CORRELATION OF DIOXIN ANALOGUES CONCENTRATIONS BETWEEN AMBIENT AIR AND PINE NEEDLE IN JAPAN 2
- CASE STUDY IN GREATER TOKYO AREA-

Komichi Ikeda[1], Teiichi Aoyama[2], Atsushi Takatori[3], Hideaki Miyata[4], Patrick Pond[5] Branko Brzic [6], and Carola Serwotka [7]

Environmental Research Institute Inc., Tokyo Japan[1-3], Food Hygiene Laboratory, Faculty of Pharmaceutical Sciences, Setsunan University, Osaka Japan[4], Environmental Science Division, Maxxam Analytics Inc., Ontario Canada[5-7]

Introduction

The needle leaves of Japanese black pine (hereafter abbreviated as pine needle) has been used as an effective bio-monitor of ambient air pollution. Miyata Laboratory of Setsunan University has reported that the pine needle can accumulate PCDDs and PCDFs (hereafter abbreviated as D/F) through photosynthesis and respiration for during their lifetime.[1] The D/F in the ambient air is absorbed quite rapidly into the pine needle at the early stages of growth. However, 4 months after the sprout the accumulation rate reaches a steady state in accordance with pollution levels of the local ambient air.[1]

The purpose of this study is to clearly show the correlation of average D/F concentration between pine needle and ambient air. If correlation between these two matrices can be proven, then it is possible to estimate the yearly average of ambient air D/F concentration by analyzing Pine Needles sampled more than 6 months after the sprout.

In order to prove this hypothesis, we tried to analyze the correlation between the two matrices. As for the ambient air dioxin concentration data, the average of 120 related municipals' official monitoring data in three prefectures of greater Tokyo area were analyzed. The monitoring of the municipalities are generally 2 (24 hours monitoring in summer and winter) to 4 days (24 hours monitoring of 4 seasonal days) per year[4]. On the other hand, pine needles were sampled from several tens of scattered points in each municipality and blended into one representative sample of each municipality.

Method

The sampling period of pine needles was from August to December 1999 in about 120 municipalities of Greater Tokyo Area with a support of local citizen as participatory activities for D/F monitoring. The target pine needle of mostly 2 years old was sampled at ca. 1.5 m height above the ground level. The final blended sample volume was ca. 100 g per municipality. The detailed explanation of the D/F analytical methodology is shown in the reference.[1]

Results and Discussion

Table 1 shows the D/F TEQ concentration in pine needles of three prefectures. Fig. 1, Fig. 2 and Fig. 3 illustrates the spatial concentration map of each prefecture based on the municipal level concentration data, which were determined by Spline interpolation method.[2,3]

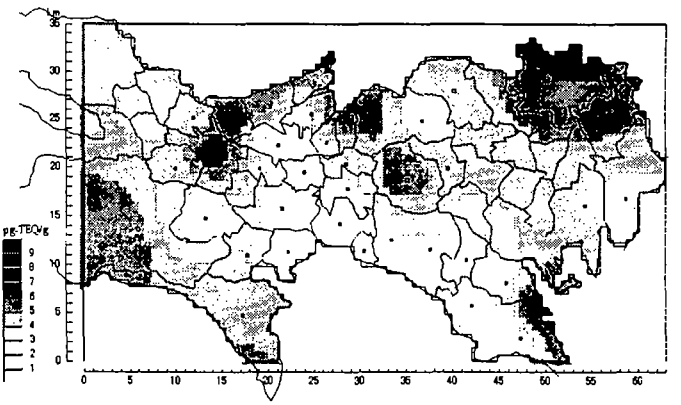

Fig.1. Pine needle D/F concentration in Tokyo Pref.

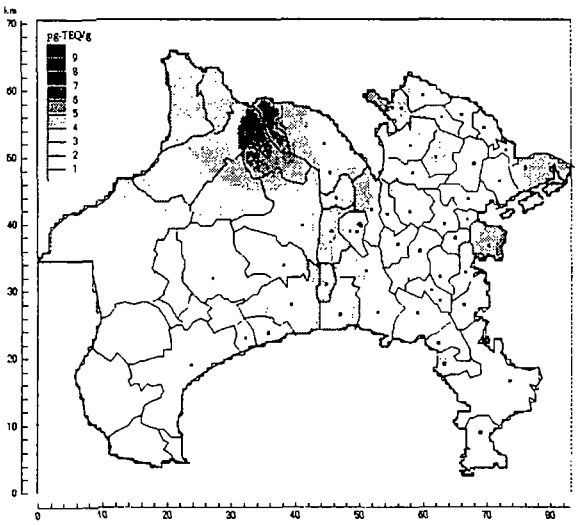

Fig.2. Pine needle D/F concentration in Kanagawa Pref.
Note: The dot in map indicates the center of gravity of scattered sampling points in each municipal.

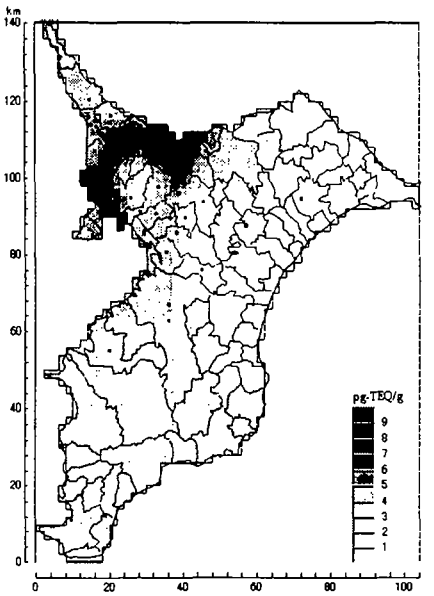

Fig.3. Pine needle D/F concentration in Chiba Pref.

In Japan, sampling of ambient air is carried out by local governments over 1-2 continuous days, usually, at a frequency of 2-4 times per year. Taking a great daily alteration of the D/F level in ambient air by 56 continuous monitoring into consideration these data are inadequacy to grasp the annual ambient air D/F concentration. Whereas, the level of D/F in pine needles for this research project was considered to represent as average level of D/F in ambient air during a long time at a target area. Then, in order to compare these two different matrix data under unified conditions of long term and area wide average, the prefectural ambient air D/F concentration data were used to estimate the average level of ambient air in each prefecture. Table 2 shows a ratio of annual average D/F concentration in ambient air versus pine needle at a large area. The ratio was in the range of 1:6 to 1:12.

Table 1. Average D/F concentration in pine needles in the prefectural level. unit:pg-TEQ/g

Prefecture	Min.	Max.	Ave.	Mean	No. of sample
Tokyo	1.58	6.86	3.98	3.73	39
Kanagawa	1.40	10.48	3.05	2.66	50
Chiba	1.29	8.02	4.48	4.31	31

Table 2 Comparison between ambient air[4] and pine needle in the prefectural level

Unit: Air pg-TEQ/m^3, Pine pg-TEQ/g

Pref.	Area	Ambient air					Pine needle		Ratio
		N=	Max.	Min.	Conc.(A)	Days	Conc(B)	N=	B/A
Tokyo	23 Wards	11	1.00	0.044	0.309	8	3.78	13	1:12
	Tama Area	9	1.50	0.002	0.389	8	3.82	23	1:10
	All Tokyo	20	1.50	0.002	0.349	8	3.81	36	1:11
Kanagawa	Yokohama	9	1.1	0.073	0.32	8	2.48	18	1:7.8
	Kawasaki	3	0.5	0.091	0.28	4	3.27	7	1:12
	Rest	6	0.92	0.06	0.35	4	3.42	25	1:10
	All Kanagawa	18	1.1	0.06	0.317	4-8	3.06	50	1:10
Chiba	Chiba	10	1.9	0.044	0.637	4	3.79	5	1:6.0
	All Chiba	26	1.4	0.100	0.500	2-4	4.48	31	1:9.0

The Japanese government has established the environmental quality standard of D/F concentration in ambient air as an annual average (0.6pg-TEQ/m^3) in the Law for controlling dioxin analogues pollution in 1999 (enacted from January 2000). Under this law, the local governments have been monitoring the ambient air dioxin concentration by using a high volume air sampler only during 2 to 8 days per year. However, in order to evaluate to the environmental quality standard with a high accuracy, it is necessary to monitor the ambient air by a continuous sampling during a long period. To consider all year continuous sampling, the cost effectiveness of the ambient air D/F monitoring becomes very unsatisfactory.

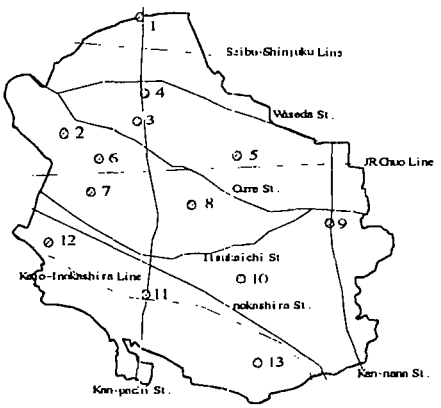

Figure 4. 13 Sampling points in Suginami.[5]

As an alternative, we compared the results of average concentration of the pine needles in 13 different sampling points with the concentration of the blended sample as a representation in a certain municipality. As indicated in Table 3, the average of the two different types of sample was almost equal. The concentration of the blended sample was 5.8 pg-TEQ/g (1999) and the average of 13 different sampling points was 5.6pg-TEQ/g. There was no

specific difference in the volume of waste incineration in Suginami Ward in these consecutive years between 1999 and 2000.

Thus, the two concentration levels were quite close to each other. It is possible to say that our propositional sampling methodology (blending samples of the scattered sampling points) is reasonable and also cost effective to identify the annual average of the ambient air D/F level by using a mixture of pine needles from different points in a certain municipal area. As above described, our new sampling methodology is quite reasonable to search an annual average level in ambient air in the whole local area.

Table 3 Comparison between 2 different sample preparation in Suginami Ward Unit: pg-TEQ/g

Sampling point	2000[5] Not blended	1999 Blended	Sampling point	2000[5] Not blended	1999 Blended
1) Igusa 4	3.0	-	8) Ogikubo 3	3.0	-
2) Zenpukuji 1	10.0	-	9) Umesato 1	5.9	-
3) Momoi 1	4.7	-	10)Omiya 1	3.7	-
4) Shimizu 3	4.8	-	11)Takaidonishi 2	3.4	-
5) Asagayakita 2	3.5	-	12)Kugayama 4	9.8	-
6) Nishiogikita 2	5.8	-	13)Eifuku 2	6.2	-
7) Nishiogiminami 4	9.0	-	**Average**	**5.6**	**5.8**

Acknowledgment

This project has been supported by the participants and organizations of the Executive Committee of Citizen Participatory Monitoring for Dioxin Concentration in Pine Needles. The authors thanks to the members who played an important role in this project; Masanori Kurakata, Shuji Nakamura, Hiroshi Tsuchida, Takashi Yamada, Hironobu Kusaba, Takeo Shibuta, and Masakazu Washino.
We also express heartfelt thanks to those members of Setsunan University, Faculty of Pharmaceutical and the staffs of Environmental Science Dept. of Maxxam Analytics Inc to analyze the Pine Needles.

References

1.Masaru Ikeda, Hideaki Miyata, (1997) Time Trend on Accumulation of PCDDs, PCDFs and Co-PCBs in Young Pine Needle (Thesis), Setsunan Univ.
2.Yukio Onishi,(1975) 2 Dimensional Interpolation by using Spline Method, Japan Oceanographic Society, Japan 31
3. Yuzuru Matsuoka, Masaaki Naito,(1983) Study on Optimal Allocation of Water Quality Monitoring Points, Research Report from the National Institute for Environmental Studies, No.48
4.Ambient Air Monitoring results (data) of related Municipals in 1999.
5.Suginami Ward, (2000) The Report on Dioxin Survey for Pine Needles