DIETARY PBDE INTAKE: A MARKET-BASKET STUDY IN KOREA

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Abstract

Based on National Health and Nutrition Examination Survey, 12 food groups (cereal products, potato products, sweeteners/seasonings, vegetables, fruits, beverages/alcohol, fats/oils, bean products, meat, egg, fish, and dairy products; comprising 41 food items) were selected for PBDEs analyses. A food market-basket, representative for the general Korean population, containing various meat, fish and dairy food products, was assembled and analyzed for its polybrominated diphenyl ether (PBDE) content. Based on the measured PBDE levels, an average daily dietary intake estimate of PBDEs was calculated.

Fish and shellfish had the highest average PBDEs levels (208 pg/g ww), followed by meat & products (95 pg/g ww), egg (41 pg/g ww), and oil and fat (30 pg/g ww). PBDE intake calculations were based on the average daily food consumption in Korea and were estimated. In the sum of PBDEs the major contributors to daily intake were fish and shellfish (40%), meat & products (26%), cereal products (10%), vegetables (9%) and dairy products (6%). The fish homogenate contained the comparatively highest levels, on a fresh weight basis. Intake calculations based on the twelve food groups showed that the estimated PBDE intake was 35 ng/day. In this study, we could find that PBDEs level in Korea is lower than other countries.

Introduction

Food is major exposure source of dioxin and PCBs[1]. Given the lipophilicity of PBDEs and their presence in consumer products and house dust, suspected routes of human exposure include both diet and the indoor environment[2]. Unlike other POPs, however, the key routes of human exposure are not thought to be food and fish, but rather are from their use in household consumer products[3,4]. The importance of the different routes of human exposure to PBDEs (diet and inhalation/ingestion) is not completely understood.

A number of studies have shown the presence of PBDEs in food samples and estimated that fish and animal products provide the largest amount of dietary exposure in Korea[4]. In this study, the Korean Food and Drug Administration composed an average Korean market basket diet. The compositions and consumption of the market baskets were based on the National Health and Nutrition Examination Survey[6]. The intake assessment of PBDEs was conducted for the first time in Korea, with our main interest focused on the origin and level of exposure to PBDEs.

Materials and Methods

The food and food group consumption data used in the composition of the market baskets and in the intake calculations consist of the average consumption figures taken from the 2005 National Health and Nutrition Examination Survey.[6] Selected products were purchased at supermarkets and local markets. Fish and meat products were also purchased at a local fish store and a local butcher's. The samples were homogenized immediately after collection and stored at −20 °C until further treatment. In case of food items where wastage could be supposed, inedible parts such as bone, skin, etc. were removed prior to homogenization.

Table 1. Description of food items (and their matching food groups) sampled in Korean market baskets (n = 9), purchased in three different cities in Korea.

No.	*Food group*	*Main items (%)*	*Daily Intake g/day (%)*
1	Cereal products	Rice(70.4), noodle(8.8), ramen noodles(5.6), bread(4.4)	321.1(24.9)
2	Potatoes and products	Potato(75)	15.2 (1.2)
3	Sweeteners/ seasonings	Sugar (65), soybean paste(23.5), say sauce (20.3)	4.9 (0.4)/ 37.5 (2.9)
4	Pulses and bean products	Bean curd (63.4)	24.9 (1.9)
5	Vegetables	Chinese cabbage (39.9), radish (9.6), onion (6.3), bean sprouts (5.0), tomato (5.0), leek (3.9), spinach (3.4)	327.0 (25.3)
6	Fruit	Orange (30.7), apple (16.0), strawberry (12.0)	87.4 (6.8)
7	Beverages & Alcohol	Beer (29.0), beverages (22.8), Soju (19.8), coffee (7.2),	145.7 (11.3)
8	Oil & fats	Beans oil (48.4), butter (1.1)	9.5 (0.7)
9	Meat & products	Pork (40.1), Beef (17.7), chicken(17.2), imported beef(16.9), processed meat products (5.5)	95.1 (7.4)
10	Egg	Egg (98.1)	25.8 (2.0)
11	Fish and shellfish	Boiled fish paste(13.1), mackerel(11.1), croaker(7.1), Alaska pollack (6.8), clam (6.4), anchovy (5.8), flatfish (3.1)	67.7 (5.2)
12	Dairy products	Milk (74.1), ice cream (10.1)	89.7 (6.9)

A 20-g aliquot of sample was homogenized, and a 10-g aliquot was spiked with the ^{13}C-labeled compounds. The sample was mixed with anhydrous sodium sulfate, dried for a minimum of 30 minutes, and extracted for 18-24 hours using methylene chloride in a Soxhlet extractor. The extract was evaporated to dryness, and the lipid content was determined. After extraction, a labeled cleanup standard was spiked into the extract and the extract was concentrated. Tissue extracts are first cleaned up using an anthropogenic isolation column, and all extracts are cleaned up using back-extraction with sulfuric acid, and gel permeation, silica gel, as required. PBDE values are based on analyses of the eight PBDE congeners BDE 28, 47, 99, 100, 153, 154, 183 and 209 in 41 food samples by gas chromatography-isotope dilution high resolution mass spectrometry.

Results and Discussion

The concentrations, as pg/g fresh weight (fw), of PBDEs in 12 market baskets and in the total diet basket are presented in Table 2. We could not observe any differences in PBDE concentrations between the foods from the different supermarkets and cities, therefore averages were calculated using all analyses regardless of the origin. However, we have found a wide variation in sum of PBDE congeners concentrations across the food groups sampled.

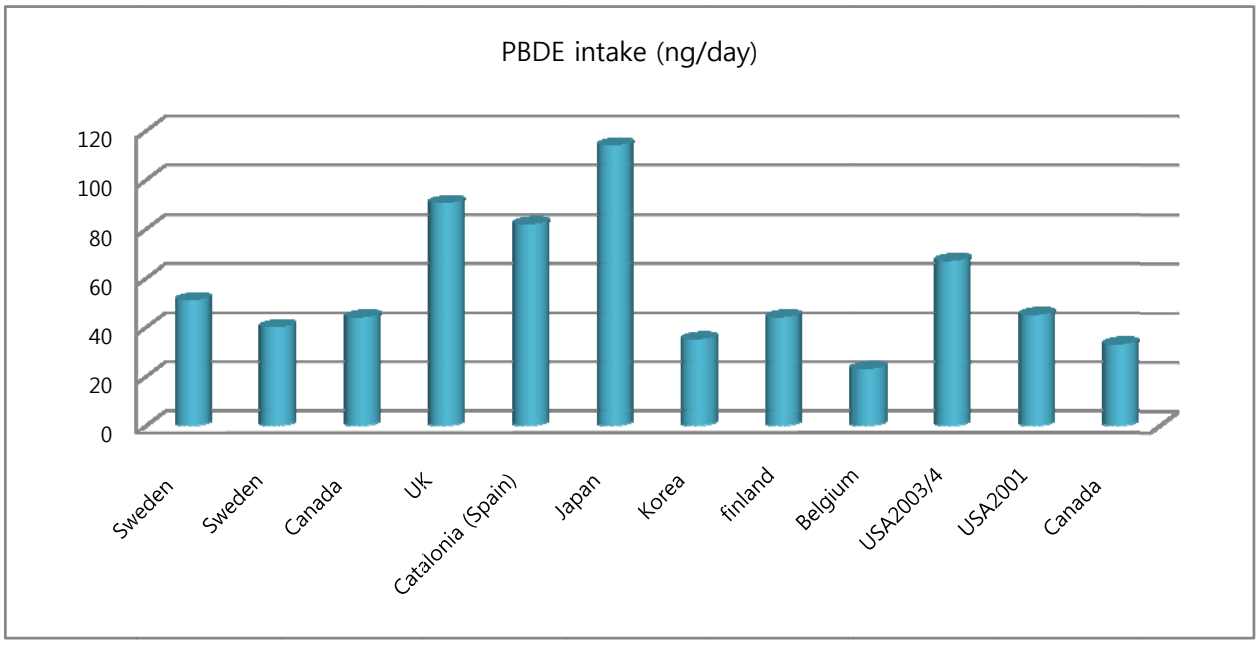
Table 2 Concentrations of PBDEs of 12 market baskets and total diet basket as pg/g fresh weight

No.	*Food group*	*PBDEs level pg/g fresh weight*	*Estimated dietary PBDE intake ng/day (%)*
1	Cereal products	10.31	3.31(9.5)
2	Potatoes and products	3.03	0.06 (0.2)
3	Sweeteners/ seasonings	4.90/12.62	0.04 (0.1)/ 0.47 (1.4)
4	Pulses and bean products	18.98	0.75 (2.1)
5	Vegetables	9.28	3.03 (8.7)
6	Fruit	4.50	0.39 (1.1)
7	Beverages & Alcohol	1.08	0.16 (0.5)
8	Oil & fats	30.86	0.29 (0.8)
9	Meat & products	95.53	9.09 (26.0)
10	Egg	41.30	1.07 (3.0)
11	Fish and shellfish	208.32	14.10 (40.3)
12	Dairy products	24.91	2.23 (6.4)

Fish and shellfish had the highest average PBDEs levels (208 pg/g ww), followed by meat & products (95 pg/g ww), egg (41 pg/g ww), and oil and fat (30 pg/g ww).

The intake calculations were based on a theoretical estimate of the average daily food consumption. The sum of PBDEs intake was 35 pg/day in the total diet basket. In the sum of PBDEs the major contributors to daily intake were fish and shellfish (40%), meat & products (26%), cereal products (10%), vegetables (9%) and dairy products (6%). The intake of PBDEs in Korea was comparable to intakes in Canada and Belgium.

Fig.1 Comparison of PBDEs intake ng/day



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