PERSISTENT ORGANIC POLLUTANTS IN THE ENVIRONMENTAL MEDIA COLLECTED FROM YOUNGHUNG ISLET AND ANSAN CITY

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Introduction

Persistent organic pollutants (POPs) such as organochlorine pesticides, polychlorinated biphenyls and polychlorinated dibenzo-*p*-dioxin/furans(PCDD/DFs), due to their high persistency, tend to be present in various environmental media. Many researchers have been concentrated on the toxic and contamination sources of PCDD/DFs and dioxin-like PCBs, because these compounds are some of the most toxic compounds among the persistent organic pollutants. However, the information is very scarce for the environmental fates and dynamics of PCDD/DFs and dioxin-like PCBs after their release from contamination sources. Especially, the detailed information for the environmental fates of PCDD/DFs and related compounds in Korea are very limited. From a geographical point of view, the investigation into the environmental pollution situation of these toxic compounds on the Korean peninsula, being located at the central part of Northeastern Asia, will be provide valuable information to understand PCDD/DFs and dioxin-like PCBs pollution situation in this area. For the estimation of the baneful influence of PCDD/DFs and dioxin-like PCBs to the ecological system in Northeastern Asia, it is also needed to understand to the environmental dynamic mechanism of these toxic compounds, such as diffusion to atmosphere, deposition to soil and transfer to water body.

The objectives of this study are to monitor the extent of PCDD/DFs and dioxin-like PCBs in ambient air and soil samples collected from the selected area (Gyeonggi provinces) in the west coast of Korea and to estimate the dynamics of PCDD/DFs and dioxin-like PCBs within the atomospheric and soil environment.

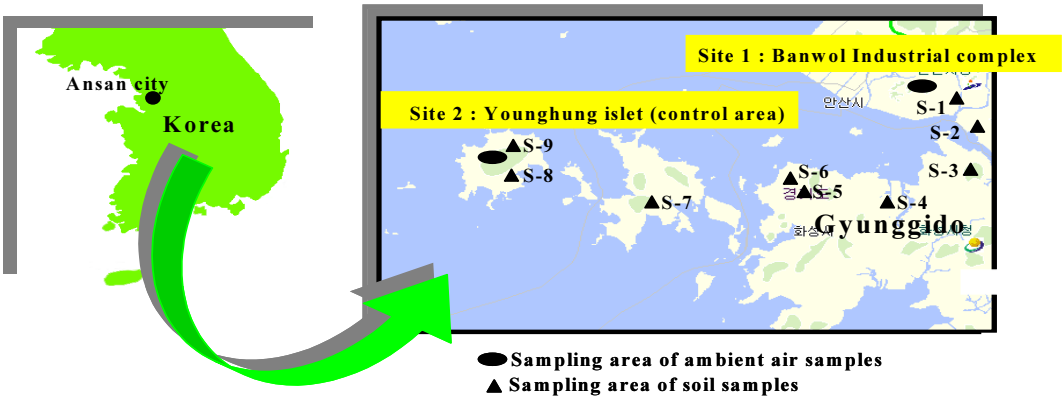
Materials and methods

The ambient air and soil samples analyzed in this study were collected from Banwol industrial complex in Ansan city and Younghung islet in Inchon city(control area). Banwol industrial complex site corresponded to area of high potential contamination source impact, while Younghung islet site is the uncontaminated area comparing with Banwol site(Fig. 1).

A glass fiber filter (GFF) and polyurethane foam plug (PUF) were used to collect the particulate and vapor of the PCDD/DFs and Dioxin-like PCBs. The high volume air sampler used in this study draws air first through a glass fiber filter(GFF) and then to polyurethane foam plug(PUF). It usually took 24 hours to sample with the air flow rate of 700 L/min. Total collected volume of ambient air was about 1000 m^3. 24 samples were collected, 12 samples for each of PUF and GFF. Younghung islet is chosen as control area site because the ambient air and soil in this site is known be cleaner than that in Banwol industrial complex. The ambient air samples were collected from 29 July to 9 August and from 28 October to 5 November, 2003.

Soil samples were collected at 9 points of Banwol industrial site and Younghung islet site in March 2004. The collected soil samples classified as industrial, paddy and forest soil in accordance with a potential source.

Fig. 1. Geographical location of sample collection from Banwol industrial complex and Younghung islet in



Korea.

Results and discussion

PCDDs/DFs and doxin-like PCBs were detected in all the ambient air samples collected from Banwol industrial complex in Ansan city and Younghung islet. The mean concentration of total PCDDs/DFs in the ambient air samples collected during the summer season was 6.24 pg/m^3 with the range of 8.02 - 3.95 pg/m^3 (n=3) for the ambient air samples from the Banwol site and 1.39 pg/m^3 with the range of 0.28 - 1.99 pg/m^3 (n=3) for the ambient air samples from Younghung islet. On the other hand, the values of the samples collected during the autumn period (from 28 October to 5 November) were 15.95 pg/m^3 (7.27 - 27.48 pg/m^3, n=3) for the samples from the Banwol site and 4.19 pg/m^3 (2.68 - 5.77 pg/m^3, n=3) for the samples from Younghung islet.

The mean concentration of total dioxin-like PCBs in the ambient samples collected from Banwol site and Younghung site in summer period was 20.49 pg/m^3 (18.19 - 23.19 pg/m^3, n=3) and 3.72 pg/m^3 (2.18 - 5.92 pg/m^3, n=3), while the values for autumn period samples were 26.17 pg/m^3 (5.51 - 52.99 pg/m^3, n=3) and 3.26 pg/m^3 (3.03 - 3.49 pg/m^3, n=3), respectively.

In general, the total PCDD/DF concentrations in air samples from Banwol were higher than those from Younghung islet as expected. The large number of contamination sources of these pollutants in Banwol may result in the higher values in this site. The PCDD/DFs and dioxin-like PCBs found in Younghung islet are either from multiple small local sources such as automobile exhaust, or from a few large distant sources. Although the differences in the concentrations of PCDD/DFs and dioxin-like PCBs between summer and autumn were not significant statistically, the average values of these compounds in autumn were about 2 times higher than those in summer. Other researchers reported that seasonal variations may occur with highest concentrations of PCDD/DFs found in the autumn or winter period, probably due to bad dispersion conditions with frequent low lying inversion layers. However, the significant changes in homologue profiles of PCDD/DFs were not reported. In the case of PCDD/DFs, the both sites show 1,2,3,4,6,7,8-HpCDF to be the most concentrated among PCDD/DF congeners, ranging from 0.23 to 5.79 pg/m^3 in the Banwol industrial complex site, and from 0.03 to 1.42 pg/m^3 in Younghung islet(summer - autumn period ; n=6). However, 2,3,7,8-TeCDD was not detected in the summer samples, even though it was detected in autumn samples. In addition, IUPAC # 118 was found to be the most concentrated dioxin-like PCBs, ranging from 3.14 to 32.36 pg/m^3 in the Banwol industrial complex site, and from 0.46 to 2.16 pg/m^3 in Younghung islet(summer - autumn period ; n=6).

The total TEQ concentrations (∑PCDDs-TEQ + ∑PCDFs-TEQ + ∑Dioxin-like PCBs-TEQ) varied from the lowest value of 0.02 pg·TEQ/m^3 for the Younghung islet site to the highest of 1.97 pg·TEQ/m^3 in the Banwol industrial complex site. The mean value of the total TEQ was substantially higher in ambient air samples collected from the Banwol site (mean; 0.70 pg·TEQ/g) than in those collected from the Younghung site (mean; 0.23 pg·TEQ/g). The percent contribution of PCDFs to the total TEQ concentrations in ambient air samples collected from the Banwol site was 74% followed by 22% for PCDDs, 3.1% for non-ortho PCBs and 0.4% for mono-ortho PCBs. The order of the total TEQ contributions from the Youghung site was similar with the Banwol site. Among the analyzed compounds, the TEQ of 2,3,4,7,8-PeCDF at 36 - 32% was the most greatly contributing factor to the total TEQ concentrations. On the other hand, the contribution of dioxin-like PCBs-TEQ to the total TEQ concentrations was minimal.

The average PCDD/DF and dioxin-like PCBs profiles of the particle and vapor phases for the sampling sites are described with Figure 2. The two sampling sites show similar PCDD/DFs and dioxin-like PCBs profiles : the total (vapor plus particle-bound) concentrations of the PCDD increase with increasing level of chlorination, while PCDFs do not show any distinct trends as PCDDs do. In addition, our investigation sites in summer show that the lower chlorinated 2,3,7,8-substituted compounds have relatively higher vapor phase fraction compared with the high-chlorinated 2,3,7,8-substituted compounds.

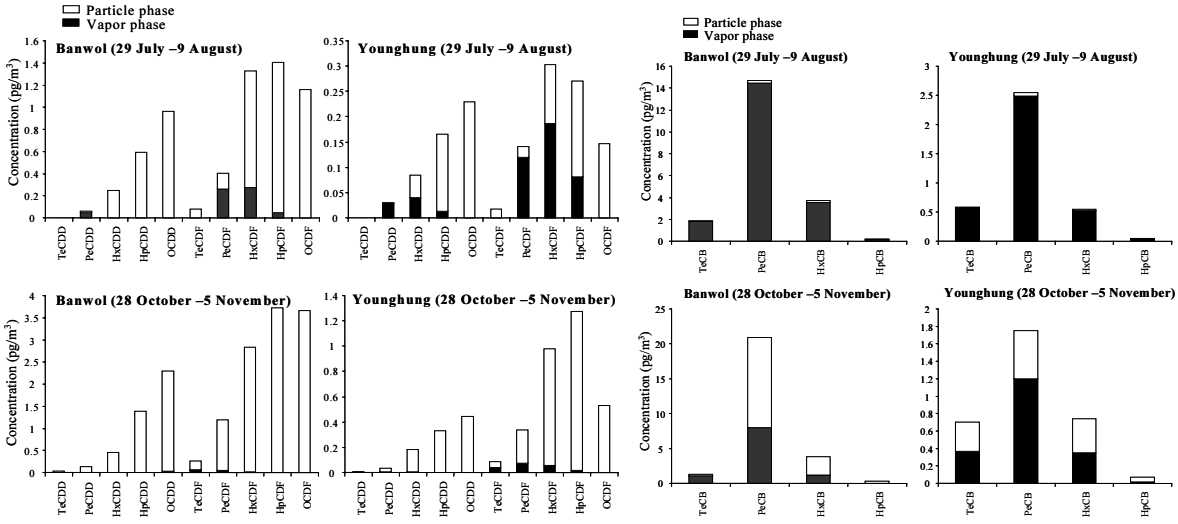


Fig. 2. Congener profiles of PCDD/DFs and Dioxin-like PCBs. The white portion of the bar is particle bound while the black portion is vapor phase (left side : PCDD/DFs, right side : Dioxin-like PCBs)

PCDDs/DFs were detected in all soil samples in this study. The total PCDDs/DFs were detected in all soil samples in the order industrial soil > paddy soil > forest soil. The mean concentration on a dry weight basis of total PCDDs/DFs determined from the various soil samples was 272.7 pg/g (n=2) for industrial soil, 57.5 pg/g (n=2) for forest soil and 146.3 pg/g (range, minimum - maximum ; 34 - 270 pg/g, n=5) for paddy soil. On the other hand, the total levels of dioxin-like PCBs were showed the order of industrial soil > forest soil > paddy soil. The mean concentration on a dry weight basis of total dioxin-like PCBs determined from the various soil samples was 67.9 pg/g (n=2) for industrial soil, 44.4 pg/g (n=2) for forest soil and 6.9 pg/g (n=5) for paddy soil. On the whole, the contamination levels of total dioxin-like PCBs in industrial and forest soil samples were higher than those in paddy samples.

The contributions of PCDFs on total PCDD/DF concentrations in industrial soil samples were relatively higher than those in paddy soil samples. This phenomenon was also reflected in the percent composition of PCDDs/DFs-TEQ. The total mean PCDDs/DFs-TEQ concentrations ranged from 2.5 pg TEQ/g for forest soil to 16 pg TEQ/g for industrial soil. Among the analyzed isomers of PCDDs/DFs in soil samples, percent contribution of TEQ for 2,3,4,7,8-PeCDF on total PCDDs/DFs was shown to be 33%.

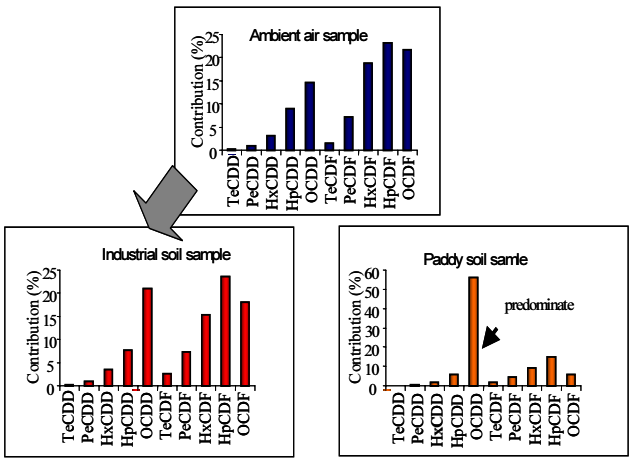


Fig.3. Compare with PCDD/DF congener profiles in Ambient air and soil samples.

Among all the analyzed soil samples, the highest level of total PCDD/DFs collected in industrial area consisted mainly of PCDFs. The proportion of PCDFs to total PCDD/DFs concentration in industrial soil was about 67%. On the other hand, PCDD concentration in paddy soils was about 2 fold greater than that of PCDFs.

The percent contribution of PCDDs to total PCDD/DFs concentration in paddy soil was about 64%. The distribution profiles of PCDD/DF homologues in industrial soil and paddy soil samples were significantly different (Fig. 3). Furthermore, the profiles of PCDD/DF congeners in industrial soils were similar with ambient air sample. In particular, OCDD was more predominant in paddy soil samples than in industrial area soil samples. This dissimilarity might be due to different contamination sources between these two soils style.

Acknowledgements
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