

BIOACCUMULATION OF POLYCHLORINATED BIPHENYLS IN LEOPARD FROGS FROM MAJOR RIVER BASINS AND A WETLAND

JEONG Gi Ho¹, MOON Ji Yong², KIM Young Bok², LEE Eun-Hwa², CHOI Kyunghee³

¹Department of Chemistry, Pusan National University, Busan 609-735, S. Korea; ²Korea Environmental Analysis Center, Busan 609-735, S. Korea; ³Environmental Exposure Assessment Division, National Institute of Environmental Research, Incheon 404-708, S. Korea

Introduction

Polychlorinated biphenyls (PCBs) are persistent, globally distributed organic pollutants despite prohibition of their production and use for over 30 years. PCBs are known endocrine disrupting chemicals and have been reported in high concentrations in liver and lipid part of amphibians.¹⁻² Amphibians have been reported as good indicators of environmental pollutants³⁻⁵ due to their physical characteristics and life cycles.⁶ In this study, polychlorinated biphenyls (PCBs) in the leopard frogs from major river basins of Korea were determined. This investigation is a part of the nationwide monitoring project of endocrine disrupting chemicals in freshwater fish and amphibians in South Korea during the year 1999-2004. The aims of this monitoring project were to investigate the distribution characteristics of endocrine disrupting chemicals in several environmental media and to prepare a database for establishing a proper policy concerning these chemicals.

Materials and Methods

Leopard frogs (*Rana pipiens*) were collected from May to July 2004 from basins along the four major rivers, several small scale rivers and a well-known wetland. Only the muscular tissue was separated and stored at below -20°C before analysis. The 17 sampling locations are selected for leopard frogs among 31 locations used in another study⁷ that also reports the analytical procedures employed in the current work.

Results and Discussion

The recovery rates determined from the certified reference material CARP-2 (Wellington Lab., Canada) ranged from 77.7% to 106.8% with standard deviations ranged from 0.6% to 9.0%, except for relatively low recovery rate of dichlorinated PCBs (51.2%). The detection limit was determined as 0.04 ng/g wet wt. for most homolog, 0.03 for hexa-CBs and 0.05 for octa- and nona-CBs. Table 1 shows site specific total PCB concentrations and homolog levels in leopard frogs. Total PCB concentrations ranged from below the detection limit to 2.28 ng/g wet wt. with an average concentration of 0.46 ± 0.68 ng/g wet wt. calculated by estimating using a value of half the detection limit for non-detected concentration. Even the highest concentration was much lower than those

determined in frogs from highly polluted sites in USA (2,330-3,880 ng/g wet wt. in liver), Sweden (92.9 ng/g wet wt.) and the Netherlands (800 ng/g lipid wt).¹⁻² The frequency of detection and the number of homolog detected were both much lower than those of the previous results.⁸ Total PCB concentrations were increased at 7 locations and decreased at 9 sites compared to the previous results⁸ but systematic changes in concentrations were not found. Only tri- to hepta-CBs were found and hexa- and penta-CBs were present in the highest concentrations, making up 40% and 30% of the total PCB concentration, respectively.

Table 1. Total PCB concentrations and homolog levels in leopard frogs (ng/g wet weight)

Site*	tri-CBs	tetra-CBs	penta-CBs	hexa-CBs	hepta-CBs	Total PCBs
3 Bokha-S	-	0.54	0.36	0.76	-	1.66
4 Kyungan-S	-	-	-	-	-	-
7 Koomee	-	-	-	0.09	-	0.09
8 Koryoung	-	-	-	-	-	-
10 Nam-R	-	-	-	0.13	-	0.13
12 Moolgum	-	-	-	-	-	-
13 Nakdong-E	-	0.27	0.51	0.42	-	1.20
14 Dachung-D	-	-	-	-	-	-
17 Booyeo	-	-	0.28	0.41	-	0.69
18 Damyang-D	-	0.26	0.31	-	-	0.57
20 Najoo	-	-	0.07	-	-	0.07
21 Mooan	-	-	-	-	-	-
22 Kosan	-	-	-	-	-	-
23 Oncheon-S	0.46	0.22	0.30	0.71	0.59	2.28
24 Myungchon	-	0.14	0.33	0.56	-	1.03
26 Hadong	-	0.23	0.55	0.47	-	1.25
31 Joonam-WL	-	-	-	-	-	-
Total	0.46	1.66	2.64	3.55	0.59	8.90

*: site no. used in the ref 8, - : none detected. D: dam, R: river, S: stream, E: estuary, WL: wet land

Table 2 shows congener specific concentrations of PCBs. Only 18 of the 62 congeners determined had concentrations that were above the detection limit. PCB-153, 110, 138, 101, and 52 were the five major congeners detected (Fig. 1) and comprised 63% of the total PCB concentration. The other 44 congeners which were never detected above the detection limit in this study were as follows: PCB-1, 3, 4, 8, 10, 15, 19, 22, 33, 37, 54, 74, 77, 81, 95, 104, 114, 118, 119, 123, 126, 128, 151, 155, 156, 157, 167, 168, 169, 171, 177, 183, 187, 188,

189, 191, 194, 199, 201, 202, 205, 206, 208, and 209. Freshwater fish collected from the same sampling locations were similar to leopard frogs in that they also contained a predominance of penta- and hexa-CBs and accumulated the same major congeners.⁹ No congeners were found at 7 sites and only one or two congeners were found at 3 sites with extremely low concentrations. The number of congeners found in this study is much lower than those of the previous results⁸ obtained from the same locations.

Results of the present study demonstrated very low levels of bioaccumulation of PCBs by leopard frogs in river basins, which indicates that the contamination status of the ecosystem surveyed is not significant. The frequency of detection and the number of both homolog and congeners detected decreased compared to the same amphibians collected 4-5 years before this study, which also shows the descending trend of the PCB concentrations in a habitat of amphibians in Korea.

Table 2. PCB congener concentrations in leopard frogs from the detected sites (ng/g wet weight)

Congener no.	Site 3	Site 7	Site 10	Site 13	Site 17	Site 18	Site 20	Site 23	Site 24	Site 26	Total
18	-	-	-	-	-	-	-	0.20	-	-	0.20
28	-	-	-	-	-	-	-	0.26	-	-	0.26
44	0.21	-	-	0.12	-	0.11	-	0.08	0.05	0.12	0.69
49	-	-	-	-	-	-	-	-	0.04	-	0.04
52	0.23	-	-	0.15	-	0.15	-	0.14	0.05	0.11	0.83
70	0.10	-	-	-	-	-	-	-	-	-	0.10
87	-	-	-	0.06	-	-	-	-	0.06	-	0.12
99	-	-	-	0.06	-	-	-	-	0.08	-	0.14
101	0.12	-	-	0.12	0.12	0.12	-	0.11	0.11	0.18	0.88
105	0.06	-	-	0.10	-	-	-	-	-	0.14	0.30
110	0.18	-	-	0.17	0.16	0.19	0.07	0.19	0.08	0.23	1.27
138	0.23	0.03	0.13	0.20	-	-	-	0.21	0.12	0.19	1.11
149	0.14	-	-	-	0.19	-	-	0.15	0.14	-	0.62
153	0.25	0.06	-	0.22	0.10	-	-	0.35	0.20	0.23	1.41
158	0.14	-	-	-	0.12	-	-	-	0.10	0.05	0.41
170	-	-	-	-	-	-	-	0.20	-	-	0.20
180	-	-	-	-	-	-	-	0.28	-	-	0.28
187	-	-	-	-	-	-	-	0.11	-	-	0.11

-: none detected

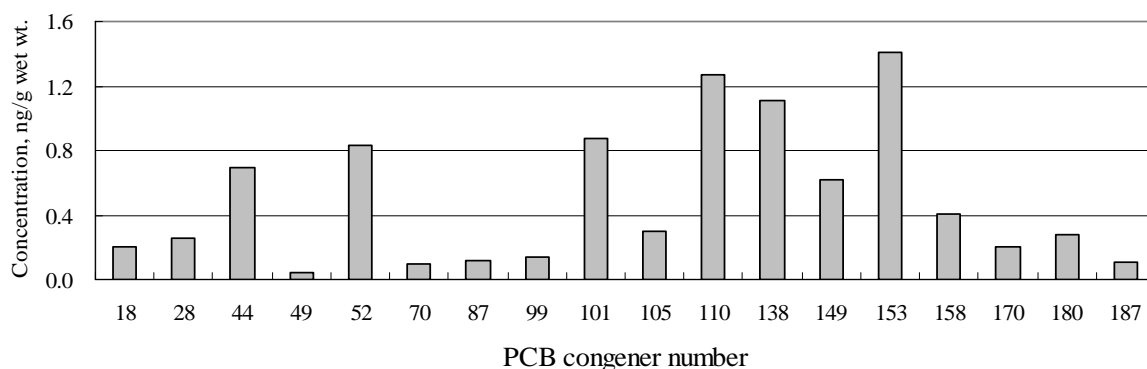


Fig. 1. Total sum of PCB congener concentrations in leopard frogs for all 17 sites

Acknowledgements

The Ministry of Environment and the National Institute of Environmental Research of Korea funded this project. We gratefully acknowledge financial support from them.

References

1. Ter Schure, A.F.H., Larsson, P., Merillä, J., Jönsson, K.I., (2002) *Environ. Sci. Technol.*, 36, 5057-5061.
2. Leonards, P.E.G., Broekhuizen, S., de Voogt, P., van Straalen, N.M., Brinkman, U.A.T., Cofino, W.P., van Hattum, B., (1998) *Arch. Environ. Contam. Toxicol.*, 35, 654-665.
3. Birdsall, C.W., Grue, C.E., Anderson, A., (1986) *Environ. Pollut. Ser. A* 40, 233-247.
4. Korfmacher, W.A., Hansen Jr., E.B., Rowland, K.L., (1986) *Sci. Total Environ.* 57, 257-262.
5. Cooke, A.S., (1981) *Environ. Pollut. Ser. A* 25, 123-133.
6. Dunson, W.A., Wyman, R.L., Corbett, E.S., (1992) *J. Herpetol.*, 26, 349-352.
7. Jeong, G.H., Kim, D.Y., Kim, M.O., Lee, J.Y., Kim, Y.B., (2001) *Organohalogen Compounds*, 51, 344-347.
8. Jeong, G.H., Kim, Y.B., Kim, D.Y., Kim, M.O., Lee, J.Y., Joo, C.H., Moon, D. H., (2002) *Organohalogen Compounds*, 59, 25-28.
9. Moon, J.Y., Kim, Y.B., Lee, S.I., Song, H., Choi, K., Jeong, G. H., (2006) *Chemosphere*, 62, 430-439.