

Concentrations of PCDDs, PCDFs, and PCBs in New Zealand Retail Foods and an Assessment of Dietary Exposure

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Introduction

This study is one component of the Ministry for the Environment's Organochlorines Programme which will develop national environmental standards and guidelines for organochlorine contaminants in New Zealand. The objectives of this part of the programme were to: (1) determine the levels of PCDD/Fs and PCBs in foods in the New Zealand diet; (2) estimate dietary intake of these contaminants for the New Zealand population; and (3) allow for a comparison of these estimates with similar international studies. While levels of PCDD/Fs and PCBs in foods and dietary exposure have been reported in other countries^{1,2,3,4,5}, this is the first time such a detailed investigation for these contaminants has been undertaken in New Zealand. Previous studies of PCDD/Fs in retail milk packaged in glass and plastic containers⁶ have found very low concentrations of these contaminants.

Materials and Methods

Fifty one foods were bought at retail outlets in four major cities, and one provincial centre and were made into 19 food group composites (Table 1). Those foods that would normally be cooked prior to consumption (meats, eggs, fish, potatoes) were cooked in a manner consistent with the methods commonly used by New Zealanders.

For analysis, samples were spiked with a range of ¹³C surrogate PCDD/F and PCB surrogate standards (Cambridge Isotope Laboratories), subject to solvent extraction, solvent exchanged into hexane, and partitioned with conc. H₂SO₄. A portion of the extract for PCDD/F analysis was chromatographed sequentially on columns of silica/H₂SO₄, silica, Al₂O₃, and Carbowax C (18% dispersed on Celite). A further portion of the extract for PCB analysis, was partitioned with acetonitrile, and further purified by Florisil column chromatography.

Quantitation was carried out by GCMS on a VG70S mass spectrometer operating in the SIM mode. Resolution for PCD/Fs was 10,000. Extracts were chromatographed on Ultra 2 (PCDD/Fs and PCBs) and SP2331 (PCDD/Fs) capillary columns. All 2,3,7,8-PCDD/F congeners were measured isomer specifically, along with homologue totals. The following PCB congeners were determined: PCB#28, 31, 52, 77, 101, 99, 123, 118, 114, 105, 126, 153, 138, 167, 156, 157, 169, 187, 183, 180, 170, 189, 202, 194, 206.

The analytical limits of detection (LOD) for non-quantified PCDD/F congeners, excluding OCDD, were typically: 0.02 - 0.1 ng kg⁻¹ for meats; 0.0007 - 0.01 ng kg⁻¹ for milk; 0.02 - 0.4 ng kg⁻¹ for butter; 0.01 - 0.2 ng kg⁻¹ for vegetable fats/oils. The analytical LOD for non-quantified PCBs were in the range 0.01 - 0.4 ng kg⁻¹ for non *ortho* congeners and 0.1 - 2 ng kg⁻¹ for other congeners.

To assess likely dietary exposures to PCDD/Fs and PCBs, two diets were chosen: an adult male (25-44 years old) consuming 10.8 MJ/day (median intake), providing an estimate of average exposure, and an adolescent male (15-18) consuming 21.5 MJ/day (90th centile) providing an estimate of high-end exposure.

Results and Discussion

A full report⁷ on this study, including the sampling and analytical methods used, and all contaminant concentration data, is available from the Ministry for the Environment.

With many congeners being at or below the limits of detection, exclusion of non-quantified congeners from the TEQ calculation gave markedly lower total TEQs. Concentrations of PCDD/Fs and PCBs in the food composites are shown in Table 1. TEQs were calculated using I-TEFs for PCDD/Fs and WHO-TEFs for PCBs.

TEQ exposure estimates for the two diets were made both including half LOD values (Table 1) and excluding LOD values. PCDD/F exposures estimated for the adult male (80 kg) were 0.18 pg I-TEQ/kg bw/day including half LOD values and 0.047 pg I-TEQ/kg bw/day excluding LOD values. For PCBs, exposures were estimated for both the sum of PCBs and for TEQ. For the sum of PCBs, exposures were 1.6 ng/kg bw/day including half LOD and 1.5 ng/kg bw/day excluding LOD. For PCB TEQs, exposures were 0.15 pg TEQ/kg bw/day, including half LOD and 0.098 pg TEQ/kg bw/day excluding LOD.

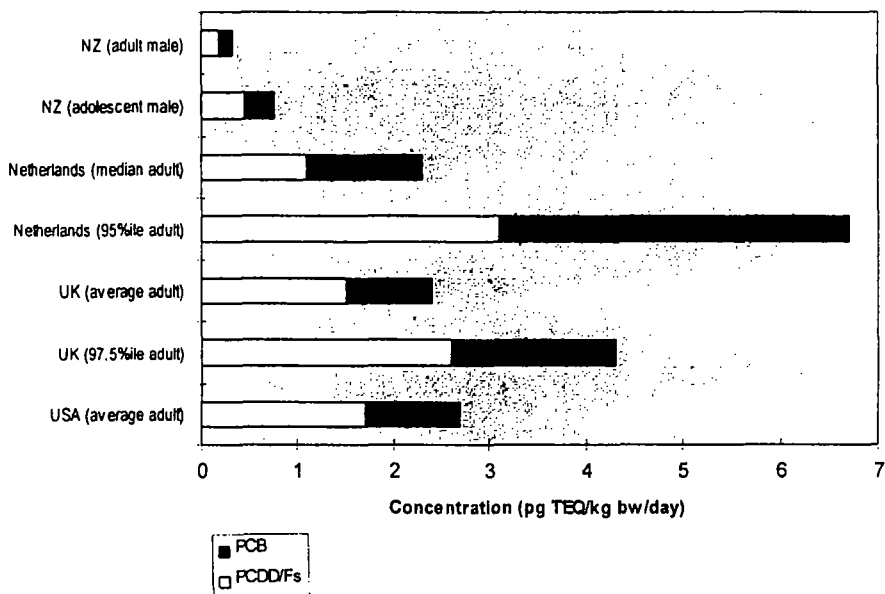
PCDD/F exposures estimated for the adolescent male (70 kg) were 0.44 pg I-TEQ/kg bw/day including half LOD and 0.14 pg I-TEQ/kg bw/day excluding LOD. For the sum of PCBs, exposures were 3.3 ng/kg bw/day including half LOD, and 3.2 ng/kg bw/day excluding LOD. For PCB TEQs exposures were 0.32 pg TEQ/kg bw/day including half LOD and 0.20 pg TEQ/kg bw/day excluding LOD.

While different dietary habits make direct comparison with results from studies in other countries difficult, the daily intake of PCDDs, PCDFs and PCBs by New Zealand males is consistently lower than that of other countries where comparable studies have been undertaken (Figure 1). In the United Kingdom the intake of PCDD/Fs has been reported³ as 1.5 pg I-TEQ/kg bw/day for a 60 kg adult, and for PCBs 0.9 pg TEQ/kg bw/day. These calculations were made using the full limit of quantification rather than half LOD values for non-detected congeners which gives a higher estimate than using half LOD values. In the USA, PCDD/F exposures of 0.3-3.0 pg I-TEQ/kg bw/day have been reported² for the average adult with variability in intake dependent on the type and amount of foods consumed (particularly meats), and PCB exposures estimated² to be 0.64 - 1 pg/kg bw/day.

The levels of PCDD/Fs and PCBs measured in New Zealand foods are consistent with the almost total absence of PCDD/Fs in New Zealand agricultural soils⁴. The low levels of dietary exposure

estimated in this study are a likely reflection of the low level of industrialisation and low population density in New Zealand relative to Europe and North America.

Figure 1 Comparison of estimated daily intake of PCDD/Fs and PCBs for New Zealanders with the USA^{2,5}, UK³, and Netherlands⁴.



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Table 1: Estimated daily intake of PCDDs, PCDFs and PCBs as TEQs (whole weight basis) for an adult male consuming 10.8 MJ day⁻¹ and an adolescent male consuming 21.5 MJ day⁻¹

Food composite	PCDD/F levels in composites (ng kg ⁻¹)		PCDD/F intake (pg day ⁻¹) Incl. half LOD		PCB levels in composites (ng kg ⁻¹)		PCB intake (pg day ⁻¹) Incl. half LOD	
	Excl LOD	Incl half LOD	Adult	Adolescent	Excl LOD	Incl half LOD	Adult	Adolescent
Beef ¹	0	0.0082	0.90	1.79	0.00026	0.0068	0.745	1.48
Sheep meat ¹	0	0.0076	0.21	0.21	0.0010	0.0048	0.13	0.13
Pork ¹	0	0.017	0.45	0.30	0.013	0.035	0.92	0.61
Beef fat ^{1,2}	0	0.090	1.31	1.31	0.065	0.068	0.99	0.99
Sheep fat ^{1,2}	0	0.032	0.14	0.14	0.0063	0.018	0.077	0.077
Pork fat ^{1,2}	0.0023	0.023	0.15	0.15	0.037	0.037	0.24	0.24
Liver ¹	0	0.050	0.66	1.31	0.0032	0.034	0.45	0.89
Processed meats ¹	0	0.014	1.13	2.00	0.0026	0.014	1.13	2.00
Milk	0.00025	0.0021	0.58	1.94	0.00035	0.0020	0.56	1.85
Butter	0	0.075	0.79	1.62	0.12	0.12	1.26	2.59
Cheese	0	0.020	0.38	0.75	0.036	0.037	0.70	1.39
Yoghurt/ice cream	0	0.014	0.55	1.09	0.0021	0.0059	0.23	0.46
NZ fish fillets ¹ and deep-fried "takeaway" fish ³	0.022	0.027	0.87	1.74	0.051	0.051	1.65	3.29
Imported tinned fish ⁴	0.11	0.12	0.63	1.26	0.16	0.16	0.84	1.67
Shellfish	0.016	0.021	0.21	0.42	0.028	0.028	0.28	0.55
Poultry ¹	0.00093	0.0072	0.33	0.44	0.00044	0.0036	0.16	0.22
Eggs ¹	0.0017	0.012	0.41	0.40	0.0049	0.010	0.34	0.34
Bread	0.0012	0.0059	0.89	1.78	0.00099	0.0040	0.61	1.21
Cereals	0.0027	0.0099	1.05	3.07	0.0017	0.0027	0.29	0.84
Vegetable fats/oils	0	0.034	0.35	6.34	0	0.013	0.13	0.99
Potatoes ¹ and hot chips	0.016	0.016	1.91	2.14	0.0012	0.0025	0.30	0.68
Snack foods	0.044	0.044	0.65	0.47	0.0025	0.014	0.21	0.18
TOTAL INTAKE			14.5	30.6			12.2	22.7

¹ Cooked without added fat; ² Separable fat trimmed from the beef, sheep meat and pork; ³ deep-fried, battered fish fillet; ⁴ packed in brine