ASSESSMENT OF ADULT DAILY INTAKE/UPTAKE FOR DIOXINS IN KOREA

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Introduction

PCDDs/Fs (polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans) are by-products of thermal processes, incineration, and fire (Hutzinger and Fielder, 1993). Polychlorinated biphenyls (PCBs) have been used as stabilizers in paints, polymers, and adhesives, and as lubricants in various industrial processes (Rogan et al., 1986a, 1987; Dewailly et al., 1996).

Humans are exposed to halogenated compounds such as PCDDs/Fs and coplanar PCBs compounds, through environmental/background, occupational or accidental exposure (US EPA, 2000). More than 90% of human exposure to PCDDs/Fs and coplanar PCBs compounds comes from food, mainly animal fats. In 1998, the WHO experts lowered the TDI (tolerable daily intake) to 1-4 pg TEQ/kg-day (WHO, 1998).

The purpose of this paper was to assess the daily intake/uptake of dioxins among the general adult population in Korea. The general population consists of people who are exposed to background levels of dioxins in the soil and air. Most of their exposure originates from the commercial food supply and they do not have significant occupational and personal exposure (eg. Smoking). In order to estimate the current daily intake/uptake of PCDDs/Fs and coplanar PCBs compounds, data concerning PCDDs/Fs and coplanar PCBs compounds in the air, soil and foods was collected using the scientific literature in Korea.

Methods and materials

Seventeen individual PCDDs/Fs, which have chlorine substitutions, at a minimum, in the 2,3,7, and 8 position and 3 co-planar mono-ortho PCBs, which have 4 or more lateral chlorines with 1 or zero substitutions in the ortho position, were selected. The TEQs (toxic equivalent) has been given using the TEF_{WHO98} (toxic equivalency factor for WHO 1998).

For the levels of PCDDs/Fs in environmental media and foods in Korea, citable scientific literature is summarized in Table 1. In order to obtain the PCDDs/Fs and PCBs concentrations in the ambient air and ground soil, contaminant data in the resident area and beside the roads in an urban area of Korea were selected. Contaminant data in the local foods were selected to obtain the PCDDs/Fs and PCBs concentration in food.

The daily intake/uptake though the exposure pathway of inhalation to indoor air, ingestion to ground soil and foods, and dermal contact to ground soil in urban area was estimated. The general equation is as follows:

$$\text{Daily Intake} = (CR_{rmedia} * C_{media} * CF) / BW$$

Where

Daily Intake(pg-TEQ/kg-day) = daily intake/uptake of PCDDs/Fs and PCBs

CR_{media}(m^3/day, g/day) = contact rate of media such as daily inhalation rate, daily consumption rate, and dermal contact rate

C_{media}(pg-TEQ/g, pg/m^3) = concentration of PCDDs/Fs and PCBs in media

CF = unit conversion factor

BW = average body weight for adult Korean (60kg)

The food ingestion rates for adults (age of 20-59 years) were derived from the 1998 National Nutrition Survey Report in Korea (MHWK, 2000). The contact rates for inhalation of the ambient air, ingestion of soil and dermal contact of soil were derived from the Exposure Factors Handbook (US EPA, 1997). In order to calculate the daily intake/uptake for adults in Korea, the body weight was

Table 1. Scientific literatures cited for calculating the levels of PCDDs/Fs and co-planar PCBs in the environmental media and foods in Korea

Environmental media	Sampling area	Sampling period	Reference
Ambient air	Urban and suburban	1999, 2000	NIER[1)] (2000, 2001)
Soil	Urban and suburban	1999, 2000	NIER (2000, 2001)
Foods	Coastal sites in southern	1995 – 1997	Hashimoto, *et al.* (1998)
	13 kinds of food that the product in a country	1999	KFDA [2)] (1999)
	21 kinds of food that the product in a country	1999	Kim, *et al.*, (2000)

1) NIER : National Institute of Environmental Research, Korea 2) KFDA : Korea Food & Drug Administration

assumed to be 60kg, which is the average body weight of an adult in Korea (MHWK, 2000).

Results and discussion

The average concentration of PCDDs/Fs in ambient air was 0.23 pg-TEQ/m^3 (ND–2.11 pg-TEQ/m^3) based on 104 samples (22 sites in the 14 cities) between Oct. 1999 and Jan. 2001. The average concentration of PCDDs/Fs in the ground soil was 1.73 pg-TEQ/g (ND–65.63 pg-TEQ/g) based on 69 samples (5 sites in the 4 cities) obtained between Oct. 1999 and Oct. 2000. The data for the PCDDs/Fs and PCBs in 11 food groups including 94 food samples were collected randomly from markets in several cities in Korea. The PCDDs/Fs concentrations accord the food groups were 0.015 pg-TEQ/g, 0.014 pg-TEQ/g, 0.015 pg-TEQ/g, 0.006 pg-TEQ/g, 0.153 pg-TEQ/g, 0.123 pg-TEQ/g, 0.011 pg-TEQ/g, 0.015 pg-TEQ/g, 0.005 pg-TEQ/g, 0.027 pg-TEQ/g, and 0.044 pg-TEQ/g for cereals, beans, vegetables, fruit, fish, shellfish, diary products, beef, pork, chicken, and eggs, respectively. The PCBs concentrations accounting to the food groups were 0.002 pg-TEQ/g, 0.165 pg-TEQ/g, 0.002 pg-TEQ/g, 0.008 pg-TEQ/g, 0.003 pg-TEQ/g, 0.001 pg-TEQ/g, and 0.011 pg-TEQ/g for beans, shellfish, diary products, beef, pork, chicken, and eggs, respectively. PCBs were not detected in the other foods.

Based on the concentrations of PCDDs/Fs and PCBs in the environmental media and foods, the adult daily intake/uptake was estimated to be 0.495 pg-TEQ/kg-day (Table 2). For all the media combined, the adult daily intake/uptake of PCDDs/Fs and PCBs in this study was much lower than that in the both Japan (2.62 pg-TEQ/kg-day) and America (0.93 pg-TEQ/kg-day).

Table 2. Adult daily intake/uptake of PCDDs/Fs and co-planar PCBs based on their concentration in the environmental media and foods in Korea

Exposure media	Intake/uptake rate	Concentration PCDDs/Fs	PCBs	Daily Intake/uptake (pg-TEQ/kg-day)
Food[1)]	(g/day)	(pg-TEQ/g)	(pg-TEQ/g)	
Cereals	350.9[3)]	0.015	0.000	0.088
Beans	28.9[3)]	0.014	0.002	0.008
Vegetables	306.2[3)]	0.015	0.000	0.076
Fruit	179.1[3)]	0.006	0.000	0.019
Fish	52.3[3)]	0.153	0.000	0.133
Shellfish	14.0[3)]	0.123	0.165	0.067
Diary products	51.9[3)]	0.011	0.002	0.012
Beef	11.0[3)]	0.015	0.008	0.004
Pork	28.8[3)]	0.005	0.003	0.004
Chicken	27.3[3)]	0.027	0.001	0.013
Eggs	20.5[3)]	0.044	0.011	0.019
Ambient air[2)]	(m^3/day)	(pg-TEQ/m^3)	(pg-TEQ/m^3)	
Inhalation	13.3[4)]	0.233	NA[5)]	0.052
Soil[2)]	(g/day)	(pg-TEQ/g)	(pg-TEQ/g)	
Ingestion	0.050[4)]	0.324	NA[5)]	0.000
Dermal uptake	0.012[4)]	0.324	NA[5)]	0.000
Total				0.495

1) Based on data from Hashimoto et al. (1998), KFDA (1999), and Kim, et al. (2000)
2) Based on data from NIER (2000, 2001)
3) Adults (20~59 years) daily intake in the foods of Korea (MHWK, 2000)
4) Daily respiratory rate, ingestion rate of soil and adherence factor of US EPA (US EPA, 2000)
5) NA : not available, There is no information of PCBs in the ambient air and soil so it cannot be assessed.

The highest exposure was estimated to occur via the ingestion of PCDDs/Fs and PCBs in fish and shellfish (0.200 pg-TEQ/kg-day), which accounted for approximately 40 % of the total adult daily intake/uptake. Cereals and vegetables was 0.164 pg-TEQ/ kg-day and accounted for approximately 33 % of the total intake. Food accounted for nearly 90 % of the total adult daily intake/uptake for PCDDs/Fs and PCBs (Fig. 1). Exposure via the inhalation of contaminated ambient air was 0.052 pg-TEQ/kg-day and account for approximately 10 % of the total adults daily intake/uptake in Korea. Exposure via soil ingestion and dermal contact with soil appeared to be very low.

In this study, the Korean adult daily intake/uptake of PCDDs/Fs and PCBs was lower than the TDI established by the WHO for the general population. However, this result still leave some uncertainty and limitations in that the exposure data surveyed in Korea insufficient for estimating the total intake of dioxins. Therefore, a more detailed survey aimed at determining the intake/uptake of PCDDs/Fs and dioxin-like PCBs from various environmental media and foods should be carried out.

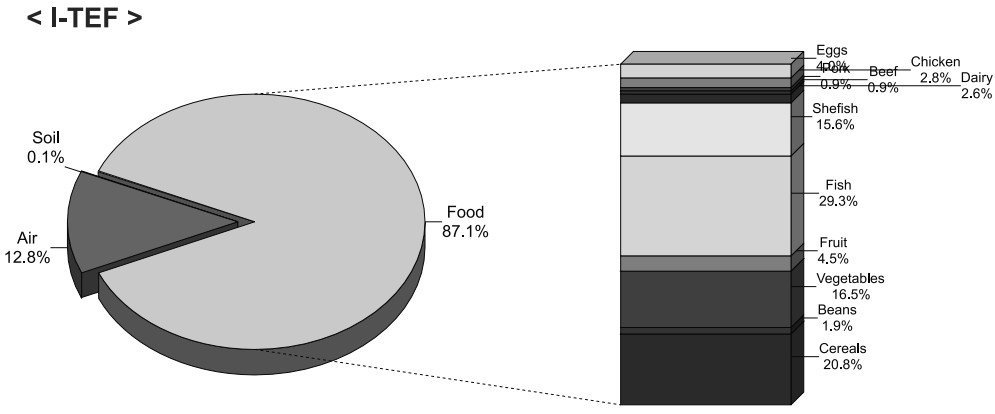

Figure 1. Percentage contribution of the various media to the total daily intake/uptake of PCDDs/Fs and PCBs in Korea

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