Biomonitoring of PCDD/F in Bavaria (Germany)

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Introduction

The concept of using spruce needles as bioindicators of atmospheric organic pollutants has been established in several applications (McLachlan et al.,1989; Reischl et al.,1987; Reischl et al., 1989). It may be used to characterize the immission situation in the plant environment, allowing a time-resolved estimate of exposure. In this work spruce needles have been used to describe the atmospheric PCDD/F contamination level in four different areas in Bavaria (Germany). The aim of this study was to answer the following questions:

- What are the concentration levels and the range of PCDD/F in the areas selected?
- What are the advantages of biomonitoring in comparision with other monitoring strategies (e.g. Soil, Air)?

Sampling and Analysis

The four sampling areas were selected according to the following criteria:

- **Area 1** (Passau, Neuburger Wald), represents a rural background area.
- **Area 2** (Nürnberg) is a industrialized and densely populated area (loaded area by air pollution corresponding to the German Federal Immission Control Act).
- **Area 3** (Schwandorf) is a small city with a municipal waste incineration plant and a coal power plant.
- **Area 4** (Hof) is situated at the former border to the German Democratic Republic (GDR) and affected by longe range transport of combustion products from coal firing from the GDR and the CSFR.

The trees to be sampled were selected on the basis of the "Bavarian Bioindicator Network". Spruce needles were collected for Areas 1-3 in December 1988 and for Area 4 in June 1989. From each area 7 to 10 samples were collected. The samples were taken from the tree top; only the 1 year old needles were used for the analysis.

The analysis was done using a VARIAN 3400 Gas Chromatograph in combination with a FINNIGAN MAT 8230 Mass Spectrometer. The Clean up and details of the GC/MS- analysis are described elsewhere (Reischl et al., 1989; Reischl et al., 1987). The 2, 3, 7, 8 - Cl_4DD Toxic Equivalents were calculated using the the German BGA method.

Results

In Figure 1 the mean values of the Dioxins and the Furans at the four locations are compared. Till now it is very problematical to discuss the apparent differences, because we cannot define the range of background levels and, which importance have the relatively higher values in Nürnberg.

Figure 1.: Comparison of the sums of PCDD/Fs

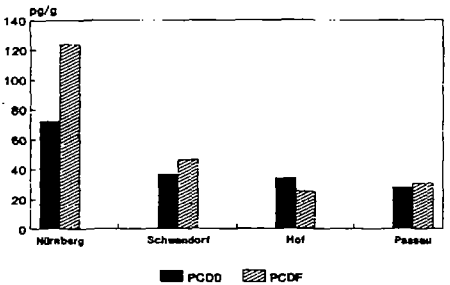


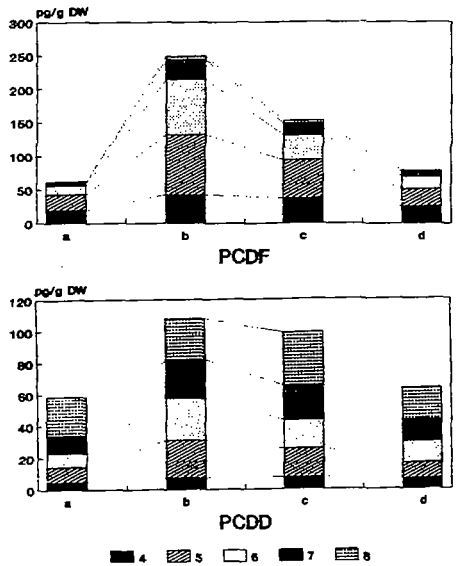
Table 1: Mean values and range of PCDD/F homologue groups

	Nürnberg (n=10)		Passau (n=10)		Hof (n=7)		Schwandorf (n=10)	
pg/g	Mean	Range	Mean	Range	Mean	Range	Mean	Range
TCDD	6.56	4.3 -12.9	3.13	0.9 - 4.3	2.03	1.7 - 2.6	3.83	3 - 6.5
PCDD	13.5	8 - 25	5.31	4 - 6.2	3.92	2.8 - 6.5	2.10	4 - 10
H6DD	16.1	9 - 31	5.28	4 - 6	5.35	3.7 - 11	8.5	4 - 12
H7DD	16.8	12 - 29	6.71	5 - 7	7.95	5 - 11	9.9	6 - 15
OCDD	23	16 - 45	9.14	7 - 10	15.98	12.7 - 22	14.15	11 - 20
SUM	72.5		27.88		34.17		36.43	
TCDF	30.5	19 - 46	12.1	10 - 16	7.3	5.2 - 10	16.35	9.2 - 32
PCDF	43.8	21 - 95	10.57	9 - 14	8.92	6.8-17	15.85	8.8 - 28
H6CDF	33.6	11 - 89	5.0	2 - 7	6.28	4.6 - 10	9.1	5 - 13
H7CDF	12.7	5 - 31	2.01	1.5 - 2	2.02	1.5 - 3	3.67	2 - 6
OCDF	3.2	2 - 5	0.67	0.5 - 0.9	0.75	0.5 - 1.2	1.23	0.8 - 2
SUM	123.8		30.45		25.27		46.2	
TE	4.47		1.17		1.15		1.83	

The mean values and ranges of all samples in the four areas are summarized in Table 1. The Toxic Equivalents range from a mean value of 4.47 pg/g (Nürnberg) to 1.15 pg/g (Hof). As can be clearly seen a complex immission situation exists especially in the Nürnberg area (Figure 2). The concentrations in the outskirts to the west of Nürnberg are comparable to background levels.

Moving towards city centre a increase in the concentrations can be noted. Especially the furans (e.g. hepta-and hexafurans) show a striking increase. Moving further from the inner city east toward the outskirts, the PCDD/F concentrations decrease but remain above the west end levels. In Figure 2 the results for Nürnberg are summarized in a cross-section showing the development of the congeners from west to east. The toxic equivalents reach a maximum of 8.79 pg/g.

Fig.2: Cross-Section through the city of Nürnberg; (a) western outskirts; (b) + (c) Center; (d) eastern outskirts



The seven samples from the Passau area show very similiar values. The samples from the Schwandorf area show - except for one sample- background values to the east and west of the town. The samples taken in the Hof area show uniform background values. However, the dioxin pattern is different from the other areas sampled. The high Cl8DD-values are especially notable. A similiar pattern was found in spruce needles from highly industrial locations in the former GDR (Umlauf et al., this volume).

5. Conclusions

The results confirm that industrialized countries undergo a atmospheric PCDD/F- contamination. Bioindication of organic atmospheric pollutants using spruce needles proves to be a useful method to monitor air quality. Comparing to other monitoring strategies the use of plant surfaces has some advantages e.g. time-resolved analysis using different needle ages. Nevertheless many questions remain open. The concentration levels in needles should be controlled by air measurements and deposition mechanisms on plants surfaces are not understood completely.

References

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