PCDD/Fs LEVELS IN SPINACH : OPEN FIELD CULTURE

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Introduction

Vegetables grown in contaminated soils play a major role in the food chain exposure pathway, and elucidating crop-soil uptake mechanism is a critical step for the assessment of public health risks. Human intake of dioxin through the consumption of vegetables has been considered negligible, since the contamination levels of vegetables were found very low level. There have been especially few studies about the systematical investigation of dioxin in spinach, despite the fact that the spinach is one of the most consumed vegetables.

According to the research on plants uptake of PCDD/Fs reported by McCrady et al. [1] and McLachlan [2]; they focused on the related plant uptake pathways of PCDD/Fs: (1) root uptake and transport to the shoot, (2) contamination of shoots by soil particles and atmospheric deposition, (3) uptake of vapor phase by aerial plant parts.

In this study, the influence of PCDD/Fs in spinach is described, in the view of identification of the principle pathway by which PCDD/Fs transport to spinach.

Methods and Materials

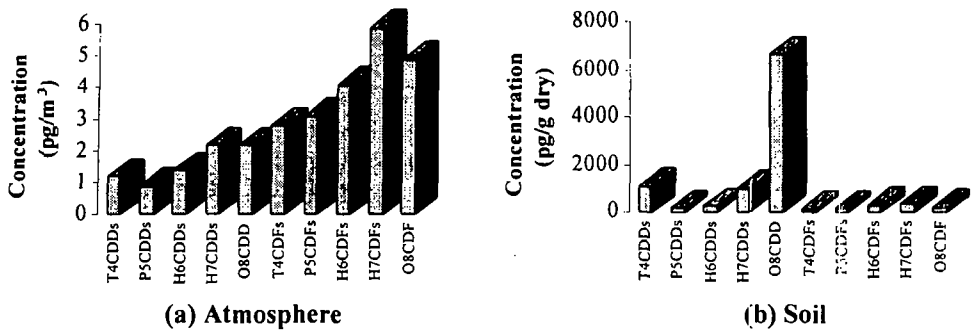
The spinach plants were sown and cultured in open field at Saitama Prefecture Agriculture and Forestry Research Center (May to July in 1999).

Detection of PCDD/Fs was carried out by HRGC/HRMS method after soxhlet/solvent extraction and gel clean-up procedures. Seventeen native (Wellington Laboratories, Canada) and ^{13}C 2,3,7,8-substituted isomers (Wellington Laboratories, Canada) were used as standard and isotope spike. Concentration of PCDD/Fs were determined by of HRGC (6890, Hewlett Packard, US) with a DB 17 column (J&W Scientific, US) and an SP 2331 column (Supelco, INC., US), connected to a HRMS (AutoSpec-Ultima, Micromass, UK) operation on a resolution of 10,000 using a positive electron ionization source and operating in the selected ion monitoring (SIM) mode. Verification of resolution in the working mass range was obtained by measuring perfluorokerosene (PFK) reference peaks. The current trap was 500 μA and the ionization energy was 30 eV. Ion source and injector temperatures were 260 °C.

Results and Discussion

In order to be able to compare and contrast the influence of cultural environment, PCDD/Fs concentrations of atmosphere and soil in the area of cultivation were measured. The concentration level of PCDD/Fs in soil was found to be 10,000 pg/g dry (39 pg-TEQ/g dry). In the case of the atmosphere, PCDD/Fs concentration of the area assessed was 29 pg/m^3 (0.33 pg-TEQ/m^3). These

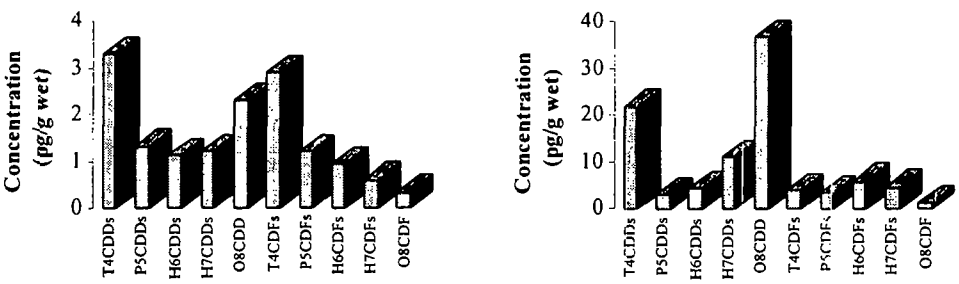
results are lower than the average value of the site of assessment at Saitama area[3] in 1996.



(a) Atmosphere (b) Soil

Fig. 1. Concentration levels of PCDD/Fs for cultural environment

The concentration level of PCDD/Fs in spinach roots was 96 pg/g wet (0.48 pg-TEQ/g wet). No correlation was found between the PCDD/Fs homologue distribution patterns for atmosphere and the patterns for spinach roots (Fig. 1,2), since spinach roots were not directly influenced by air-borne dioxins. However, the observed PCDD/Fs homologue distribution patterns for spinach roots were very similar to soil. This result reveals that the PCDD/Fs concentration in spinach roots depends on the PCDD/Fs concentration in soil. This reason may be related to the strongly attached soil particles on the root surface.



(a) Spinach leaves (b) Spinach roots

Fig.2. Concentration levels of PCDD/Fs for spinach leaves and roots

In spinach leaves, it was 15 pg/g wet (0.097 pg-TEQ/g wet). The order of concentrations of the 2,3,7,8-chlorinated PCDD/Fs was O8CDD >> 1,2,3,4,6,7,8-H7CDD > 1,2,3,4,6,7,8-H7CDF, O8CDF, etc. Among them, the concentration of O8CDD (2.3 pg/g wet) was higher than that of other 2,3,7,8-chlorinated PCDD/Fs as about 10~100 fold (Table 1). The PCDD/Fs homologue distribution patterns for spinach leaves were different from those of roots (Fig.2). These reasons may basically be explained as following: (1) spinach roots uptake of PCDD/Fs in soil and transport to leaves, (2) contamination of leaves by soil particles and atmospheric deposition. However, the investigation of many variables including plant species will be required to explain the plant uptake pathways of PCDD/Fs.

Table 1. 2,3,7,8-chlorinated PCDD/Fs levels

Congener	Atmosphere (pg/m^3)	Soil (pg/g dry)	Spinach roots (pg/g wet)	Spinach leaves (pg/g wet)
2,3,7,8-T4CDD	N.D.	1.4	0.01	N.D.
1,2,3,7,8-P5CDD	0.03	13	0.15	0.03
1,2,3,4,7,8-H6CDD	0.04	16	0.26	0.03
1,2,3,6,7,8-H6CDD	0.1	38	0.61	0.05
1,2,3,7,8,9-H6CDD	0.06	37	0.46	0.05
1,2,3,4,6,7,8-H7CDD	1.1	570	6.6	0.5
O8CDD	2.2	6700	37	2.3
2,3,7,8-T4CDF	0.05	4.5	0.06	0.04
1,2,3,7,8-P5CDF	0.19	6.6	0.1	0.06
2,3,4,7,8-P5CDF	0.16	5.7	0.09	0.05
1,2,3,4,7,8-H6CDF	0.32	17	0.29	0.07
1,2,3,6,7,8-H6CDF	0.34	14	0.24	0.07
1,2,3,7,8,9-H6CDF	0.03	0.6	0.02	N.D.
2,3,4,67,8-H6CDF	0.74	15	0.32	0.12
1,2,3,4,6,7,8-H7CDF	3	140	1.9	0.36
1,2,3,4,7,8,9-H7CDF	0.6	12	0.16	0.04
O8CDF	4.9	220	1.3	0.32

Acknowledgements

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References

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2. McLachlan, M.S. (1997) Chemosphere 34, 1263.
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