

Accumulation of 2,3,7,8-substituted dioxins, furans and coplanar PCBs in crucian carp from major rivers and a wetland in Korea

JI YONG MOON¹, Gi Ho Jeong¹, Chang-Han Joo², Dong-Ho Moon², Sangwon Lee²

¹Pusan National University

²Environmental Management Co.

Introduction

Dioxins and polychlorinated biphenyls (PCBs) are a group of organohalogen compounds that consist of hundreds of congeners differing in physical and chemical properties. Most of the average human intake of dioxins and PCBs originated from food of animal origin.¹ The range of total PCDDs/Fs levels determined from common trout collected along the River Turina, Spain was 0.183-0.230 WHO-TEQs pg/g wet weight.² The total dioxin level in the muscle of common carp from the Ya-Er Lake in China was 1.26 pg/g I-TEQ.³

The available information on the distribution characteristics and accumulation levels of dioxins and dioxin-like compounds in freshwater fish is very limited in Korea. We have four major river systems, which are the Han, Kum, Youngsan, and Nakdong Rivers. We collected crucian carp (*Carassius auratus*) from these rivers, several small-scale rivers and a wetland. The concentrations of 2,3,7,8-substituted dioxins, furans and co-planar PCBs, *i.e.*, total dioxins, accumulated in the muscle portion of crucian carp were determined.

Materials and Methods

In this research, 17 congeners of 2,3,7,8-substituted PCDDs and PCDFs, and 12 congeners of coplanar PCBs were determined from the crucian carp collected at 16 sites along several rivers and a wetland from May to October, 2004. The sampling locations were illustrated previously.⁴ Whole fishes were filleted, skinned and stored at below -20°C before analysis. Several individuals were mixed and homogenized for a pooled sample from each sampling site. Lipid levels were determined by the Soxhlet extraction⁵ with reference to the U.S. EPA method 1613 CIL EDF-9999 or Wellington Lab. EPA-1613CVS was used for the construction of the calibration curves. CIL EDF-8999 or Wellington Lab. EPA-1613LCS was used for sample spiking prior to extraction in order to determine dioxins. CIL EDF-5999 or Wellington Lab. EPA-1613ISS was used for spiking of the cleaned-up extraction prior to analysis in order to measure the recovery rates. The recovery rates for the whole process were ranged from 50% to 120%. Relative response factor (RF) values were obtained from the peak area ratio of native standard material and corresponding ¹³C-labeled standard material with HRGC/HRMS. These RF values were applied to calculate final concentrations of each congener. Detailed analysis procedure was previously described.⁶

Results and Discussion

The detection level and frequency of PCDFs are much higher than those of PCDDs, and the detailed levels and distribution pattern are illustrated in Table 1, Fig. 1, and Fig. 2. This trend is consistent during the last 5 years.⁴ The highest concentration for the sum of PCDDs and PCDFs was 0.30 pg-TEQ/g on a wet weight (w.w.) basis at Kyungan-stream. The total PCDFs (0.70 pg-TEQ/g wet weight) level for the sum of 16 sites is around 6 times higher than that of PCDDs (0.12 pg-TEQ/g, w.w.).

The 13 congeners of PCDDs, PCDFs and co-PCBs were detected among 29 congeners examined. The total level of co-PCBs is 3.5 pg-TEQ/g wet weight, which is much higher than that of PCDDs and PCDFs. The proportion of PCDDs, PCDFs, and co-PCBs to the total dioxins (PCDDs/PCDFs/co-PCBs) is 2.7%, 16.2%, and 81.2%, respectively. Thus, it is evident that co-PCBs should be included to determine the total dioxin levels from the freshwater fish. PCB-126 (3,3',4,4',5-penta CB) showed the highest levels (Fig. 1) and followed by 2,3,4,7,8-PeCDF which is a primary combustion product and PCB-118 (2,3',4,4',5-penta CB), which accounted for 65.2%, 12.5% and 6.5% of total dioxins, respectively.

The total level was highest at Kyungan-stream and followed by Koomi and Nakdong-estuary, which accounted for 52.9% of total dioxins for the sum of 16 sites (Fig. 2). The 1,2,3,7,8-PeCDD, 2,3,4,7,8-PeCDF, and PCB 126 comprised the major congeners in dioxins, furans and co-PCBS, respectively. The absolute predominance of co-PCBs over dioxins, much higher proportion of PCDFs over PCDDs, and the individual congeners detected were consistent for the last 5 years⁴. Total levels of PCDDs, PCDFs and co-PCBs were lower than last year⁴.

Acknowledgements

This project was planned and supported by the Ministry of Environment and the National Institute of Environmental Research of Korea. We gratefully acknowledge financial support from them.

References

1. Liem, A.K.D., Furst, P., and Rappe, C. (2000) *Food Addit. Contam.* 17: 241-259.
2. Bordajandi, L.R., Gomez, G., Fernandez, M.A., Abad, E., Rivera, J., and Gonzalez, M.J. (2003) *Chemosphere* 53: 163.
3. Wu, W.Z., Zhang, Q.H., Schramm, K.W., Xu, Y., and Kettrup, A. (2000) *Ecotox. Environ. Safety* 46: 252, Environ. Research, Section B.
4. Jeong, G.H., Kim, Y.B., Joo, C.H., You, J.C., and Chang, Y.S. (2004) *Organohalogen Compounds* 66: 1796.
5. U.S. EPA Method 1613 Revision B (1996) Tetra-Through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS.
6. Jeong, G.H., Moon, D.H., Joo, C.H., and Lee, S. (2003) *Organohalogen Compounds* 64: 386.

Table 1. Site specific total dioxins and coplanar PCBs levels of crucian carp in Korea

Locations	(pg-TEQ/g wet weight)														Site total
	12378- PeCDD	2378- TCDF	12378- PeCDF	23478- PeCDF	PCB 105	PCB 114	PCB 118	PCB 123	PCB 126	PCB 156	PCB 157	PCB 169	PCB 189		
Uiam-Dam	0.013				0.001	0.003		0.076	0.002	0.001				0.083	
Han River Bokha- stream					0.002	0.001	0.008	0.098	0.006	0.001	0.002			0.118	
Kyungan- stream	0.065	0.038	0.008	0.189	0.022	0.008	0.065	0.002	0.725	0.043	0.009	0.012	0.001	0.890	
Nakdong River Koomi		0.020		0.138	0.010	0.003	0.029	0.001	0.379	0.020	0.005	0.008		0.456	
Nakdong- estuary					0.001		0.003	0.047	0.002					0.053	
Kum River Dacheong- Dam					0.030	0.010	0.091	0.002	0.287	0.043	0.009	0.003		0.476	
Booyeo		0.012			0.001		0.002	0.053	0.002					0.058	
Youngsan River Damyang- Dam					0.003	0.001	0.008	0.112	0.006	0.001	0.004			0.135	
Najoo					0.001		0.002	0.050	0.001		0.002			0.056	
Other Small Scaled Rivers Oncheon- stream		0.015		0.078	0.003	0.001	0.009	0.081	0.006	0.001				0.102	
Myungchon		0.012			0.004	0.002	0.011	0.208	0.009	0.002	0.003			0.240	
Yangyang					0.007	0.003	0.019	0.167	0.011	0.003	0.002			0.215	
Hadong					0.001		0.002	0.035	0.002					0.040	
Kangnung		0.012		0.053	0.001	0.001	0.004	0.080	0.002	0.001	0.002			0.092	
wet land Joonam	0.051	0.028		0.081	0.004	0.002	0.014	0.231	0.007	0.002	0.005			0.222	
Total	0.116	0.150	0.008	0.539	0.095	0.034	0.282	0.007	2.813	0.172	0.037	0.048	0.001	3.502	

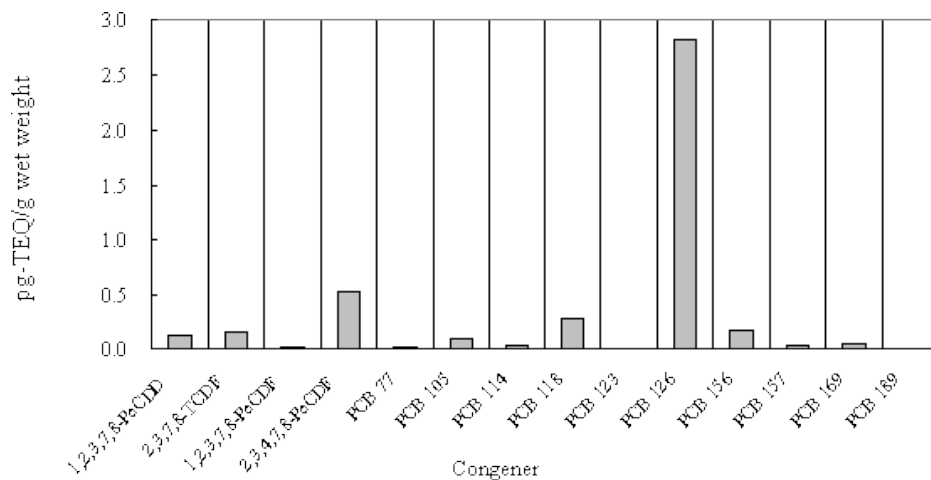


Fig. 1. Congener specific total levels of PCDDs, PCDFs, and co-PCBs in crucian carp from rivers in Korea during 2004

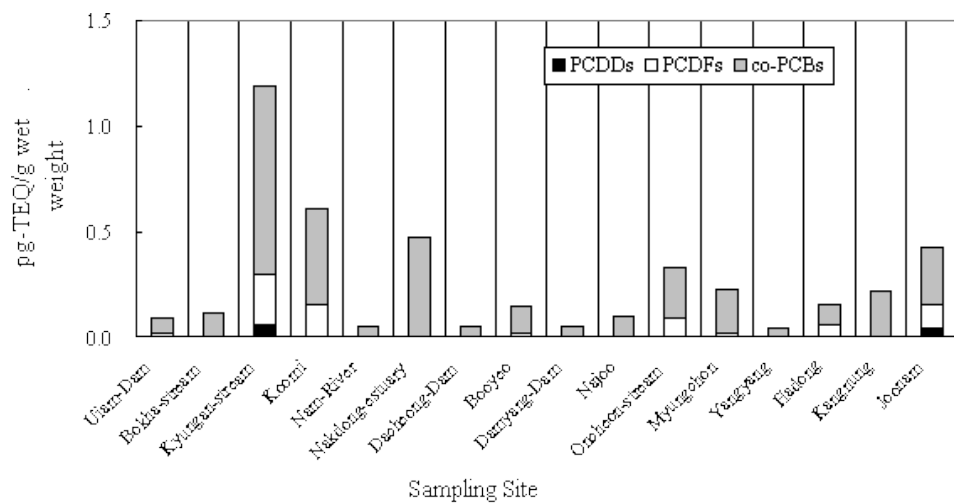


Fig. 2. Site specific total levels of PCDDs, PCDFs, and co-PCBs in crucian carp from rivers in Korea during 2004