PCDDs, PCDFs AND DLPCBs IN SURFACE SEDIMENTS FROM NAKDONG RIVER ESTUARY AND ITS ADJACENT COAST OF KOREA

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Introduction

Polychlorinated dibenzo-*p*-dioxins (PCDDs), dibenzofurans (PCDFs) and dioxin-like polychlorinated biphenyls (DLPCBs) are the persistent, bioaccumulative and toxic contaminants in the environment [1]. PCDDs/DFs are not manufactured on deliberate purpose. These compounds are unintentional byproducts of industrial processes involving chlorine or burning of organic matter in the presence of chlorine. On the other hand, DLPCBs enter into the environment from two potential sources of the use of PCB formulations and the combustion processes[2]. These contaminants derived from various sources are mainly transported to the aquatic system through the atmospheric dry and wet deposition and/or directly via rivers. Because of hydrophobic characters of these chemicals, PCDDs/DFs and DLPCBs were strongly adsorbed onto surface of particles in seawater and then deposited the underlying sediments. Thus, the deposited sediments can act as a long-term reservoir for release of the pollutants, with adverse effects on the aquatic life and bioaccumulate in organism through food chain[3].

The objective of this study was to investigate the contamination by PCDDs/DFs and DLPCBs in surface sediments from Nakdong River estuary and its adjacent coast of Korea.

Methods and Materials

Surface sediments (0 5 cm) were sampled at 23 stations from Nakdong River estuary and its adjacent coastal area of Korea in Octorber 2001 (Fig. 1) and descriptions of sampling sites are given in Table 1.

Sediment samples were dried at a room temperature and sieved 2 mm mesh. The experimental procedure and instrumental analysis of PCDDs/DFs and DLPCBs was based on the previous papers published[4,5] . Briefly 20 g samples of dried sediments were extracted in a Soxhlet apparatus with 200 mL toluene for 16 hours. Purification was obtained using a multi-layer silica gel column chromatography and an activated alumina column chromatography. PCDDs/DFs and DLPCBs in sediment samples were determined with HRGC/HRMS (HP 6890/JMS 700D). Ignition loss and grain size analyses were also measured in the sediments.

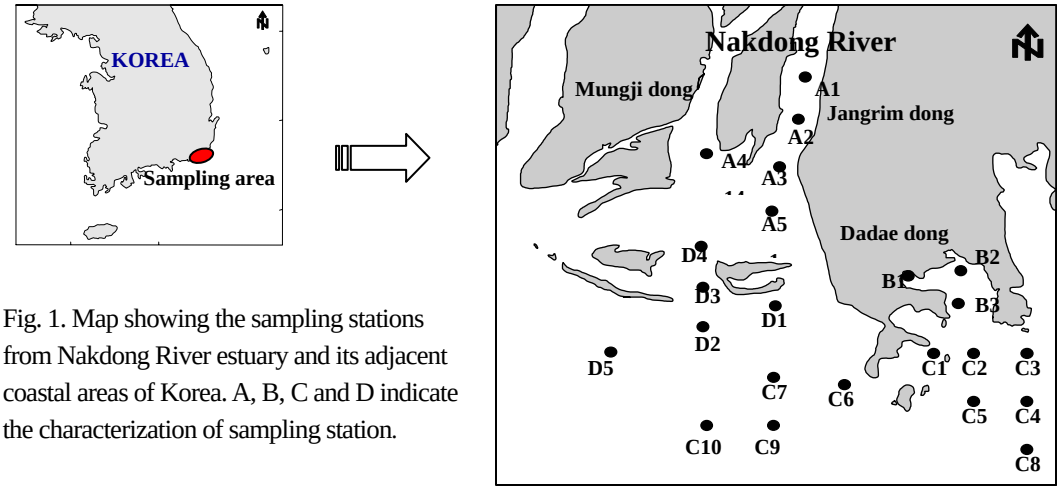

Fig. 1. Map showing the sampling stations from Nakdong River estuary and its adjacent coastal areas of Korea. A, B, C and D indicate the characterization of sampling station.

Table 1. Classifications and descriptions of sampling stations

Group	Site	Description
A	A1 A5	Estuary ; the mouth of Nakdong River
B	B1 B5	Offshore ; Dadae harbor
C	C1 C10	Open sea 1 ; mud and sand composition in the geochemical component
D	D1 D5	Open sea 2 ; mostly sand fraction (over 95%) in the grain size

Results and Discussion

The PCDDs/DFs and DLPCBs were detected in all the sediment samples. The concentrations of PCDDs/DFs and DLPCBs in surface sediments from Nakdong River estuary and its adjacent coast of Korea were summarized in Table 2. Total concentrations of PCDDs/DFs ranged from 3.3 to 1,800 pg/g dry weight and DLPCBs concentrations varied from 19 to 6,000 pg/g dry weight. These levels of PCDDs/DFs in the surface sediments from studied stations were moderate and/or lower than earlier data reported from the Korean coastal areas and other countries [6].

WHO-TEQ levels of PCDDs/DFs ranged from 0.01 to 28 pg/g dry weight and WHO-TEQ levels of DLPCBs were in the range of 0.02 – 28 pg/g dry weight for investigated stations. The TEQ values for PCDDs/DFs in all sediment samples were below the safety sediment value (20 pg-TEQ/g dry weigh[7]) for the chronic toxicity assessment and seemingly moderate. However, the total TEQ for the same sediments including DLPCBs and PAHs exceeded the 20 pg-TEQ/g dry weight. This finding indicates that the toxic potency assessment for aquatic environment should be considered to dioxin-like contaminants.

The PCDDs/DFs and DLPCBs levels in surface sediments sampled from estuary and offshore stations showed significantly higher values than those from open sea stations. The wide range of these toxic organic contaminants residue levels in sediments from open sea station (included group C and D, n=15) can be partly explained by the great disparity of the sediments. The residue levels in sediments from group D stations showed the low concentrations of toxic organic contaminants owing to the low ignition loss values and mud fraction of grain size. The phenomenon suggests that IL and grain size are one of the important factors governing toxic organic contaminants including PCDDs/DFs and DLPCBs in this investigation.

Homologue profiles of PCDDs/DFs in sediments average normalised profiles of PCDDs/DFs in sediments are presented in fig. 2.

Homologue profiles of PCDDs/DFs in sediments from estuary, open sea 1 and open sea 2 showed the similar distributions. OCDD was a predominant homologue for PCDDs. Whereas PCDFs showed the similar contributions of each homologue group. These patterns were in accordance with typical homologue profiles of PCDDs/DFs in sediment reported [4].

However, in the case of PCDDs/DFs profiles in sediment from offshore area showed the different patterns with three group mentioned above. Homologue profiles were the increasing contributions with the increasing chlorination for PCDDs, while PCDFs revealed the decreasing contributions with the increasing chlorination.

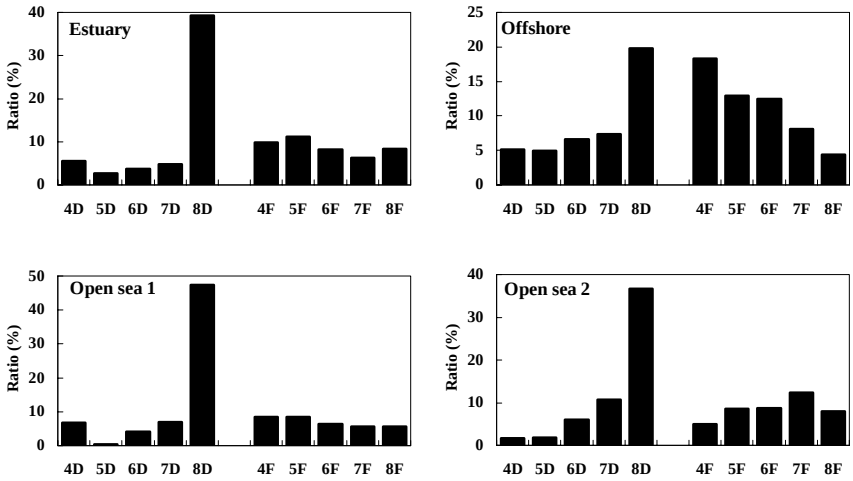

Fig. 2. Average normalized compositions of dioxin homologues in sediments from Nakdong River estuary and its adjacent coast of Korea.

Table 2. The concentration (pg/g dry weight) of PCDDs/DFs and DLPCBs in surface sediments from Nakdong River estuary and its adjacent coast of Korea

	Estuary			Offshore			Open sea 1			Open sea 2		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
TeCDDs	11	77.5	43.2	19	57.5	42.2	2.3	30	19.2	n.d.	0.4	0.13
PeCDDs	0.13	62.5	21	10.8	87.5	40.3	0.18	4	0.94	n.d.	0.7	0.14
HxCDDs	6.25	70	28.8	11.5	133	54.6	1.48	16.5	11.7	n.d.	1.25	0.46
HpCDDs	8.75	85	37.2	24.3	125	60.6	3.5	30	19.6	0.4	1.43	0.81
OCDD	65	700	305	100	203	163	25	218	134	1.43	5.25	2.79
TeCDFs	12.8	165	76.3	90	190	151	1.75	40	23.9	n.d.	0.98	0.37
PeCDFs	18.3	198	86.7	27.5	238	107	1.48	37.5	23.7	n.d.	1.8	0.65
HxCDFs	11.8	165	63.7	23	245	103	1.55	27.5	17.9	n.d.	1.8	0.67
HpCDFs	10.3	115	48.5	19	15	66.3	2.1	24	16.1	0.55	1.8	0.94
OCDF	11.3	155	64.7	16.5	47.5	36.3	1.75	25	16	0.38	0.93	0.61
PCDDs	97.5	1000	432	165	600	355	32.5	300	185	2.15	8.5	4.32
PCDFs	65	800	341	178	850	459	8.75	300	98	1.15	7.25	3.21
PCDDs/DFs	163	1800	777	350	1450	825	42.5	425	283	3.25	16	7.6
WHO-TEQ	1.38	21.2	7.7	2.91	28.3	12.1	0.24	3.67	2.17	0.01	0.23	0.08
TeCBs	84	830	353	95.8	3510	2110	27.8	509	240	17.9	37.4	27.8
PeCBs	93.4	1980	495	276	1800	956	29.6	262	169	1.38	18.8	11.5
HxCBs	n.d.	160	46.6	43	1590	749	n.d.	47.7	20.6	n.d.	n.d.	n.d.
HpCBs	n.d.	1.61	0.32	n.d.	96.4	46.9	n.d.	2.1	0.21	n.d.	n.d.	n.d.
DLPCBs	246	2970	895	415	6000	3860	86.6	766	430	19.3	56.2	39.5
WHO-TEQ	0.13	2.44	0.71	0.22	28.4	11.5	0.07	0.52	0.31	0.02	0.03	0.03

*n.d. : not detected.

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