SURVEILLANCE PROGRAM ON DIOXIN-LIKE COMPOUNDS IN FATTY FOOD IN KOREA

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Introduction

Although dioxin-like compounds (PCDD/Fs and co-planar PCBs) are environmental contaminants mainly produced from municipal waste incineration[1], the main route of human intake of these are food. This is because these chemicals have strong tendencies to bioaccumulate in lipid-rich compartments of organisms because of their highly lipophilic property[2]. The contamination levels of dioxin-like compounds depends 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, eggs, 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 the risk assessment. The aim of this study was to measure the levels of dioxin-like compounds of retail food in Korea and then assess the health risks potentially associated with the dioxin-like compounds intake.

Materials and Methods

Sampling list: Samples were collected in the three regions of Seoul, Pusan and Kwangju respectively. Samples collected included rice, meat (beef, pork, chicken), fish (mackerel, hair tail, eel, spanish mackerel, pacific saury, crab, oyster), milk and milk products (milk, cheese) and eggs(Table 1).

Analysis: The sample preparation was carried out as described below. All food samples were homogenized by meat mincer three times in order to make a composite sample out of three samples collected from different region, divided into the suitable size. Samples were kept at -20 until analyzed except milk. About 20g of each sample was taken, transferred to a pre-extracted cellulose thimble(43x123) and mixed with 80g of sodium sulfate, anhydrous. The samples were then fortified with the ^{13}C-labeled standards and extracted with Soxhlet extractor using a mixture of hexane/methylene chloride(1:3) for 18 hours. After extraction, the solvent was removed and the lipid contents were determined gravimetrically. 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 milk, about 10g was taken per sample, digested with acetonitrile:water(1:1, 20) and sodium oxalate (0.2g) in a Teflon bottle (500ml) by wrist-action shaker for 30 minutes. Each sample was loaded onto the C18 cartridge (10g, 75) at 5ml/min, which was pre-activated with methanol (100) and water (100) at 20 /min by the peristaltic pump. After rinsing the C18 cartridge with water (20) and methanol (2), each sample was dried completely under the vacuum (10psi) for 1.5 hours and eluted with hexane (12 , three times) at 5 /min. The next step for the milk 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 using HP6890 with a DB-5MS column (30m, 0.25 id, 0.1 film thickness). The oven temperature program was 100 (held for 1min), increased at 15 /min to 150 and increased at 3 /min to 210 and increased at 5 /min to 290 . Helium at a flow rate 1.0 ml/min was used as a carrier gas. Injector and transfer line temperature were 280 each. The samples were splitlessly injected (1). HRMS analysis was performed with a Finnigan MAT95XL in MID mode operating positive EI ionization at a resolving power of >10,000 at *m/z* 314 of PFTBA. The ion source temperature was 250 .[3, 4] The limit of detection were about 0.01ppt for TCDD/Fs, 0.02ppt for PeCDD/Fs, HxCDD/Fs and HpCDD/Fs and 0.04ppt for OCDD/Fs at S/N >3.

Results and Discussion

The levels of contamination were determined as the TEQ values by multiplying with the corresponding WHO-TEFs for each congener.[5] And the TEQ values were assumed 0.0 for non-detects. As results, the levels of PCDD/Fs(pg WHO-TEQ/g ww) of food samples were 0.045 for beef, <0.001 for pork, 0.002 for chicken, 0.002 for egg, <0.001 for milk, 0.011 for cheese, <0.001 for rice, 0.318 for mackerel, 0.116 for hair tail, 0.050 for eel, 0.124 for spanish mackerel, <0.001 for pacific saury, 0.002 for crab and <0.001 for oyster, respectively. In addition, the levels of co-planar PCBs(pg WHO-TEQ/g ww) of food samples were 0.084 for beef, 0.004 for pork, 0.001 for chicken, 0.015 for egg, 0.006 for milk, 0.012 for cheese, <0.001 for rice, 0.641 for mackerel, 0.395 for hair tail, 1.088 for eel, 0.045 for spanish mackerel, 0.191 for pacific saury, 0.175 for crab and 0.009 for oyster, respectively.

The highest level of dioxin-like compounds was detected in the eel sample(1.159 pgTEQ/g ww), whereas the lowest level of them is found in the rice sample (0.001 pgTEQ/g ww) as expected. Table 1 presents the food samples and food consumption obtained from the report on 2001 National Health and Nutrition Survey-Dietary Intake Survey performed by Ministry of Health and Welfare, Korea in 2002. Total food consumption is 1,312.5g/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 consumption for the foods included in the target sample is 20.5% for plant food, 57.8% for animal food, and 27.9% for total food. The sum of daily exposure of dioxin-like compounds in food samples is estimated as 10.74 pgTEQ so that one average Korean (body weight=55kg) intakes 0.195 pgTEQ/kg bw/day. It is only 4.9% of TDI(4 pgTEQ/kg bw/day). In conclusion, the retail food in Korea is safe but it is necessary to intake food with balance consumption for reducing the risk considering high level of dioxin-like compound in special species such as eel, mackerel and hair tail.

Table 1. Average consumption of food.

Daily intake(g/day)				
Food groups		Food items		Fat content(%)
Cereals	310.3	Rice	215.9	0.46
Subtotal	1051.4		215.9	
Meats and meat products	91.5	Beef	20.4	20.69
		Pork	12.1	33.01
		Chicken	13.2	12.69
Eggs		Egg	20.8	27.97 (york only)
Dairy products	84.6	Milk	70.6	3.50
		Cheese	0.5	29.94
Fishes and shellfishes	63.9	Mackerel	5.6	13.00
		Hair tail	2.5	7.26
		Eel	0.2	11.06
		Spanish mackerel	1.1	7.48
		Pacific saury	0.9	19.90
		Crab	1.8	2.59
		Oyster	1.1	2.24
Subtotal	261.1		150.8	
Total intake	1312.5		366.7	

Table 2. Estimated daily exposure to dioxin-like compounds.

Route of	Contaminated level(pgTEQ/g ww)	Food intake	Estimated daily

exposure/source	Range	Average	(g/day)	exposure(pgTEQ/day)
Rice	<0.001	0.000	215.9	0.00
Beef	0.001-0.404	0.129	20.4	2.63
Pork	0.002-0.007	0.004	12.1	0.05
Chicken	0.001-0.006	0.003	13.2	0.04
Egg	0.007-0.036	0.052	20.8	0.02
Milk	<0.001-0.018	0.006	70.6	0.42
Cheese	<0.001-0.068	0.023	0.5	0.01
Mackerel	0.453-1.385	0.959	5.6	5.37
Hair tail	0.010-1.507	0.511	2.5	1.28
Eel	0.515-2.329	1.159	0.2	0.23
Spanish mackerel	0.008-0.407	0.169	1.1	0.19
Pacific saury	0.156-0.258	0.191	0.9	0.17
Crab	0.061-0.268	0.177	1.8	0.32
Oyster	0.002-0.015	0.009	1.1	0.01
Sum			366.7	10.74

Acknowledgments

We are thank to the staffs of the Endocrine Toxicology Division with this study.

References

1. Scheter, A., (1994) Dioxins and Health, first edition, Plenum Press, New York.
2. Sean, M., H., Lesa, L., A., (2003) Regul. Toxicol. Pharmacol., 37, 202.
3. Choi, D., Hu, S., Jeong, J., Won, G., Song, I., (2002) Chemosphere 46, 1423.
4, Choi, Y., Cha, S., Choi, D., (2001) Organohalogen Compd., Vol 50, 150.
5. 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.