

EXPOSURE OF PCDD/DFs VIA AIR AND FOOD IN KOREANS

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1. Introduction

Over the years, Polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) have never been manufactured intentionally, and for this reason, they pose a dominance in ubiquity throughout the environment.

Various surveys on dioxin-like substances in many countries have been undertaken by measuring concentrations of environmental samples such as foodstuff, soil, sediment, air, and water, etc. Concurrently, TDI (tolerable daily intakes) is established and just reviewed recently.

Within the general population, it is important to know that food has been a major source of PCDD/DFs. However, only a few data on these chemicals obtained from municipal waste incinerators, sediment, soil etc are available in Korea. Further more, because investigation was not performed on daily diet, TDI was established in tentative.

With the above information serving as a background, the objective of this study is to investigate the estimated exposure levels of PCDD/DFs via ambient air and food which was daily consumed on the average by the general population in Korea

2. Material and Methods

According to the results from the National Nutrition Research (a sector of the Korean Ministry of Health and Welfare, 1997); 23 different selected food samples were collected from March to October 1999 from retail and wholesale shops in Seoul. First of all, every sample was finely homogenised. Plant food samples were extracted with toluene in a Soxhlet extractor and fatty samples were digested in 1N-KOH/ethanol solution at room temperature for a period of 2hrs. After extraction, the samples were treated with concentrated sulfuric acid. Crude extract from every sample was further purified in silica gel column, basic Alumina column and finally, in activated carbon impregnated silica gel column chromatography.

Air samples were collected from residential areas referred to as 2-point and industrial areas referred to as 1-point on January 2000 in Seoul. These air samples were collected using a high volume air sampler which has a sampling rate of 700L/min, a sampling time of 24hrs (1 day), and a total sample size of 1000Nm³. Glass fiber filter and polyurethane foam (PUF) plugs were extracted with toluene in a Soxhlet extractor. After extraction, the same analytical procedure with food samples was carried out.

Quantifications using ¹³C₁₂ labelled internal standards were performed with HRGC/HRMS Autospec Ultima at 10,000 resolutions. The levels were expressed in 2,3,7,8-TCDD toxic equivalents using calculations of International Toxic Equivalent Factors (I-TEFs) for PCDD/DFs.

3. Results and Discussion

Levels in ambient air

The TEQ levels for the ambient air are 0.222-1.432pg/Nm³ as listed in Table 1 and these levels appear in order of industrial district sample, dense apartment sample (residential 1), and business district sample(residential 2). The Isomer distribution of these samples was very similar to municipal waste incinerators in Korea¹⁾, and these same samples dominated 123789-HpCDF and OCDF.

Table 1. Concentrations of PCDD/DFs in ambient air (pgTEQ/ Nm³)

District	Sample volume	PCDFs	PCDDs	Total PCDD/Fs	Total TEQ
Residential 1	900	2.254	1.187	3.441	0.222
Residential 2	1,000	11.242	4.081	15.323	0.651
Industrial 3	990	22.527	6.257	28.783	1.432
Average		12.007	3.841	15.849	0.7682

Table 2. Concentration of PCDD/DFs in foodstuffs (pg /g wet weight)

Food item	No. of pools	PCDDs	PCDFs	Total PCDD/Fs	Total TEQ
Allaskan pollack	5	0.2410	0.0920	0.3330	0.0115
Oyster	3	1.2073	0.8947	2.1020	0.2018
Little neck clam	2	1.0730	0.6780	1.7510	0.1380
Mackerel	2	0.8840	0.9790	1.8630	0.2749
Anchovy	3	4.1978	1.1953	5.3930	0.3153
Beef(imported)	3	0.5718	0.0600	0.6317	0.0137
Beef(domestic)	3	0.2056	0.0408	0.2464	0.0100
Pork(imported)	4	6.0235	0.3083	6.3318	0.0979
Pork(domestic)	2	0.1055	0.0076	0.1131	0.0010
Chicken	4	0.6795	0.3472	1.0267	0.0477
Eggs	3	0.6570	0.3760	1.0330	0.0665
Milk	3	0.0084	0.0124	0.0208	0.0031
Pulses	3	1.4862	0.1273	1.6136	0.0134
Corn(imported)	3	0.8516	0.1021	0.9537	0.0111
Rice	3	0.8850	0.0920	0.9771	0.0123
Potatoes	3	0.3768	0.0554	0.4322	0.0059
Wheat flour	3	0.6991	0.1442	0.8433	0.0187
Radish	3	0.6717	0.0871	0.7588	0.0073
Chinese cabbages	3	0.6509	0.3884	1.0393	0.0415
Scallion	4	0.1391	0.1394	0.2785	0.0215
Tangerine	3	0.4408	0.0607	0.5015	0.0059
Apples	3	0.4870	0.0441	0.5311	0.0072
Oranges	3	0.3328	0.0363	0.3691	0.0050

Levels in food item

Concentrations of PCDD/DFs in food samples ranged from 0.02(milk) to 5.39(anchovy)pg/g as given in Table 2. TEQ levels appeared in order of fish/shellfish, meat, vegetable, grains, fruits and milk and these values ranged from 0.0008 to 0.3153pgTEQ/g. Generally, the levels of imported food groups are higher than the levels of domestic groups. However, the levels of fish/shellfish groups show that coastal sea products are higher in our country than in open sea. With predominance of over 40-85% in OCDD, the isomer distribution of food samples shows a different pattern compared to ambient air sample.

Estimated exposure of PCDDs/DFs via air and food

Table 3 gives the average dietary intake, inhalation, and concentrations of PCDD/DFs. However, in our attempt to calculate the intake of PCDD/DFs, the concentration of foodstuff that wasn't analyzed in this study, applied to one of similar food samples in our results. As illustrated in Table 3; the exposure level of PCDD/DFs via dietary intake is 30.452pg/day (0.507pg/kg body weight /day for the 60kg adult).

Figure 1 shows a comparison of dietary and PCDD/DFs intakes. From this result (Figure 1-1), it can be seen that the majority of dietary intake are basically plant-food groups such as vegetables, grains, and fruit, while fish/shellfish predominates the PCDD/DFs intake.

Table 3. Estimated average exposure levels of PCDDs/DFs per day via ambient air and foodstuffs

Group			Average intake (g/day)	Level of PCDDs/DFs (pgTEQ/g)	Intake of PCDD/DFs (pgTEQ/day)	
Food	Plant foods	Grains	308.7	0.013	4.004	
		Vegetables	288.4	0.030	8.781	
		Fruits	146.0	0.006	0.942	
		Pluses	34.7	0.013	0.465	
		Potatoes	21.20	0.006	0.126	
		Oil and Fats(plant)	7.5	0.084	0.628	
		Others	41.8	0.015	0.644	
	Fatty foods	Fish, shellfish	75.1	0.160	12.003	
		Meats	67.7	0.018	1.194	
		Milk	65.6	0.003	0.203	
		Eggs	21.8	0.067	1.451	
		Oil and Fats (Ani.)	0.1	0.109	0.011	
	Subtotal			1078.6	-	30.452
	Air	ambient	Average	20.0(m ³ /day)	0.768 (pg TEQ/Nm ³)	15.364
Total estimated exposure levels of PCDDs/DFs (pg TEQ/day)					45.816	

With reference to fish/shellfish group, we remark that the portion of PCDD/DFs is 6 times higher than dietary intake (about 7%), but, compared to other food groups, the levels of PCDD/DFs intake via foodstuff are similar or lower. Also, the level of exposure via inhalation is 15.364pg/day (0.256pg/kg · bw/day for the 60kg adult).

In overall, the average dietary and inhalation exposure to PCDD/DFs determined in our study was about 45.82pg TEQ/person/day, which corresponds to 0.763pg TEQ/kg body weight/day for a 60kg adult.

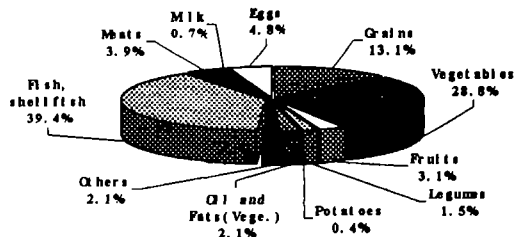
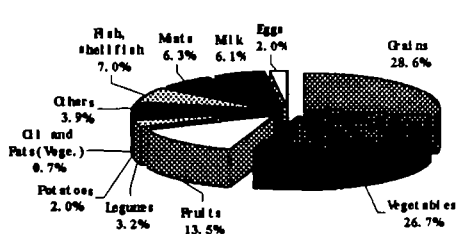


Figure 1-1. Percentage of dietary intakes via foodstuff (left)

Figure 1-2. Percentage of PCDD/DFs intake via foodstuff in pg TEQ (right)

We don't investigate on dioxin-like PCB. But according to the extensive literature search, the significance of including dioxin-like PCB as well as PCDD/DFs has been conducted in human risk assessment process and the extent of dioxin-like PCB contamination in a variety of environmental matrix. Actually in many studies, distribution of dioxin-like PCB is similar and/or larger than PCDD/DFs²⁻⁵). These suggest that, we should be planning to perform levels of dioxin-like PCB and PCDD/DFs in the future.

4. Acknowledgment

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