Levels of Dioxin-like Compounds in Imported Foodstuffs in Korea (Ⅱ)

Kyung-Jin Lee[1], Kab-Ryong Chae[1], Sang-Yub Kim[2], Woo-Seoung Kim[1], Dong-Gil Leem[1], O-Sung Kwon[1], Dea-Byung Kim[1], Jin-Soo Kim[1]

[1] Test and analysis Laboratory Busan Regional Food and Drug Administration
[2] Food and Drug Administration, Seoul

Introduction

Dioxin-like compounds which include Polychlorinated Dibenzo-*p*-Dioxins(PCDDs), Polychlorinated Dibenzo Furans(PCDFs) and Polychlorinated Biphenyls(PCBs) are detected routinely, as they are widely distributed in the environment and accumulation in the food chain.[1] Moreover, Food is the major route of human intake of toxic dioxin-like compounds. Also the inhalation route contributes only a negligible extent[2]. This is because these chemicals have strong tendencies to bioaccumulate in lipid-rich compartments of organisms because of their highly lipophilic property[3]. The contamination levels of dioxin-like compounds depend on species. Species with a higher fat content may have higher contamination levels so that detectable levels are found in fatty food such as meat, dairy products and fishes. Therefore, it is very important to measure the levels of dioxin-like compounds in food (especially fatty food) and to do a risk assessment. The aim of this study was to measure the levels in dioxin-like compounds of imported foodstuffs in Korea and then to assess the health risks potentially associated with the dietary intake of dioxin-like compounds.

Materials and Methods

Sampling list: Imported and domestic samples were randomly collected in local markets, large supermarkets, and department store in Busan, Korea. The samples included rice, meat (beef, pork, chicken), fish (hair tail, mackerel, crab, shrimp), green tea, salt and milk products (cheese) (Table 1).

Analysis: The preparation of sample was carried out as described below. All food samples were homogenized by mixer. Samples were kept at -20°C until they were analyzed. After the aliquots of each sample were taken and transferred to a pre-extracted cellulose thimble(43x123mm). It was mixed with 40g of anhydrous sodium sulfate. The samples were then fortified with the ^{13}C-labeled standards and extracted with Soxhlet extractor using a mixture of hexane/methylene chloride(1:1) for 24 hours. The extracts were cleaned up using sulfuric acid impregnated silica gel and purified on a series of silica gel, alumina and carbon column prior to analysis by HRGC/HRMS. In the case of salt, 20g of sample was dissolved in water and brought to pH 2.0. The samples were then fortified with the ^{13}C-labeled standards and extracted with methylene chloride. After extraction, The next step for the salt samples was same as the other food samples. For each run, samples were prepared including a method blank and a QC sample.

Instrumental analysis: HRGC analysis was accomplished by using HP6890 with a DB-5MS column (60m, 0.25mm id, 0.25μm film thickness). The oven temperature of dioxins was programmed as follows: 160°C for 4min then to 220°C at 5°C /min, hold for 15min then to 290°C at 5°C /min, hold for 10min then to 300°C at 5°C /min and held for 7min. In the case of co-planar PCBs, The oven temperature program was set 150°C for 1min then to 185°C at 20°C /min, hold for 3min then to 245°C at 2°C /min, hold for 3min then to 300°C at 6°C /min and held for 4min. Helium at a flow rate 1.0 ml/min was used as a carrier gas. Injector and transfer line temperature were 290°C each. HRMS analysis was performed with Micro-Mass AutoSpec-Ultima in SIR mode operating positive EI ionization at a resolving power of >10,000 at m/z 331 of PFK. The MS source was set at 35eV, the trap current was 400 μA and The ion source temperature was 260 °C [4, 5]. Under these conditions, all 17 congeners of PCDDs/PCDFs and all 12 congeners of Co-planar PCBs were separated.

Results and Discussion

The levels of contamination were determined as the TEQ values by multiplying with the corresponding WHO-TEFs for each congener.[6] The TEQ values were assumed 0.0 for non-detects and the results are shown in table 1. The levels of Dioxin-like compounds(pg WHO-TEQ/g ww) of food samples were <0.001 for rice, 0.038

for beef, 0.102 for domestic beef, 0.015 for pork, 0.049 for domestic pork , 0.011 for chicken, 0.178 for hair tail, 0.505 for mackerel, 0.615 for crab, 0.006 for shrimp, 0.130 for green tea, 0.126 for domestic green tea, <0.001 for salt and 0.131 for cheese. The highest level of dioxin-like compounds was detected in the mackerel (0.505 pgTEQ/g ww). The lowest level was detected in the rice sample (<0.001 pgTEQ/g ww) as expected, since the rice was dehusked(thus removing surface contaminants due to environmental pollution). To assess dietary exposure food consumption data was obtained from the report '2001 National Health and Nutrition Survey-Dietary Intake Survey' performed by Ministry of Health and Welfare, Korea in 2002. Total food consumption is 1312.5g/day for average Korean and the rate of animal food consumption (261.1g) is 19.9% and the rate of plant food consumption (1051.4g) is 80.1%. The level of average food consumption for the foods included in the target sample is 25.0% for total food. The sum of daily exposure of dioxin compounds in target food samples was estimated as 6.74pgTEQ/day. The average Korean (body weight=55kg) intakes were calculated to be 0.123 pgTEQ/kg body weight/day, 3.1% of the WHO TDI (4 pgTEQ/kg bw/day). In conclusion, the levels of dioxin-like compounds currently detected in imported foodstuffs in Korea are at a safe level provided there is not a high consumption of oily fish such as mackerel.

Table1. Results and estimated daily exposure to dioxin like compounds(PCDD/Fs and co-planar PCBs)

Source of exposure	Contaminated level(pgTEQ/g)		Food intake (g/day)	Estimated daily Exposure (pgTEQ/day)	Lipid content(%)
	Range	Average			
Rice	<0.001	-	215.9	-	0.1
Beef	0.001~0.142	0.038	20.4	1.428*	15.3
Beef(Domestic)	0.051~0.150	0.102	-	-	16.3
Pork	<0.001~0.285	0.015	22.1	0.707*	26.1
Pork(Domestic)	0.004~0.309	0.049	-	-	33.4
Chicken	0.003~0.022	0.011	13.2	0.145	17.2
Hair tail	0.059~0.240	0.178	2.5	0.445	1.4
Mackerel	0.145~0.894	0.505	5.6	2.828	1.8
Crab	0.489~0.783	0.615	1.8	1.107	1.5
Shrimp	0.003~0.009	0.006	1.5	0.009	0.7
Green tea	0.026~0.285	0.130	0.0	-	0.5
Green tea (Domestic)	0.002~0.330	0.126	0.0	-	0.5
Salt	<0.001	-	2.5	-	-
Cheese	0.028~0.226	0.131	0.5	0.066	15.9
Sum			286	6.735	

*: average of Imported and Domestic

Acknowledgments
We thank to the staffs of the Food Contaminants Division, KFDA.

References

1. Dewailly. (1992) Chemosphere 25, 1245-1249.
2. Safe S. (1992) Chemosphere 25, 61-64
3. Sean, M., H., Lesa, L., A., (2003) Regul. Toxicol. Pharmacol., 37, 202.
4. Choi, D., Hu, S., Jeong, J., Won, G., Song, I., (2002) Chemosphere 46, 1423.
5. Choi, Y., Cha, S., Choi, D., (2001) Organohalogen Compd., Vol 50, 150.
6. Berg, M., V., D., Birnbaum, L., Bosveld, A., T. C., Brunstrom, B., Cook, P., Feeley, M., Giesy, J., P., Hanberg, A., Hasegawa, R., Kennedy, S., W., Kubiak, T., Larsen, J., C., Leeuwen, F.X. R., V., Liem, A.K. Nolt, C., Peterson, R., E., Poellinger, L., Safe, S., Schrenk, D., Tillitt, D., Tysklind, M., Younes, M., Waern, F. and and Zacharewski, T., (1998) Environ. Health Perspect., 106, 12. 775.