and liquid parts were stored for analysis.

3.1.2 Organochlorine pesticides, polychlorobiphenyls, brominated flame retardants, phthalates and artificial musks

Sub-samples of the solid food materials were collected, spiked with internal standards and mixed with anhydrous sodium sulphate. These samples were soxhlet extracted overnight with a mixture of hexane and diethylether. Appropriate amounts of the liquid phases of the milk and orange juice were extracted with hexane and the extracts were combined with those of the solid material. A sub-sample of the olive oil was directly dissolved in hexane. All extracts were concentrated to equal volumes and split in two equal parts.

Part A of the extract was concentrated to a smaller volume and treated with sulphuric acid to remove the major part of the lipids. The remaining extract was purified further over a glass chromatographic column packed with florisil to isolate the fraction containing the OCPs, PCBs, PBDEs and HBCD. The eluate of the florisil column was concentrated to a small volume and a syringe standard was added. The final extracts were analysed with gas chromatography coupled with mass spectrometry (GC/MS) in the selected ion monitoring mode (SIM).

Part B of the extract was purified using a DMF-hexane partition to remove lipids. The resulting extract was purified further over a glass chromatographic column packed with florisil to isolate the fraction containing the phthalates and artificial musk compounds. The eluate of the florisil column was concentrated to a small volume and a syringe standard was added. The final extracts were analysed with GC/MS in the SIM mode.

3.1.3 Alkylphenols and tetrabromobisphenol-A

Sub-samples of each sample were collected, spiked with internal standards and mixed with Milli-Q water and 1 ml of concentrated hydrochloric acid in the round-bottom flask of a steam-distillation apparatus. During the overnight distillation process the organic phenols are isolated in an organic solvent. The organic fraction is isolated, concentrated and the solvent is exchanged into methanol. The methanol extract is concentrated further and analysed with liquid chromatography coupled with mass spectrometry (LC/MS) in the SIM mode.

3.1.4 Perfluorinated chemicals

Sub-samples of each sample are collected in poly-propylene tubes. The samples are extracted with acetonitril by shaking and centrifuged. The clear liquid is decanted and purified over a glass chromatographic column packed with florisil, silica, LC-NH_2 and activated carbon. The extraction is repeated three times and the purified extracts are combined and concentrated to a small volume. Octanol is added as a keeper and the solvent is exchanged into methanol. The extracts are stored in poly-propylene vials and analysed with LC/MS in the SIM mode.

3.1.5 Organotin compounds

A sub-sample is mixed with 1M hydrobromic acid in methanol and the internal standard is added. The mixture is sonicated for 1 hour, left overnight and sonicated again. The mixture is centrifuged and the clear liquid decanted. The residue is extracted once more, centrifuged and the liquid phases are combined. The extracts are concentrated to half the volume and Milli-Q water and a HAc/NaAc buffer with pH 4.5 are added. The organotin compounds are in-situ ethylated by the addition of a 10% solution of sodium tetraethylborate in Milli-Q water and extracted with hexane. The hexane extracts are concentrated and purified over a glass chromatographic column packed with silica. The fraction containing the ethylated organotin compounds is isolated and concentrated to a small volume. After the addition of a syringe standard the organotin compounds are analysed with GC/MS in the SIM mode.

3.2 Identification, quantification and expression of results

The identification of analytes was based on correct retention times and qualifier ion ratios, compared to an external standard. The quantification was based on an external standard analysed together with the samples. The recovery of the added internal standards was used to determine the performance of the analysis, but not to correct the results of the target compounds.

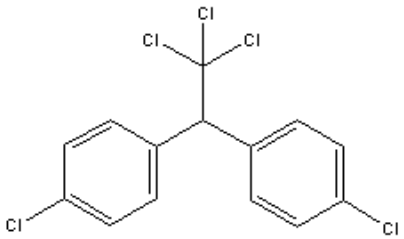
The results of the analysis are expressed as ng/g product and are based on wet weight. When reading the tables in section 4 and the appendix of this report please note that results are generally rounded to two significant numbers, e.g. a result of 1.23 ng/g will be rounded to 1.2 ng/g and a result of 1234 ng/g will be changed to 1200 ng/g. Statistical calculations like average or median concentrations are always made on the originally, non-rounded data.

4. Results

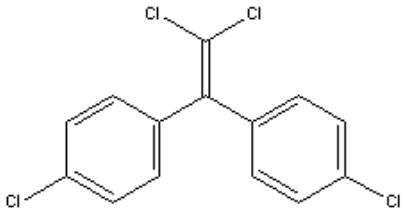
4.1 Organochlorine pesticides

4.1.1 General information

Organochlorine pesticides (OCPs) include compounds like DDT, lindane, hexachlorobenzene and chlordane, among others. DDT is a well-known agricultural insecticide that has been used extensively on a global basis for over 40 years. Although their manufacture and application are now largely prohibited or restricted in industrialized western countries, they can still be found in environmental and biological matrices due to their persistence. The structures of p,p'-DDT and it's breakdown product p,p'-DDE, are shown below.



p,p'-DDT



p,p'-DDE

As a part of its monitoring program, the Food and Drug Administration (FDA) determines the levels of pesticide residues in a wide variety of foods typically consumed by Americans. Over the past ten years, these surveys have detected DDE and other OCPs in a variety of foods including meat, fish and shell fish products, eggs, root vegetables, legumes (beans, peas, peanuts), some fruits, and leafy greens. In 1999 DDE or DDT were detected in 22% of the 1,040 food items analyzed in the 1999 FDA Total Diet Study[11]. The results for the 2003 Total Diet Study indicate DDT, but mainly DDE in 18% of the various food items in concentrations ranging from 0.1 to 11 ng/g[12]. Those for chlordane and lindane range from 0.1 to 3.8 and from 0.1 to 8.4 ng/g product. In general, the concentrations as well as the frequency of detection of OCPs were lower in the 2003 study.

---

[11] Food and Drug Administration Total Diet Study **1999**; http://vm.cfsan.fda.gov/~acrobat/pes99rep.pdf.

[12] Food and Drug Administration Total Diet Study **2003**: http://www.cfsan.fda.gov/~comm/tds-toc.html

4.1.2 Results for organochlorine pesticides in this study

The results of the OCPs are presented in table 1 in the appendix. OCPs are found in 18 of the 27 samples. The predominant OCPs that are detected are p,p'-DDE and HCB both found in 16 of the 27 samples. In addition o,p'-DDE and cis-chlordane were found in one and two samples. The maximum concentration found for p,p'-DDE was 5.6 ng/g in sample 6030-17, pickled herring. The median concentrations for p,p'-DDE and HCB were 0.43 and 0.14 ng/g. Compared to the FDA's Total Diet Study, p,p'-DDE and HCB are found more frequently but in lower concentrations.

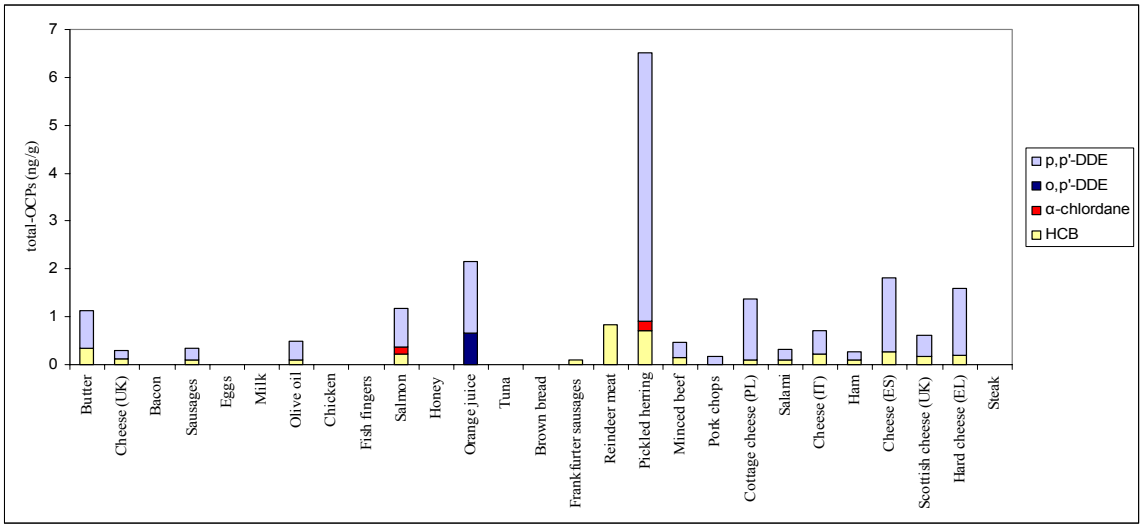
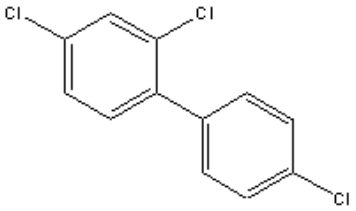


Figure 1 Graphic presentation of the total-OCPs concentration in 27 food items.

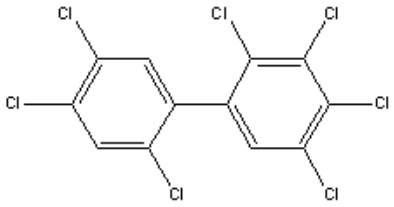
4.2 Polychlorinated biphenyls

4.2.1 General information

Polychlorinated biphenyls (PCBs) were marketed as cooling or insulating fluids for transformers, as softeners in the varnish and adhesive industries, and as hydraulic fluids. These compounds are not combustible, are heat resistant and make good solvents. On the other hand there is a severe toxic effect of PCBs, which damage the organs responsible for metabolism and also the nervous system. Because of their persistence, PCBs are now ubiquitous in the environment and, due to their high lipo-solubility, concentrated in human, animal and plant tissue. The structures of two of the seven indicator PCBs, PCB-28 and PCB-180 are shown below.



2,4,4'-trichlorobiphenyl (PCB 28)



2,2',3,4,4',5,5'-heptachlorobiphenyl (PCB 180)

The FDA studies mentioned in section 4.1.1 also determined levels of the sum of the seven indicator-PCBs (i-PCBs) in food samples. In the Total Diet Study of 2003 the levels of the sum of the i-PCBs (e.g. PCB-28, PCB-52, PCB-101, PCB-118, PCB-138, PCB-153 and PCB-180) ranged from 6 to 70 ng/g product. The Estonian Environment Research Centre determined levels of the sum of the i-PCBs in Estonian butter and found a relative narrow concentration range of 5.2 to 8.8 ng/g lipid, translating to a range of 4.2 to 7.0 ng/g on a wet weight basis[13]. A study of the European Food Safety Association (EFSA) of different food types sampled across Europe between 1997 and 2003 reports median concentrations for the sum of the i-PCBs ranging from 1.4 to 12 ng/g. Only fish oil showed a higher median concentration of 52 ng/g for the sum of the i-PCBs[14].

4.2.2 Results for polychlorinated biphenyls in this study

The results for the PCBs in this study are presented in table 2 in the appendix. A graphic summary is given in figure 2. PCBs are found in every sample of the 26 samples analysed with PCB-18, -28 and -52, with the highest frequency. The highest PCB concentrations were found in the pickled herring (6030-17) and the salmon (6030-10) with concentrations for the sum of the i-PCBs of 13 and 3.3 ng/g. The highest concentration of an individual PCB was for PCB-153, 5.5 ng/g in sample 6030-17. The results found are comparable with those reported by EFSA for different food types sampled across Europe.

---

[13] *Persistent organic pollutants levels in human milk and food*; http//preprint.chemweb.com/envchem/0207001

[14] B. Gallani, A. Boix, A. Di Domenico and R. Fanelli. *Occurence of NDL-PCB in food and feed in Europe.* Organohalogen Compounds Volume 66 **2004.**

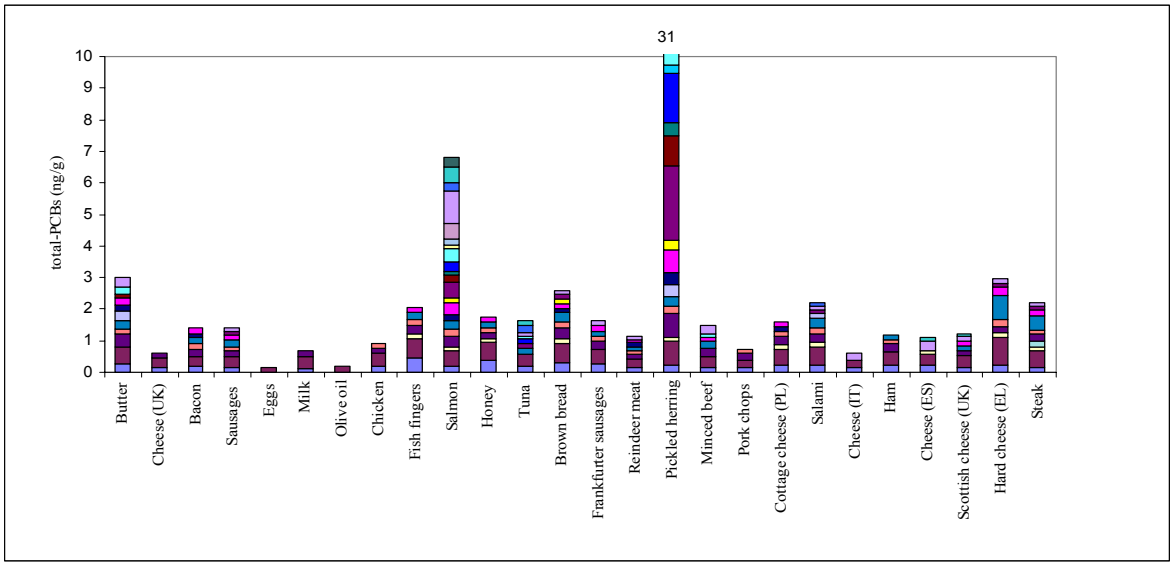


Figure 2 *Graphic presentation of the total-PCB concentration in 26 food items. For detailed information see table 2 in the appendix.*

4.3 Brominated flame retardants

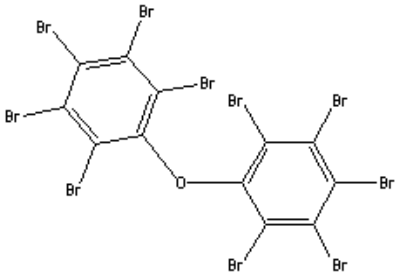
4.3.1 General information

Brominated flame retardants (BFRs) are widely used in electronic household equipment, plastics, textile and polyurethane foam in furniture and cars for safety reasons. Of the brominated products, about one-third contains tetrabromobisphenol-A (TBBPA) and derivatives, another third contains various bromines, including hexabromocyclododecane (HBCD) and the last third contains polybrominated diphenylethers (PBDEs). All three types of BFRs are determined in this study. The PBDEs are commercial mixtures with different degrees of bromination and used as additives to fireproof polymers. HBCD is a cyclo-aliphatic brominated chemical introduced as a replacement for the PBDEs with the same applications. TBBPA is mainly used as a reactive (chemically bound) flame retardant in epoxy polymers such as printed circuit boards in electronic equipment. The structure of BDE-209 (better known as deca-BDE), HBCD and TBBPA is shown below.

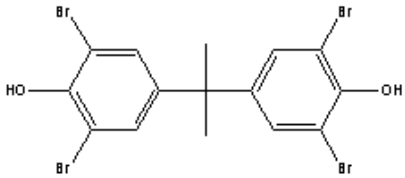
In a study by the Dutch National Institute for Public Health and the Environment the levels of various PBDEs, HBCD and TBBPA in 84 food products were determined[15]. With the exception of fish products PBDEs were absent or present in low concentrations (< 0.1 ng/g) in food products. For the fish products the

[15] de Winter-Sorkina R, Bakker MI, van Donkersgoed G, van Klaveren JD. RIVM report 310305001/2003, *Dietary intake of brominated flame retardants by the Dutch population*, **2003**.

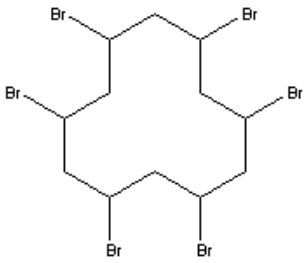
concentrations of the congeners BDE-28, -47, -99, -100, -153 and -154 ranged from 0.1 to 14 ng/g. BDE-209 was found in none of the 84 products while TBBPA was found in 7 products in concentrations ranging from 0.1 to 3.4 ng/g. Surprisingly, HBCD was found in 28 of the 84 samples in concentrations ranging from 0.1 to 8.9 ng/g product. TBBPA and HBCD were predominantly found in fish products, especially in eel.



decabromo diphenylether (BDE 209)



tetrabromo bisphenol-A (TBBA)



hexabromocyclododecane (HBCD)

A recent report on the results of a round robin exercise for BFRs in environmental, human and food samples gives some results for herring and salmon. The highest concentrations are found for BDE-47, up to 9.3 ng/g in herring and 0.89 ng/g in salmon. Those for the BDE-28, -99, -100, -153, -154 and -183 are in the range of 0.1 to 1.3 ng/g. BDE-209 and HBCD were not detected in these samples. The results for PBDEs in typical market basket studies show some differences, While studies in Spain[16] and Japan[17] show a predominance of the tetra- and penta-BDE with maximum concentrations up to 0.34 ng/g, an American study reports PBDE levels up to 3.1 ng/g product with a predominance of BDE-209 which comprised as much as 50% of the total PBDE content in some of the samples.

[16] Bocio A, Llobet JM, Domingo JL, Corbella J, Teixido A, Casa C. J. Agric Food Chem. 3191-3195, *51*, **2003**.

[17] Ohta S, Ishizuka d, Nishimura H, Teruyuki N, Aozasa O, Shimidzu Y, Ochiai F, Kida T, Nishi M, Miyata H. Chemosphere 689-696, *46*, **2002**.

4.3.2 Results for brominated flame retardants in this study

The results for the BFRs in this study are reported in table 3 in the appendix. PBDEs were found in 19 of the 26 samples analysed. BDE-209, TBBPA and HBCD were found in none of the samples. BDE-47, -32 and -99 seem to be the predominant and the highest concentration for an individual PBDE was 0.82 ng/g found for BDE-47 in sample 6030-25, Scottish Cheese. Surprisingly, and different from other studies, only a limited number of BFRs were found in the fish products, in salmon no BFRs were found at all. The total PBDE concentrations ranged from 0.15 to 1.3 ng/g with the highest concentration in minced beef, sample 6030-18. The concentrations found in this study are therefore comparable with those found in the Spanish and Japanese study and much lower than those found in the American food study.

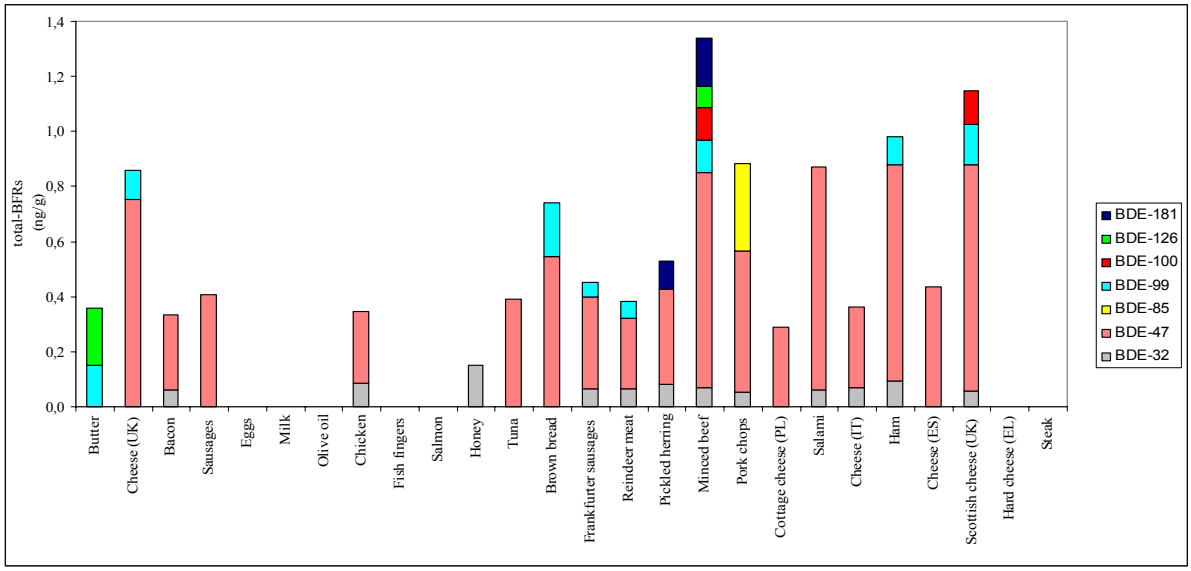


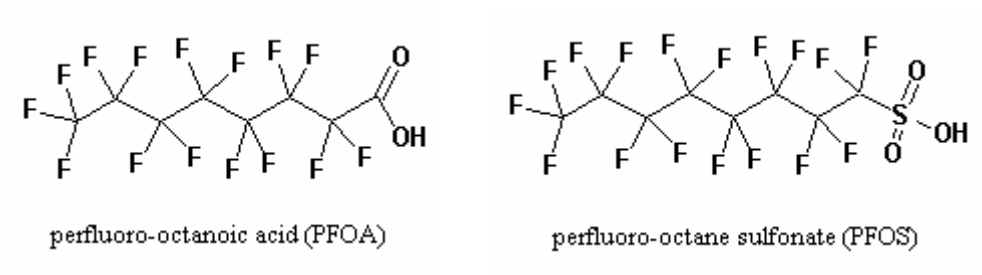
Figure 3 Graphic presentation of the total-BFRs concentration in 26 food samples.

4.4 Perfluorinated compounds

4.4.1 General information

Perfluorinated compounds (PFCs) are synthetic compounds characterised by an alkyl chain in which the hydrogen atoms are completely replaced by fluorine atoms. PFCs are heat stable, very resistant to degradation and environmental breakdown and have an amphiphilic nature (they repel water as well as oil). Because of these properties PFCs are used a myriad of applications, such as non-stick pans, stain and water repelling coatings for clothing, furniture and paper with

typical brand names as Teflon, Gortex, Stainmaster and Scotchguard[18]. PFCs accumulate in the environment and they have been detected far from manufacturing plants in birds, marine plants and mammals from the Arctic to the Pacific and Indian Oceans and in land creatures in Europe and the USA[19,20,21]. In addition PFCs have been found in human blood[22,23]. The structures of the two most common PFCs, PFOA and PFOS are given below.



Many studies focus on biota such as fish and birds and only limited information about levels of PFCs in food seem to be available. In 2001 the Centre Analytical Laboratory performed a study for the 3M-company as part of a Multi-City Study. PFCs were found in a limited number of samples. PFOS was found in five samples, four whole milk samples and a ground beef sample in concentrations up to 0.85 ng/g. PFOA was found in seven samples, two ground beef samples, two bread samples, two apple samples and one green been sample in concentrations up to 2.35 ng/g[24].

4.4.2 Results for perfluorinated compounds in this study

The results for PFCs are given in table 4 in the appendix. PFOS and PFOSA are found in one of the five samples that were analysed. The concentrations found in sample 6030-17, pickled herring, are 1.3 ng/g for PFOS and 0.2 ng/g for PFOSA. These concentrations are in the range of those found for PFOA in the Multi-City Study of the 3M-company.

---

18 3M. *Fluorochemical Use, Distribution and Release Overview*. EPA docket AR226-0550, **1999**.

19 Martin JW, Mabury SA, Solomon KR, Muir DCG. Environ. Tox. Chem. 196-204, *22*, **2003**.

20 Martin JW, Whittle DM, Muir DCG, Mabury SA. Env. Sci. Technol. 5379-5385, *38*, **2004**.

21 Kannan K, Corsolini S, Falandysz J, Oehme G, Focardi S, Giesy JP. Env. Sci. Technol. 3210-3216, *36*, **2002**.

22 Kannan K, Corsolini S, Falandysz J, Fillman G, Kumar KS, Loganathan BG, Mohd MA, Olivero J, Van Wouwe N, Yang JH, Aldous KM. Env. Sci. Technol. 4489-4495, *38*, **2004**.

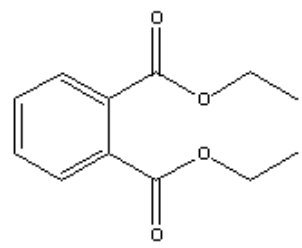
23 Peters RJB, TNO report B&O-A R 2005/129, *Man-made chemicals in maternal and cord blood*, March **2005**.

24 Centre Analytical Laboratory, study number 023-057: *Analysis of PFOS, FOSA and PFOA from various food matrices using HPLC electronspray/mass spectrometry*, June **2001**.

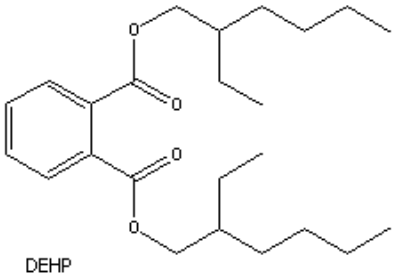
4.5 Phthalates

4.5.1 General information

Phthalates are one of the most ubiquitous classes of chemical contaminants in our everyday environment as a consequence of their high volume uses in open applications. They are used as plasticizers to increase the flexibility of high molecular weight polymers (mainly in PVC), as heat-transfer fluids and as carriers, and can be found in ink, paint, adhesives, pesticides, vinyl flooring[2], but also in cosmetics and personal care products. Consequently, the potential for human exposure is very high. Di-(2-ethylhexyl) phthalate (DEHP) and di-ethyl phthalate (DEP) are two of the most common used plasticizers. DEHP is nowadays gradually replaced by iso-alkyl phthalate mixtures like di-isononyl phthalate (DINP). The chemical structure of DEP and DEHP is shown below.



DEP



DEHP

There is not much information about concentrations of phthalates in food. Most attention has been focused on phthalates in plastic wrapping materials for food products. An older study dating from 1994 deals with the determination of DEHP in milk, cream, butter and cheese[25]. DEHP was found in all these products in concentrations ranging from 330 to 980 ng/g. More recent information is available from the UK Food Standard Agency and is concerned with the presence of phthalates in infant formulae[26]. Seven phthalates including DEHP were determined in 39 samples of infant formulae. In 12 of the 39 samples none of the phthalates were found. In the remaining samples di-butyl phthalate (DBP), benzylbutyl phthalate (BBP) and DEHP were found. DEHP was the most abundant individual phthalate in concentrations ranging from 50 to 440 ng/g product. DBP was found in concentrations up to 90 ng/g and BBP up to 15 ng/g product. Concentrations of other phthalates were less than 10 ng/g.

---

25 Sharman M, Read WA, Castle L, Gilbert J. Food Addit. Contam. 375-385, *11*, **1994**.

26 Joint Food Safety and Standards Group, Food surveillance information sheet, number 168, December **1998** (http://archive.food.gov.uk/maff/archive/food/infsheet/1998/no168/168phtha.htm).

4.5.2 Results for phthalates in this study

The results for phthalates in this study are presented in table 5 in the appendix. 16 of the 21 samples analysed for phthalates did contain one or more of these compounds. DIDP was the only phthalate that was not found in any of the samples. As expected DEHP is the predominant phthalate found in 16 of the 21 samples with concentrations ranging from 20 to 24,000 ng/g. It should be mentioned that the latter concentration is an exception and was found for sample 6030-17, olive oil. The neck of the olive oil bottle contains a polymer spout that may be responsible for the high DEHP concentration in the olive oil. Other phthalates that are frequently found (>50% of the samples) are DBP and BBP, be it in lower concentrations than DEHP.

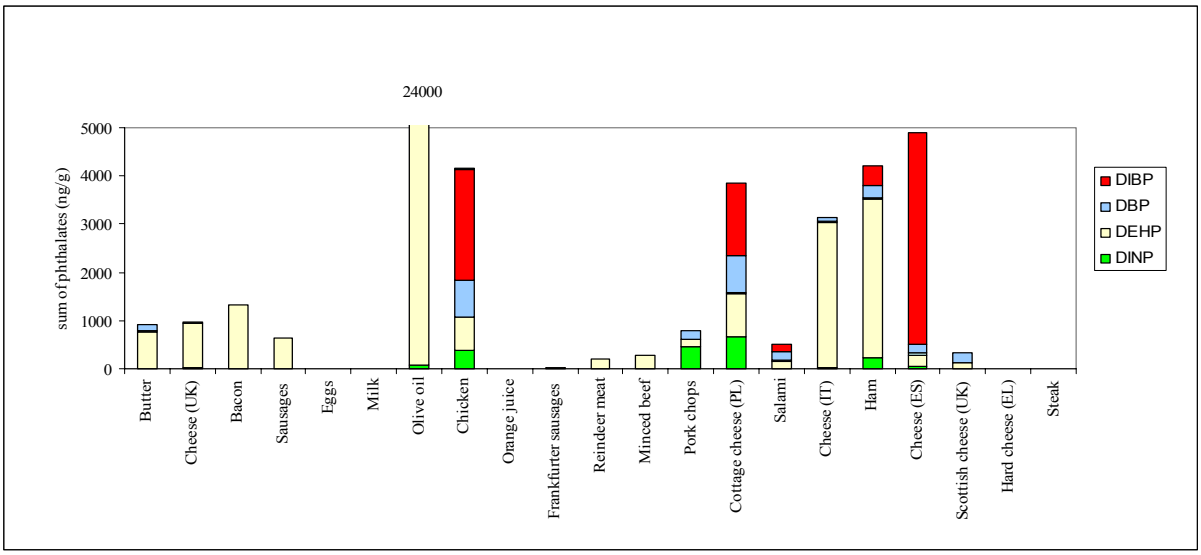
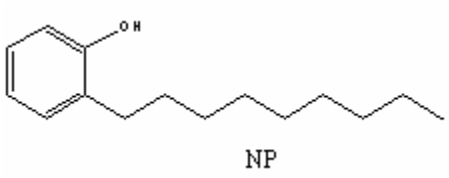


Figure 4 *Graphic presentation of the sum of the eight phthalates in 21 food items. In the legend the 4 most abundant phthalates are shown, for more details see table 5 in the appendix.*

4.6 Alkylphenols

4.6.1 General information

Alkylphenols, but primarily alkylphenol ethoxylates are used as additives in plastics and as surface-active ingredients in industrial detergents and emulsifiers. The ethoxylates are produced by a condensation reaction of alkylphenols with ethylene oxide. Alkylphenols commonly used are nonylphenol (NP) and to a lesser extent octylphenol (OP), in both cases pre-dominantly the para-substituted isomers (> 90%). Alkylphenols are the common products of bio- or chemical degradation of the ethoxylates. The chemical structure of n-NP is shown below.



NP

As with the phthalates only little information seems to be available about levels of alkylphenols in food. Guenther et al. determined NPs in 60 different commercially available foodstuffs and concluded that NPs are ubiquitous in food[27]. The concentrations of NPs (sum of the isomers) varied between 0.1 and 19.4 ng/g product and were found in all samples. Despite the lipophilic properties of NPs, high concentrations of NPs were not only found in fatty foods but also in non-fatty food products. In another study OP and NP were determined in composite foods[28]. OP was found in only one sample in a concentration of 8.7 ng/g while NP was found in concentrations up to 25 ng/g. In a previous TNO study alkylphenols were determined in wrapped fresh meat and cheese products[29]. Since the alkylphenols were determined in slices of the product collected directly below the foil or wrapper, the results are not representative for the entire product. OP was detected in none of the samples while NPs were found in five of the eight sub-samples in concentrations ranging from 9 to 590 ng/g. For one sample the whole food item was analysed resulting in a much lower concentrations in the order of 1 ng/g for NP.

4.6.2 Results for alkylphenols in this study

The results for alkylphenols in this study are given in table 5 in the appendix. NP was found in 2 of the 21 samples analysed, sample 6030-01 and -03 in concentrations around 5 ng/g. OP was found in none of the samples. Although the concentrations are in the range of what Guenther found, the results are different because the frequency of detection in this study is far lower. Perhaps this is a result of the way sub-samples are collected since higher concentration may be found in top-layers beneath the packaging foil.

---

[27] Guenther K, Heinke V, Thiele B, Kleist E, Prast H, Raecker T. Environ. Sci. Technol, 1676-1680, *36*, **2002**.

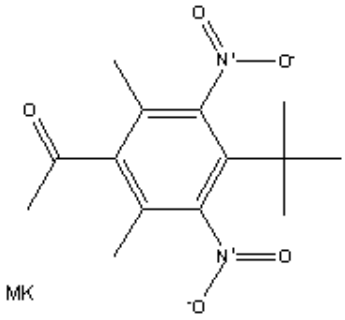
[28] Fernandes AR, Costley CT, Rose M. Food Addit Contam 846-852, *20*, **2003**.

[29] Geenen R. TNO report TR 03/725, *The determination of additives in food products*, December **2003**.

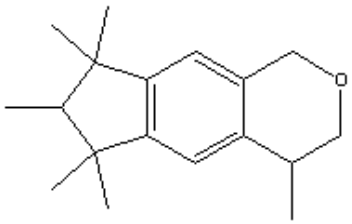
4.7 Musk compounds

4.7.1 General information

In nature, musk is a compound produced by a gland in male deer which has been used in perfumes, but the increasing demand resulted in the production of artificial musk compounds. The most well known are nitro musks like MX and MK that are nowadays replaced by polycyclic musks like AHTN and HHCB. Musks are used as additives for perfumes, in detergents and soaps, in body lotions and deodorizers. The structure of MK and HHCB is presented below.



MK



HHCB

As far as we know there are no reports or studies concerning the presence of artificial musks in food or food products. However, since 1981 it is known that artificial musks can be found in fish[30,31,32,33,34], and as a results artificial musks may be present in fish products.

4.7.2 Results for musks in this study

The results for musks in this study are given in table 6 in the appendix. The nitro-musks MK and MX are not found in the four fish products analysed for artificial musks. The polycyclic musks AHTN and HHCB are found in two of the samples, 6030-13 and 6030-17 in a maximum concentration of 0.56 ng/g for the latter sample. As in other environmental matrices and human blood the HHCB concentrations are about twice that of the AHTN concentrations. That the concentrations

---

30 Yamagishi T, Miyazaki T, Horii S, Akiyama K. Arch Environ Contain Toxicol, 83-89, *12*, **1983**.

31 Yamagishi T, Miyazaki T, Horii S, Kaneko S. Bull Environ Contain Toxicol, 656-662, *26*, **1981**.

32 Rimkus GG, Wolf M. Chemosphere. 641-651, *30*, **1995**.

33 Gatermann R, Biselli S, Huhnerfuss H, Rimkus GG, Hecker M, Karbe L. 2002. Arch Environ Contam Toxicol, 437-446, *42*, **2002**.

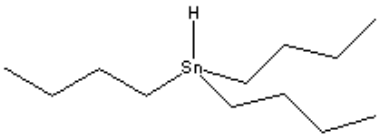
34 Fromme H, Otto T, Pilz K. Food Addit Contam. 937-944, *11*, **2001**.

are lower than those reported for fish in the literature is probably because most literature studies report results for fish in waterways connected to sewer effluents and not for typical marine fish species.

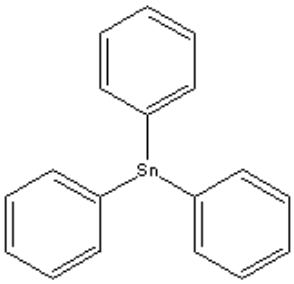
4.8 Organotin compounds

4.8.1 General information

The main organotin compounds (OTCs) to be found in food are likely to be tri-substituted compounds, tributyltin (TBT) and triphenyltin (TPT), which have been used extensively as biocides in wood preservatives, in antifouling paints for boats and as pesticides. Mono- and di-substituted OTC's (dibutyltin, mono-n-octyltin and di-n-octyltin) are used as stabilizers in PVC plastics, and di-alkyltins have been approved as PVC stabilizers for food contact materials. OTCs tend to accumulate in fish and other aquatic organisms and tri-alkyltins are bio-degraded to di- and mono-alkyltin compounds and therefore these may be found also in addition to the tri-substituted OTCs. The structures of TBT and TPT are presented below.



tributyltin (TBT)



triphenyltin (TPT)

Based on an EU SCOOP report the European Food Safety Authority estimated that the median concentrations of TBT, DBT and TPT in fish and fishery products are 7.0, 2.5 and 4.0 ng/g product[35,36]. The EU SCOOP report contains very few data on DOT, which were always below the limit of detection.

---

[35] EC (European Commission). Report on Tasks for Scientific Cooperation (SCOOP), task 3.2.13. Assessment of the dietary exposure to organotin compounds of the population of the EU member states. European Commission, Directorate-General Health and Consumer Protection, Reports on tasks for scientific co-operation, October **2003.**

[36] EFSA (European Food Safety Authority), *Opinion of the Scientific Panel on Contaminants in the Food Chain on a request from the Commission to assess the health risks to consumers associated with the exposure to organotins in foodstuffs*. The EFSA Journal, 1-119, *102*, **2004**.

4.8.2 Results for organotin compounds in this study

The results for organotin in this study are given in table 7 in the appendix. Organotin were found in three of the four samples that were analysed. The highest concentration of 9.0 ng/g was found for mono-butyl tin (MBT), a degradation product of TBT in sample 6030-13. Di-butyl tin (DBT) and TBT were also found in this sample. The pickled herring (6030-17) and the fish fingers (6030-09) contained butyl-tin as well as octyl-tin compounds.

4.9 Quality control measurements

4.9.1 Recovery of internal standards

For the determination of the organochlorine pesticides, polychlorinated biphenyls, brominated flame retardants, phthalates, artificial musks and organotin compounds internal standards were added to each sub-sample prior to analysis. For the perfluorinated compounds two relevant samples are spiked with the compounds of interest and analysed. The actual recovery of the internal standard and spikes is given below. With the exception of PCBs and OCTs, the results are not corrected for the recovery of the internal standards or spikes since the spikes used are not compound specific and their recovery is only used to evaluate the performance of the method.

Recovery internal standard

Description	unit	Min	Max	Correction applied
Organochlorine pesticides	%	69	126	no
Polychlorinated biphenyls	%	86	121	yes
Brominated flame retardants	%	72	120	no
Phthalates	%	75	133	no
Perfluorinated compounds	%	81	113	no
Alkylphenols	%	not applied		
Artificial musks	%	56	87	no
Organotin compounds	%	67	99	yes

4.9.2 Blank samples

With each series of samples a blank sample was included. For the blank analysis the complete analytical procedure was followed, including all chemicals and solvents, but no sample was added. Blank results were only found for the phthalates DEHP, DIBP and DBP, The results were corrected for these blank values and the detection limits were raised to 10 ng/g for DIBP and DBP, and to 20 ng/g for DEHP.

5. Conclusions

In this study the concentrations of a number of typical man-made chemicals in food or food products were determined. The compound groups of interest were organochlorine pesticides, polychlorinated biphenyls, brominated flame retardants, phthalates, alkylphenols, artificial musks, perfluorinated compounds and organotin compounds. The results show that:

- Many of these compounds are present food in the range of 0.1 to 10 ng/g with the exception of phthalates for which the typical concentrations are two orders of magnitude higher.

- Organochlorine pesticides were found in the 19 of the 27 samples analysed. The main organochlorine pesticides found in food are p,p'-DDE, a metabolite of DDT, and HCB in concentrations up to 5.6 ng/g.

- Polychlorinated biphenyls were found in all 26 samples analysed with predominance for PCB-18, -28 and -52. The sum of the indicator-PCBs ranged from 0.16 to 13 ng/g and total PCBs up to 32 ng/g. The highest concentrations were found in fish.

- Brominated flame retardants were found in 19 of the 26 samples analysed with predominance for the tetra- and penta-PBDEs, especially BDE-47, -32 and -99. Total PBDE concentrations ranged from 0.15 to 1.3 ng/g with the highest concentration found in meat and not in fish as in other studies. BDE-209, HBCD and TBBPA were not found in any of the samples.

- The perfluorinated compounds PFOS and PFOSA were found in one of the four samples analysed, a fish sample, in concentrations of 1.3 and 0.2 ng/g.

- The predominant phthalates in food were DEHP, DBP and BBP. Phthalates were found in 16 of the 21 samples analysed. DEHP concentrations ranged from 20 to 24,000 ng/g, the latter for a sample of olive oil, with a median concentration of 640 ng/g. Median concentrations for DBP and BBP were 200 and 17 ng/g. Alkylphenols were detected in 2 of the 21 samples, in both cases nonylphenol in concentrations around 5 ng/g.

- Of the artificial musks the polycyclic musks HHCB and AHTN were found 2 of the 4 samples in concentrations up to 0.56 ng/g for HHCB. As in other matrices the AHTN concentrations are about half those of HHCB.

- Organotin compounds were found in three of the four samples. Apart from TBT and it's metabolites DBT and MBT, two samples also contained octyltin compounds.

6. QA/QC Statement

TNO Build Environment and Geosciences operates in compliance with the Quality System standard ISO 9001 (certificate no. 07246-2003-AQ-ROT-RvA.). The analytical determinations in this study are performed in compliance with that Quality System.

7. Authentication

Name and address of the principal:

WWF-UK
Panda House, Weyside Park
Godalming, Surrey GU7 1XR
United Kingdom

Names and functions of the cooperators:

Dr. R.J.B. Peters	Project Leader
Ing. S. Walraven	Technician
Ing. A. van Renesse	Technician
Drs. R.J. van Delft	Technician
Ing. M. Diks	Technician

Names and establishments to which part of the research was put out to contract:

-

Date upon which, or period in which, the research took place:

February 2006 – March 2006

Signature:

R.J.B. Peters
Project leader MA

Approved by:

Ir. H. Buijtenhek
Head of Expert Team MA

Appendix 1 Full results of all samples

In the result tables in this appendix the abbreviations of table 1 are used. Results below the detection limit are indicated with a < sign. The reporting units and method detection limits are given after the compound name in each table. Note that results for all compounds are expressed in ng/g wet weight.

Table 1 Organochlorine pesticides in food.

Sample code TNO			6030-01	6030-02	6030-03	6030-04	6030-05
Description			Butter	Cheese	Bacon	Sausages	Eggs
Country recieved from	unit	LOD	UK	UK	UK	UK	UK
α-HCH	ng/g	0.1	<	<	<	<	<
β-HCH	ng/g	0.1	<	<	<	<	<
γ-HCH	ng/g	0.1	<	<	<	<	<
HCB	ng/g	0.1	0.34	0.12	<	0.10	<
α-chlordane	ng/g	0.1	<	<	<	<	<
β-chlordane	ng/g	0.1	<	<	<	<	<
o,p'-DDE	ng/g	0.1	<	<	<	<	<
p,p'-DDE	ng/g	0.1	0.79	0.18	<	0.25	<
o,p'-DDD	ng/g	0.1	<	<	<	<	<
p,p'-DDD	ng/g	0.1	<	<	<	<	<
o,p'-DDT	ng/g	0.1	<	<	<	<	<
p,p'-DDT	ng/g	0.1	<	<	<	<	<

Sample code TNO			6030-06	6030-07	6030-08	6030-09	6030-10
Description			Milk	Olive oil	Chicken	Fish fingers	Salmon
Country recieved from	unit	LOD	UK	UK	UK	UK	UK
α-HCH	ng/g	0.1	<	<	<	<	<
β-HCH	ng/g	0.1	<	<	<	<	<
γ-HCH	ng/g	0.1	<	<	<	<	<
HCB	ng/g	0.1	<	0.10	<	<	0.22
α-chlordane	ng/g	0.1	<	<	<	<	0.13
β-chlordane	ng/g	0.1	<	<	<	<	<
o,p'-DDE	ng/g	0.1	<	<	<	<	<
p,p'-DDE	ng/g	0.1	<	0.40	<	<	0.83
o,p'-DDD	ng/g	0.1	<	<	<	<	<
p,p'-DDD	ng/g	0.1	<	<	<	<	<
o,p'-DDT	ng/g	0.1	<	<	<	<	<
p,p'-DDT	ng/g	0.1	<	<	<	<	<

Table 1 Organochlorine pesticides in food (continued).

Sample code TNO			6030-11	6030-12	6030-13	6030-14	6030-15
Description			Honey	Orange juice	Tuna	Brown bread	Frankfurter sausages
Country recieved from	unit	LOD	UK		UK	UK	Finland
α-HCH	ng/g	0.1	<	<	<	<	<
β-HCH	ng/g	0.1	<	<	<	<	<
γ-HCH	ng/g	0.1	<	<	<	<	<
HCB	ng/g	0.1	<	<	<	<	0.10
α-chlordane	ng/g	0.1	<	<	<	<	<
β-chlordane	ng/g	0.1	<	<	<	<	<
o,p'-DDE	ng/g	0.1	<	0.65	<	<	<
p,p'-DDE	ng/g	0.1	<	1.5	<	<	<
o,p'-DDD	ng/g	0.1	<	<	<	<	<
p,p'-DDD	ng/g	0.1	<	<	<	<	<
o,p'-DDT	ng/g	0.1	<	<	<	<	<
p,p'-DDT	ng/g	0.1	<	<	<	<	<

Sample code TNO			6030-16	6030-17	6030-18	6030-19	6030-20
Description			Reindeer meat	Pickled herring	Minced beef	Pork chops	Cottage cheese
Country recieved from	unit	LOD	Finland	Sweden	Sweden	Poland	Poland
α-HCH	ng/g	0.1	<	<	<	<	<
β-HCH	ng/g	0.1	<	<	<	<	<
γ-HCH	ng/g	0.1	<	<	<	<	<
HCB	ng/g	0.1	0.83	0.70	0.14	<	0.10
α-chlordane	ng/g	0.1	<	0.20	<	<	<
β-chlordane	ng/g	0.1	<	<	<	<	<
o,p'-DDE	ng/g	0.1	<	<	<	<	<
p,p'-DDE	ng/g	0.1	<	5.6	0.33	0.17	1.3
o,p'-DDD	ng/g	0.1	<	<	<	<	<
p,p'-DDD	ng/g	0.1	<	<	<	<	<
o,p'-DDT	ng/g	0.1	<	<	<	<	<
p,p'-DDT	ng/g	0.1	<	<	<	<	<

Table 1 Organochlorine pesticides in food (continued).

Sample code TNO			6030-21	6030-22	6030-23	6030-24	6030-25
Description			Salami	Cheese	Ham	Cheese	Scottish cheese
Country recieved from	unit	LOD	Italy	Italy	Spain	Spain	UK
α-HCH	ng/g	0.1	<	<	<	<	<
β-HCH	ng/g	0.1	<	<	<	<	<
γ-HCH	ng/g	0.1	<	<	<	<	<
HCB	ng/g	0.1	0.10	0.22	0.10	0.26	0.18
α-chlordane	ng/g	0.1	<	<	<	<	<
β-chlordane	ng/g	0.1	<	<	<	<	<
o,p'-DDE	ng/g	0.1	<	<	<	<	<
p,p'-DDE	ng/g	0.1	0.21	0.48	0.17	1.6	0.43
o,p'-DDD	ng/g	0.1	<	<	<	<	<
p,p'-DDD	ng/g	0.1	<	<	<	<	<
o,p'-DDT	ng/g	0.1	<	<	<	<	<
p,p'-DDT	ng/g	0.1	<	<	<	<	<

Sample code TNO			6110-05	6110-06
Description			Hard cheese	Steak
Country recieved from	unit	LOD	Greece	Greece
α-HCH	ng/g	0.1	<	<
β-HCH	ng/g	0.1	<	<
γ-HCH	ng/g	0.1	<	<
HCB	ng/g	0.1	0.20	<
α-chlordane	ng/g	0.1	<	<
β-chlordane	ng/g	0.1	<	<
o,p'-DDE	ng/g	0.1	<	<
p,p'-DDE	ng/g	0.1	1.4	<
o,p'-DDD	ng/g	0.1	<	<
p,p'-DDD	ng/g	0.1	<	<
o,p'-DDT	ng/g	0.1	<	<
p,p'-DDT	ng/g	0.1	<	<

Table 2 Polychlorinated biphenyls in food.

Sample code TNO			6030-01	6030-02	6030-03	6030-04	6030-05
Description			Butter	Cheese	Bacon	Sausages	Eggs
Country recieved from	unit	LOD	UK	UK	UK	UK	UK
PCB 18	ng/g	0.1	0.25	0.13	0.19	0.16	<
PCB 28/31	ng/g	0.1	0.56	0.31	0.32	0.35	0.16
PCB 22	ng/g	0.1	<	<	<	<	<
PCB 41/64	ng/g	0.1	0.27	<	<	<	<
PCB 44	ng/g	0.1	0.27	<	0.18	0.24	<
PCB 49	ng/g	0.1	0.18	<	0.19	0.13	<
PCB 52	ng/g	0.1	0.40	0.16	0.21	0.16	<
PCB 54	ng/g	0.1	<	<	<	<	<
PCB 56/60	ng/g	0.1	<	<	<	<	<
PCB 70	ng/g	0.1	0.20	<	0.21	0.12	<
PCB 74	ng/g	0.1	0.22	<	0.11	<	<
PCB 87	ng/g	0.1	<	<	<	<	<
PCB 90/**101**	ng/g	0.1	<	<	<	0.11	<
PCB 99	ng/g	0.1	0.14	<	<	<	<
PCB 104	ng/g	0.1	<	<	<	<	<
PCB 105	ng/g	0.1	<	<	<	<	<
PCB 110	ng/g	0.1	<	<	<	<	<
PCB 114	ng/g	0.1	<	<	<	<	<
PCB 118	ng/g	0.1	0.23	<	<	<	<
PCB 123	ng/g	0.1	<	<	<	<	<
PCB 138	ng/g	0.1	<	<	<	<	<
PCB 141	ng/g	0.1	<	<	<	<	<
PCB 149	ng/g	0.1	<	<	<	<	<
PCB 151	ng/g	0.1	<	<	<	<	<
PCB 153/168	ng/g	0.1	0.29	<	<	0.12	<
PCB 156	ng/g	0.1	<	<	<	<	<
PCB 157	ng/g	0.1	<	<	<	<	<
PCB 158	ng/g	0.1	<	<	<	<	<
PCB 167	ng/g	0.1	<	<	<	<	<
PCB 170	ng/g	0.2	<	<	<	<	<
PCB 177	ng/g	0.2	<	<	<	<	<
PCB 180	ng/g	0.2	<	<	<	<	<
PCB 183	ng/g	0.2	<	<	<	<	<
PCB 187	ng/g	0.2	<	<	<	<	<
PCB 188	ng/g	0.2	<	<	<	<	<
PCB 189	ng/g	0.2	<	<	<	<	<
PCB 194	ng/g	0.2	<	<	<	<	<
PCB 199	ng/g	0.2	<	<	<	<	<
PCB 203	ng/g	0.2	<	<	<	<	<
Sum indicator-PCB	ng/g		1.5	0.47	0.53	0.74	0.16
Total PCB	ng/g		3.0	0.60	1.4	1.4	0.16

Table 2 Polychlorinated biphenyls in food (continued).

Sample code TNO			6030-06	6030-07	6030-08	6030-09	6030-10
Description			Milk	Olive oil	Chicken	Fish fingers	Salmon
Country recieved from	unit	LOD	UK	UK	UK	UK	UK
PCB 18	ng/g	0.1	0.12	<	0.20	0.45	0.19
PCB 28/31	ng/g	0.1	0.36	0.19	0.40	0.63	0.49
PCB 22	ng/g	0.1	<	<	<	0.13	0.11
PCB 41/64	ng/g	0.1	<	<	<	<	<
PCB 44	ng/g	0.1	<	<	<	0.22	0.24
PCB 49	ng/g	0.1	<	<	0.13	0.21	0.23
PCB 52	ng/g	0.1	0.21	<	0.17	0.27	0.36
PCB 54	ng/g	0.1	<	<	<	<	<
PCB 56/60	ng/g	0.1	<	<	<	<	0.18
PCB 70	ng/g	0.1	<	<	<	0.14	0.38
PCB 74	ng/g	0.1	<	<	<	<	0.19
PCB 87	ng/g	0.1	<	<	<	<	0.12
PCB 90/**101**	ng/g	0.1	<	<	<	<	0.47
PCB 99	ng/g	0.1	<	<	<	<	0.24
PCB 104	ng/g	0.1	<	<	<	<	<
PCB 105	ng/g	0.1	<	<	<	<	0.14
PCB 110	ng/g	0.1	<	<	<	<	0.30
PCB 114	ng/g	0.1	<	<	<	<	<
PCB 118	ng/g	0.1	<	<	<	<	0.40
PCB 123	ng/g	0.1	<	<	<	<	<
PCB 138	ng/g	0.1	<	<	<	<	0.24
PCB 141	ng/g	0.1	<	<	<	<	<
PCB 149	ng/g	0.1	<	<	<	<	0.49
PCB 151	ng/g	0.1	<	<	<	<	0.17
PCB 153/168	ng/g	0.1	<	<	<	<	1.0
PCB 156	ng/g	0.1	<	<	<	<	<
PCB 157	ng/g	0.1	<	<	<	<	<
PCB 158	ng/g	0.1	<	<	<	<	0.50
PCB 167	ng/g	0.1	<	<	<	<	<
PCB 170	ng/g	0.2	<	<	<	<	<
PCB 177	ng/g	0.2	<	<	<	<	<
PCB 180	ng/g	0.2	<	<	<	<	0.32
PCB 183	ng/g	0.2	<	<	<	<	<
PCB 187	ng/g	0.2	<	<	<	<	<
PCB 188	ng/g	0.2	<	<	<	<	<
PCB 189	ng/g	0.2	<	<	<	<	<
PCB 194	ng/g	0.2	<	<	<	<	<
PCB 199	ng/g	0.2	<	<	<	<	<
PCB 203	ng/g	0.2	<	<	<	<	<
Sum indicator-PCB	ng/g		0.57	0.19	0.57	0.90	3.3
Total PCB	ng/g		0.69	0.19	0.91	2.0	6.8

Table 2 Polychlorinated biphenyls in food (continued).

Sample code TNO			6030-11	6030-13	6030-14	6030-15
Description			Honey	Tuna	Brown bread	Frankfurter sausages
Country recieved from	unit	LOD	UK	UK	UK	Finland
PCB 18	ng/g	0.1	0.38	0.20	0.29	0.26
PCB 28/31	ng/g	0.1	0.55	0.38	0.61	0.44
PCB 22	ng/g	0.1	0.11	<	0.16	<
PCB 41/64	ng/g	0.1	<	<	<	<
PCB 44	ng/g	0.1	0.19	0.19	0.29	0.18
PCB 49	ng/g	0.1	0.15	<	0.19	0.16
PCB 52	ng/g	0.1	0.19	<	0.35	0.27
PCB 54	ng/g	0.1	<	<	<	<
PCB 56/60	ng/g	0.1	<	<	0.14	<
PCB 70	ng/g	0.1	0.16	<	0.17	0.17
PCB 74	ng/g	0.1	<	<	0.11	<
PCB 87	ng/g	0.1	<	<	<	<
PCB 90/**101**	ng/g	0.1	<	0.14	0.15	<
PCB 99	ng/g	0.1	<	<	<	<
PCB 104	ng/g	0.1	<	<	<	<
PCB 105	ng/g	0.1	<	<	<	<
PCB 110	ng/g	0.1	<	0.14	<	<
PCB 114	ng/g	0.1	<	<	<	<
PCB 118	ng/g	0.1	<	0.11	<	<
PCB 123	ng/g	0.1	<	<	<	<
PCB 138	ng/g	0.1	<	0.20	<	<
PCB 141	ng/g	0.1	<	<	<	<
PCB 149	ng/g	0.1	<	<	<	<
PCB 151	ng/g	0.1	<	<	<	<
PCB 153/168	ng/g	0.1	<	0.12	0.13	0.14
PCB 156	ng/g	0.1	<	<	<	<
PCB 157	ng/g	0.1	<	<	<	<
PCB 158	ng/g	0.1	<	0.16	<	<
PCB 167	ng/g	0.1	<	<	<	<
PCB 170	ng/g	0.2	<	<	<	<
PCB 177	ng/g	0.2	<	<	<	<
PCB 180	ng/g	0.2	<	<	<	<
PCB 183	ng/g	0.2	<	<	<	<
PCB 187	ng/g	0.2	<	<	<	<
PCB 188	ng/g	0.2	<	<	<	<
PCB 189	ng/g	0.2	<	<	<	<
PCB 194	ng/g	0.2	<	<	<	<
PCB 199	ng/g	0.2	<	<	<	<
PCB 203	ng/g	0.2	<	<	<	<
Sum indicator-PCB	ng/g		0.75	0.94	1.2	0.85
Total PCB	ng/g		1.8	1.6	2.6	1.6

Table 2 Polychlorinated biphenyls in food (continued).

Sample code TNO			6030-16	6030-17	6030-18	6030-19	6030-20
Description			Reindeer meat	Pickled herring	Minced beef	Pork chops	Cottage cheese
Country recieved from	unit	LOD	Finland	Sweden	Sweden	Poland	Poland
PCB 18	ng/g	0.1	0.14	0.23	0.14	0.16	0.24
PCB 28/31	ng/g	0.1	0.26	0.76	0.36	0.23	0.49
PCB 22	ng/g	0.1	<	0.13	<	<	0.14
PCB 41/64	ng/g	0.1	<	0.38	<	<	<
PCB 44	ng/g	0.1	0.14	0.33	0.24	<	<
PCB 49	ng/g	0.1	0.13	0.22	<	0.12	0.14
PCB 52	ng/g	0.1	0.15	0.74	0.25	0.20	0.29
PCB 54	ng/g	0.1	<	<	<	<	<
PCB 56/60	ng/g	0.1	<	0.31	<	<	<
PCB 70	ng/g	0.1	0.11	0.71	0.13	<	0.16
PCB 74	ng/g	0.1	0.12	0.37	<	<	0.14
PCB 87	ng/g	0.1	<	0.41	<	<	<
PCB 90/**101**	ng/g	0.1	<	2.4	<	<	<
PCB 99	ng/g	0.1	<	0.95	<	<	<
PCB 104	ng/g	0.1	<	<	<	<	<
PCB 105	ng/g	0.1	<	0.59	<	<	<
PCB 110	ng/g	0.1	<	1.6	<	<	<
PCB 114	ng/g	0.1	<	<	<	<	<
PCB 118	ng/g	0.1	<	1.8	0.11	<	<
PCB 123	ng/g	0.1	<	0.27	<	<	<
PCB 138	ng/g	0.1	<	1.5	<	<	<
PCB 141	ng/g	0.1	<	0.30	<	<	<
PCB 149	ng/g	0.1	<	2.8	<	<	<
PCB 151	ng/g	0.1	<	0.92	<	<	<
PCB 153/168	ng/g	0.1	0.11	5.5	0.26	<	<
PCB 156	ng/g	0.1	<	0.22	<	<	<
PCB 157	ng/g	0.1	<	<	<	<	<
PCB 158	ng/g	0.1	<	3.2	<	<	<
PCB 167	ng/g	0.1	<	0.19	<	<	<
PCB 170	ng/g	0.2	<	0.66	<	<	<
PCB 177	ng/g	0.2	<	0.56	<	<	<
PCB 180	ng/g	0.2	<	0.90	<	<	<
PCB 183	ng/g	0.2	<	0.43	<	<	<
PCB 187	ng/g	0.2	<	1.6	<	<	<
PCB 188	ng/g	0.2	<	<	<	<	<
PCB 189	ng/g	0.2	<	<	<	<	<
PCB 194	ng/g	0.2	<	<	<	<	<
PCB 199	ng/g	0.2	<	<	<	<	<
PCB 203	ng/g	0.2	<	<	<	<	<
Sum indicator-PCB	ng/g		0.52	13	0.98	0.43	0.77
Total PCB	ng/g		1.2	31	1.5	0.72	1.6

Table 2 Polychlorinated biphenyls in food (continued).

Sample code TNO			6030-21	6030-22	6030-23	6030-24	6030-25
Description			Salami	Cheese	Ham	Cheese	Scottish cheese
Country recieved from	unit	LOD	Italy	Italy	Spain	Spain	UK
PCB 18	ng/g	0.1	0.22	0.15	0.24	0.22	0.16
PCB 28/31	ng/g	0.1	0.59	0.22	0.43	0.37	0.36
PCB 22	ng/g	0.1	0.14	<	<	0.11	<
PCB 41/64	ng/g	0.1	0.14	<	<	<	<
PCB 44	ng/g	0.1	0.29	<	0.17	<	0.18
PCB 49	ng/g	0.1	0.19	<	0.11	<	<
PCB 52	ng/g	0.1	0.28	<	0.24	<	0.15
PCB 54	ng/g	0.1	<	<	<	<	<
PCB 56/60	ng/g	0.1	<	<	<	<	<
PCB 70	ng/g	0.1	<	<	<	<	0.12
PCB 74	ng/g	0.1	<	<	<	<	<
PCB 87	ng/g	0.1	<	<	<	<	<
PCB 90/**101**	ng/g	0.1	0.13	<	<	<	<
PCB 99	ng/g	0.1	<	<	<	<	<
PCB 104	ng/g	0.1	<	<	<	<	<
PCB 105	ng/g	0.1	<	<	<	<	<
PCB 110	ng/g	0.1	<	<	<	<	<
PCB 114	ng/g	0.1	<	<	<	<	<
PCB 118	ng/g	0.1	<	<	<	<	<
PCB 123	ng/g	0.1	<	<	<	<	<
PCB 138	ng/g	0.1	0.10	<	<	<	<
PCB 141	ng/g	0.1	<	<	<	<	<
PCB 149	ng/g	0.1	<	<	<	<	<
PCB 151	ng/g	0.1	<	<	<	<	<
PCB 153/168	ng/g	0.1	0.13	0.22	<	0.31	0.16
PCB 156	ng/g	0.1	<	<	<	<	<
PCB 157	ng/g	0.1	<	<	<	<	<
PCB 158	ng/g	0.1	<	<	<	0.12	0.10
PCB 167	ng/g	0.1	<	<	<	<	<
PCB 170	ng/g	0.2	<	<	<	<	<
PCB 177	ng/g	0.2	<	<	<	<	<
PCB 180	ng/g	0.2	<	<	<	<	<
PCB 183	ng/g	0.2	<	<	<	<	<
PCB 187	ng/g	0.2	<	<	<	<	<
PCB 188	ng/g	0.2	<	<	<	<	<
PCB 189	ng/g	0.2	<	<	<	<	<
PCB 194	ng/g	0.2	<	<	<	<	<
PCB 199	ng/g	0.2	<	<	<	<	<
PCB 203	ng/g	0.2	<	<	<	<	<
Sum indicator-PCB	ng/g		1.2	0.44	0.66	0.67	0.67
Total PCB	ng/g		2.2	0.59	1.2	1.1	1.2

Table 2 Polychlorinated biphenyls in food (continued).

Sample code TNO			6110-05	6110-06
Description			Hard cheese	Steak
Country recieved from	unit	LOD	Greece	Greece
PCB 18	ng/g	0.1	0.22	0.15
PCB 28/31	ng/g	0.1	0.88	0.53
PCB 22	ng/g	0.1	0.14	0.11
PCB 54	ng/g	0.1	<	0.21
PCB 52	ng/g	0.1	0.22	0.20
PCB 49	ng/g	0.1	0.22	0.14
PCB 44	ng/g	0.1	0.74	0.43
PCB 64/41	ng/g	0.1	<	<
PCB 74	ng/g	0.1	<	<
PCB 70	ng/g	0.1	0.27	0.21
PCB 56/60	ng/g	0.1	<	<
PCB 104	ng/g	0.1	<	<
PCB 90/101	ng/g	0.1	0.11	0.12
PCB 99	ng/g	0.1	<	<
PCB 87	ng/g	0.1	<	<
PCB 110	ng/g	0.1	<	<
PCB 123	ng/g	0.1	<	<
PCB 118	ng/g	0.1	<	<
PCB 114	ng/g	0.1	<	<
PCB 105	ng/g	0.1	<	<
PCB 151	ng/g	0.1	<	<
PCB 149	ng/g	0.1	<	<
PCB 153/168	ng/g	0.1	0.17	0.11
PCB 141	ng/g	0.1	<	<
PCB 138	ng/g	0.1	<	<
PCB 158	ng/g	0.1	<	<
PCB 167	ng/g	0.1	<	<
PCB 156	ng/g	0.1	<	<
PCB 157	ng/g	0.1	<	<
PCB 188	ng/g	0.2	<	<
PCB 187	ng/g	0.2	<	<
PCB 183	ng/g	0.2	<	<
PCB 177	ng/g	0.2	<	<
PCB 180	ng/g	0.2	<	<
PCB 170	ng/g	0.2	<	<
PCB 189	ng/g	0.2	<	<
PCB 199	ng/g	0.2	<	<
PCB 203	ng/g	0.2	<	<
PCB 194	ng/g	0.2	<	<
Sum indicator-PCB	ng/g		1.4	0.96
Total PCB	ng/g		3.0	2.21

Table 3 Brominated flame retardants in food,

Sample code TNO			6030-01	6030-02	6030-03	6030-04	6030-05
Description			Butter	Cheese	Bacon	Sausages	Eggs
Country recieved from	unit	LOD	UK	UK	UK	UK	UK
BDE-17	ng/g	0.1	<	<	<	<	<
BDE-28	ng/g	0.1	<	<	<	<	<
BDE-32	ng/g	0.05	<	<	0.06	<	<
BDE-35	ng/g	0.05	<	<	<	<	<
BDE-37	ng/g	0.05	<	<	<	<	<
BDE-47	ng/g	0.05	<	0.75	0.27	0.41	<
BDE-49/71	ng/g	0.05	<	<	<	<	<
BDE-66	ng/g	0.05	<	<	<	<	<
BDE-75	ng/g	0.05	<	<	<	<	<
BDE-77	ng/g	0.05	<	<	<	<	<
BDE-85	ng/g	0.05	<	<	<	<	<
BDE-99	ng/g	0.05	0.15	0.10	<	<	<
BDE-100	ng/g	0.05	<	<	<	<	<
BDE-119	ng/g	0.05	<	<	<	<	<
BDE-126	ng/g	0.05	0.21	<	<	<	<
BDE-138	ng/g	0.05	<	<	<	<	<
BDE-153	ng/g	0.05	<	<	<	<	<
BDE-154	ng/g	0.05	<	<	<	<	<
BDE-156	ng/g	0.05	<	<	<	<	<
BDE-166	ng/g	0.05	<	<	<	<	<
BDE-181	ng/g	0.05	<	<	<	<	<
BDE-183	ng/g	0.05	<	<	<	<	<
BDE-184	ng/g	0.05	<	<	<	<	<
BDE-190	ng/g	0.1	<	<	<	<	<
BDE191	ng/g	0.1	<	<	<	<	<
BDE-196	ng/g	0.2	<	<	<	<	<
BDE-197	ng/g	0.2	<	<	<	<	<
BDE-206	ng/g	1	<	<	<	<	<
BDE-207	ng/g	1	<	<	<	<	<
BDE-209	ng/g	5	<	<	<	<	<
total PBDE	ng/g		0.36	0.86	0.33	0.41	
TBBPA	ng/g	0.1	<	<	<	<	<
HBCD	ng/g	0.2	<	<	<	<	<

Table 3 Brominated flame retardants in food (continued).

Sample code TNO			6030-06	6030-07	6030-08	6030-09	6030-10
Description			Milk	Olive oil	Chicken	Fish fingers	Salmon
Country recieved from	unit	LOD	UK	UK	UK	UK	UK
BDE-17	ng/g	0.1	<	<	<	<	<
BDE-28	ng/g	0.1	<	<	<	<	<
BDE-32	ng/g	0.05	<	<	0.08	<	<
BDE-35	ng/g	0.05	<	<	<	<	<
BDE-37	ng/g	0.05	<	<	<	<	<
BDE-47	ng/g	0.05	<	<	0.26	<	<
BDE-49/71	ng/g	0.05	<	<	<	<	<
BDE-66	ng/g	0.05	<	<	<	<	<
BDE-75	ng/g	0.05	<	<	<	<	<
BDE-77	ng/g	0.05	<	<	<	<	<
BDE-85	ng/g	0.05	<	<	<	<	<
BDE-99	ng/g	0.05	<	<	<	<	<
BDE-100	ng/g	0.05	<	<	<	<	<
BDE-119	ng/g	0.05	<	<	<	<	<
BDE-126	ng/g	0.05	<	<	<	<	<
BDE-138	ng/g	0.05	<	<	<	<	<
BDE-153	ng/g	0.05	<	<	<	<	<
BDE-154	ng/g	0.05	<	<	<	<	<
BDE-156	ng/g	0.05	<	<	<	<	<
BDE-166	ng/g	0.05	<	<	<	<	<
BDE-181	ng/g	0.05	<	<	<	<	<
BDE-183	ng/g	0.05	<	<	<	<	<
BDE-184	ng/g	0.05	<	<	<	<	<
BDE-190	ng/g	0.1	<	<	<	<	<
BDE191	ng/g	0.1	<	<	<	<	<
BDE-196	ng/g	0.2	<	<	<	<	<
BDE-197	ng/g	0.2	<	<	<	<	<
BDE-206	ng/g	1	<	<	<	<	<
BDE-207	ng/g	1	<	<	<	<	<
BDE-209	ng/g	5	<	<	<	<	<
total PBDE	ng/g				0.34		
TBBPA	ng/g	0.1	<	<	<	<	<
HBCD	ng/g	0.2	<	<	<	<	<

Table 3 Brominated flame retardants in food (continued).

Sample code TNO			6030-11	6030-13	6030-14	6030-15
Description			Honey	Tuna	Brown bread	Frankfurter sausages
Country recieved from	unit	LOD	UK	UK	UK	Finland
BDE-17	ng/g	0.1	<	<	<	<
BDE-28	ng/g	0.1	<	<	<	<
BDE-32	ng/g	0.05	0.15	<	<	0.06
BDE-35	ng/g	0.05	<	<	<	<
BDE-37	ng/g	0.05	<	<	<	<
BDE-47	ng/g	0.05	<	0.39	0.55	0.33
BDE-49/71	ng/g	0.05	<	<	<	<
BDE-66	ng/g	0.05	<	<	<	<
BDE-75	ng/g	0.05	<	<	<	<
BDE-77	ng/g	0.05	<	<	<	<
BDE-85	ng/g	0.05	<	<	<	<
BDE-99	ng/g	0.05	<	<	0.19	0.05
BDE-100	ng/g	0.05	<	<	<	<
BDE-119	ng/g	0.05	<	<	<	<
BDE-126	ng/g	0.05	<	<	<	<
BDE-138	ng/g	0.05	<	<	<	<
BDE-153	ng/g	0.05	<	<	<	<
BDE-154	ng/g	0.05	<	<	<	<
BDE-156	ng/g	0.05	<	<	<	<
BDE-166	ng/g	0.05	<	<	<	<
BDE-181	ng/g	0.05	<	<	<	<
BDE-183	ng/g	0.05	<	<	<	<
BDE-184	ng/g	0.05	<	<	<	<
BDE-190	ng/g	0.1	<	<	<	<
BDE191	ng/g	0.1	<	<	<	<
BDE-196	ng/g	0.2	<	<	<	<
BDE-197	ng/g	0.2	<	<	<	<
BDE-206	ng/g	1	<	<	<	<
BDE-207	ng/g	1	<	<	<	<
BDE-209	ng/g	5	<	<	<	<
total PBDE	ng/g		0.15	0.39	0.74	0.45
TBBPA	ng/g	0.1	<	<	<	<
HBCD	ng/g	0.2	<	<	<	<

Table 3 Brominated flame retardants in food (continued).

Sample code TNO			6030-16	6030-17	6030-18	6030-19	6030-20
Description			Reindeer meat	Pickled herring	Minced beef	Pork chops	Cottage cheese
Country recieved from	unit	LOD	Finland	Sweden	Sweden	Poland	Poland
BDE-17	ng/g	0.1	<	<	<	<	<
BDE-28	ng/g	0.1	<	<	<	<	<
BDE-32	ng/g	0.05	0.06	0.08	0.07	0.05	<
BDE-35	ng/g	0.05	<	<	<	<	<
BDE-37	ng/g	0.05	<	<	<	<	<
BDE-47	ng/g	0.05	0.26	0.35	0.78	0.52	0.29
BDE-49/71	ng/g	0.05	<	<	<	<	<
BDE-66	ng/g	0.05	<	<	<	<	<
BDE-75	ng/g	0.05	<	<	<	<	<
BDE-77	ng/g	0.05	<	<	<	<	<
BDE-85	ng/g	0.05	<	<	<	0.32	<
BDE-99	ng/g	0.05	0.06	<	0.12	<	<
BDE-100	ng/g	0.05	<	<	0.11	<	<
BDE-119	ng/g	0.05	<	<	<	<	<
BDE-126	ng/g	0.05	<	<	0.08	<	<
BDE-138	ng/g	0.05	<	<	<	<	<
BDE-153	ng/g	0.05	<	<	<	<	<
BDE-154	ng/g	0.05	<	<	<	<	<
BDE-156	ng/g	0.05	<	<	<	<	<
BDE-166	ng/g	0.05	<	<	<	<	<
BDE-181	ng/g	0.05	<	0.10	0.18	<	<
BDE-183	ng/g	0.05	<	<	<	<	<
BDE-184	ng/g	0.05	<	<	<	<	<
BDE-190	ng/g	0.1	<	<	<	<	<
BDE191	ng/g	0.1	<	<	<	<	<
BDE-196	ng/g	0.2	<	<	<	<	<
BDE-197	ng/g	0.2	<	<	<	<	<
BDE-206	ng/g	1	<	<	<	<	<
BDE-207	ng/g	1	<	<	<	<	<
BDE-209	ng/g	5	<	<	<	<	<
total PBDE	ng/g		0.38	0.53	1.3	0.88	0.29
TBBPA	ng/g	0.1	<	<	<	<	<
HBCD	ng/g	0.2	<	<	<	<	<

Table 3 Brominated flame retardants in food (continued).

Sample code TNO			6030-21	6030-22	6030-23	6030-24	6030-25
Description			Salami	Cheese	Ham	Cheese	Scottish cheese
Country recieved from	unit	LOD	Italy	Italy	Spain	Spain	UK
BDE-17	ng/g	0.1	<	<	<	<	<
BDE-28	ng/g	0.1	<	<	<	<	<
BDE-32	ng/g	0.05	0.06	0.07	0.09	<	0.06
BDE-35	ng/g	0.05	<	<	<	<	<
BDE-37	ng/g	0.05	<	<	<	<	<
BDE-47	ng/g	0.05	0.81	0.30	0.78	0.43	0.82
BDE-49/71	ng/g	0.05	<	<	<	<	<
BDE-66	ng/g	0.05	<	<	<	<	<
BDE-75	ng/g	0.05	<	<	<	<	<
BDE-77	ng/g	0.05	<	<	<	<	<
BDE-85	ng/g	0.05	<	<	<	<	<
BDE-99	ng/g	0.05	<	<	0.10	<	0.15
BDE-100	ng/g	0.05	<	<	<	<	0.12
BDE-119	ng/g	0.05	<	<	<	<	<
BDE-126	ng/g	0.05	<	<	<	<	<
BDE-138	ng/g	0.05	<	<	<	<	<
BDE-153	ng/g	0.05	<	<	<	<	<
BDE-154	ng/g	0.05	<	<	<	<	<
BDE-156	ng/g	0.05	<	<	<	<	<
BDE-166	ng/g	0.05	<	<	<	<	<
BDE-181	ng/g	0.05	<	<	<	<	<
BDE-183	ng/g	0.05	<	<	<	<	<
BDE-184	ng/g	0.05	<	<	<	<	<
BDE-190	ng/g	0.1	<	<	<	<	<
BDE191	ng/g	0.1	<	<	<	<	<
BDE-196	ng/g	0.2	<	<	<	<	<
BDE-197	ng/g	0.2	<	<	<	<	<
BDE-206	ng/g	1	<	<	<	<	<
BDE-207	ng/g	1	<	<	<	<	<
BDE-209	ng/g	5	<	<	<	<	<
total PBDE	ng/g		0.87	0.36	0.98	0.43	1.15
TBBPA	ng/g	0.1	<	<	<	<	<
HBCD	ng/g	0.2	<	<	<	<	<

Table 3 Brominated flame retardants in food (continued).

Sample code TNO			6110-05	6110-06
Description			Hard cheese	Steak
Country recieved from	unit	LOD	Greece	Greece
BDE-17	ng/g	0.1	<	<
BDE-28	ng/g	0.1	<	<
BDE-32	ng/g	0.05	<	<
BDE-35	ng/g	0.05	<	<
BDE-37	ng/g	0.05	<	<
BDE-47	ng/g	0.05	<	<
BDE-49/71	ng/g	0.05	<	<
BDE-66	ng/g	0.05	<	<
BDE-75	ng/g	0.05	<	<
BDE-77	ng/g	0.05	<	<
BDE-85	ng/g	0.05	<	<
BDE-99	ng/g	0.05	<	<
BDE-100	ng/g	0.05	<	<
BDE-119	ng/g	0.05	<	<
BDE-126	ng/g	0.05	<	<
BDE-138	ng/g	0.05	<	<
BDE-153	ng/g	0.05	<	<
BDE-154	ng/g	0.05	<	<
BDE-156	ng/g	0.05	<	<
BDE-166	ng/g	0.05	<	<
BDE-181	ng/g	0.05	<	<
BDE-183	ng/g	0.05	<	<
BDE-184	ng/g	0.05	<	<
BDE-190	ng/g	0.1	<	<
BDE191	ng/g	0.1	<	<
BDE-196	ng/g	0.2	<	<
BDE-197	ng/g	0.2	<	<
BDE-206	ng/g	1	<	<
BDE-207	ng/g	1	<	<
BDE-209	ng/g	5		
total PBDE	ng/g			
TBBPA	ng/g	0.1	<	<
HBCD	ng/g	0.2	<	<

Table 4 Perfluorinated compounds in food.

Sample code TNO			6030-09	6030-10	6030-13	6030-14	6030-17
Description			Fish fingers	Salmon	Tuna	Brown bread	Pickled herring
Country recieved from	unit	LOD	UK	UK	UK	UK	Sweden
PFOA	ng/g	0.2	<	<	<	<	<
PFNA	ng/g	0.2	<	<	<	<	<
PFDA	ng/g	0.2	<	<	<	<	<
PFUnA	ng/g	0.2	<	<	<	<	<
PFDoA	ng/g	0.2	<	<	<	<	<
PFTrA	ng/g	0.2	<	<	<	<	<
PFOS	ng/g	0.2	<	<	<	<	1.3
PFOSA	ng/g	0.2	<	<	<	<	0.2

Table 5 Phthalates and nonylphenols in food.

Sample code TNO			6030-01	6030-02	6030-03	6030-04	6030-05
Description			Butter	Cheese	Bacon	Sausages	Eggs
Country recieved from	unit	LOD	UK	UK	UK	UK	UK
DMP	ng/g	1	<	<	<	<	<
DEP	ng/g	1	5.6	<	<	<	<
DIBP	ng/g	10	<	<	<	<	<
DBP	ng/g	10	132	<	<	<	<
BBP	ng/g	1	17	21	2.0	<	<
DEHP	ng/g	20	770	910	1320	640	<
DINP	ng/g	20	<	31	<	<	<
DIDP	ng/g	20	<	<	<	<	<
NP (sum of isomers)	ng/g	2	5.1	<	5.5	<	<
OP (sum of isomers)	ng/g	2	<	<	<	<	<

Sample code TNO			6030-06	6030-07	6030-08	6030-12	6030-15
Description			Milk	Olive oil	Chicken	Orange juice	Frankfurter sausages
Country recieved from	unit	LOD	UK	UK	UK	UK	Finland
DMP	ng/g	1	<	<	4.9	<	<
DEP	ng/g	1	<	<	24	<	<
DIBP	ng/g	10	<	<	2300	<	<
DBP	ng/g	10	<	<	760	<	<
BBP	ng/g	1	<	340	11	<	<
DEHP	ng/g	20	<	24000	670	<	20
DINP	ng/g	20	<	72	390	<	<
DIDP	ng/g	20	<	<	<	<	<
NP (sum of isomers)	ng/g	2	<	<	<	<	<
OP (sum of isomers)	ng/g	2	<	<	<	<	<

Table 5 Phthalates and nonylphenols in food (continued).

Sample code TNO			6030-16	6030-18	6030-19	6030-20	6030-21
Description			Reindeer meat	Minced beef	Pork chops	Cottage cheese	Salami
Country recieved from	unit	LOD	Finland	Sweden	Poland	Poland	Italy
DMP	ng/g	1	<	<	<	<	<
DEP	ng/g	1	<	<	<	<	<
DIBP	ng/g	10	<	<	<	1500	165
DBP	ng/g	10	<	<	170	780	183
BBP	ng/g	1	<	<	13	25	12
DEHP	ng/g	20	210	290	140	890	160
DINP	ng/g	20	<	<	470	660	<
DIDP	ng/g	20	<	<	<	<	<
NP (sum of isomers)	ng/g	2	<	<	<	<	<
OP (sum of isomers)	ng/g	2	<	<	<	<	<

Sample code TNO			6030-22	6030-23	6030-24	6030-25
Description			Cheese	Ham	Cheese	Scottish cheese
Country recieved from	unit	LOD	Italy	Spain	Spain	UK
DMP	ng/g	1	<	1.1	<	<
DEP	ng/g	1	<	<	<	<
DIBP	ng/g	10	<	400	4400	<
DBP	ng/g	10	76	260	190	200
BBP	ng/g	1	32	17	50	9.9
DEHP	ng/g	20	3000	3300	210	130
DINP	ng/g	20	26	230	59	<
DIDP	ng/g	20	<	<	<	<
NP (sum of isomers)	ng/g	2	<	<	<	<
OP (sum of isomers)	ng/g	2	<	<	<	<

Table 5 Phthalates and nonylphenols in food (continued).

Sample code TNO			6110-05	6110-06
Description			Hard cheese	Steak
Country recieved from	unit	LOD	Greece	Greece
DMP	ng/g	1	<	<
DEP	ng/g	1	<	<
DIBP	ng/g	10	<	<
DBP	ng/g	10	<	<
BBP	ng/g	1	<	<
DEHP	ng/g	20	<	<
DINP	ng/g	20	<	<
DIDP	ng/g	20	<	<
NP (sum of isomers)	ng/g	2	<	<
OP (sum of isomers)	ng/g	2	<	<

Table 6 Artificial musks in food.

Sample code TNO			6030-09	6030-10	6030-13	6030-17
Description			Fish fingers	Salmon	Tuna	Pickled herring
Country recieved from	unit	LOD	UK	UK	UK	Sweden
AHTN	ng/g	0.1	<	<	0.18	0.29
HHCB	ng/g	0.1	<	<	0.27	0.56
MK	ng/g	0.1	<	<	<	<
MX	ng/g	0.1	<	<	<	<

Table 7 Organotin compounds in food.

Sample code TNO			6030-09	6030-10	6030-13	6030-17
Description			Fish fingers	Salmon	Tuna	Pickled herring
Country recieved from	unit	LOD	UK	UK	UK	Sweden
MBT	ng/g	0.2	0.5	<	9.0	<
DBT	ng/g	0.2	<	<	1.1	0.6
TBT	ng/g	0.2	<	<	0.2	0.8
MOT	ng/g	0.2	0.3	<	<	0.8
DOT	ng/g	0.2	<	<	<	1.2