Monitoring of PCDD/F-Levels with Bioindicator Plants

J. Köhler, L. Peichl, R. Dumler-Gradl, H. Thoma and O. Vierle
Bayerisches Landesamt für Umweltschutz (Bavarian Department of Environmental Protection) D-81 925 München, Postfach 810129, Germany

1. Introduction

The origins of the diverse atmospheric distribution of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/F) are nowadays identified unambiguously as human. Besides chlorine chemistry general thermal processes like waste incineration, melting processes, car traffic and house heating are the most important sources of emission. Whereas in the meantime the PCDD/F-emissions from waste incineration stacks in Germany are strictly limited to 0.1 ng I-TE/Nm^3 and regularly controlled by measurements, the other sources are most not limited and not controlled. With methods of biomonitoring it is possible to give indications about the input of these emissions in the environment. The organic substances for example are able to accumulate in the lipophil cuticle of spruce needles (Picea abies) or grass culture (Lolium multiflorum) and kale (Brassica oleracea). There is a difference between passive monitoring where the substances are detected in organisms naturally grown at the investigation site (e.g. spruce trees) and active monitoring where standardized plant cultures (e.g. grass culture and kale) were exposed at a chosen location.
This report will present two programs which use accumulation indicators to clarify the influence of house heating on the additional increase of PCDD/F during winter and to determine the background load of PCDD/F in Bavaria.

2. Experimental

For the investigation on house heating 26 sites of the spruce tree indicator grid were selected. Samples were taken in October '92 and from the same trees again in April '93. The needles were extracted with methylene-chloride, isolation of PCDD/F was carried out like described in 1, 2). Standardized grass culture and kale were exposed during the vegetation period 1993 and 1994 at four background stations as described in 3). The samples were freeze-dried and treated as described in 2).
The following HRGC/HRMS-analysis was done with a high-resolution mass spectrometer VG Autospec:
Temperature program: 100 °C, 3 min. isothermal; rate 1, 20 °C/min up to 180 °C, rate 2, 5 °C/min up to 250 °C
Injector: KAS 3, splitless mode

Carriergas: helium
Column: SP 2331, 60 m, 0,32 mm id, filmthickness 0,2 µm
The analysis was carried out in the SIM mode

3. Results

Spruce needles

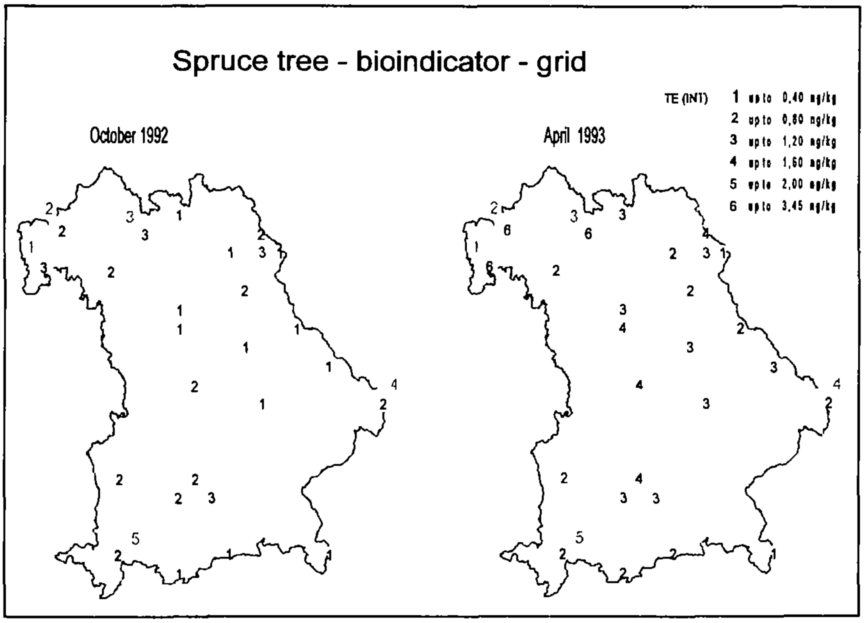

Fig. 1: PCDD/F-concentrations in spruce needles

Figure 1 shows the distribution of PCDD/F-concentrations as TE-INT. in ng/kg in October '92 and April '93 at 26 sites of the spruce tree grid. The locations with the highest changes in PCDD/F-concentrations are marked by italic numbers 1 to 3. Whereas the italic numbers 4 and 5 mark the locations with very low changes during the same exposition period.

Standardized grass culture

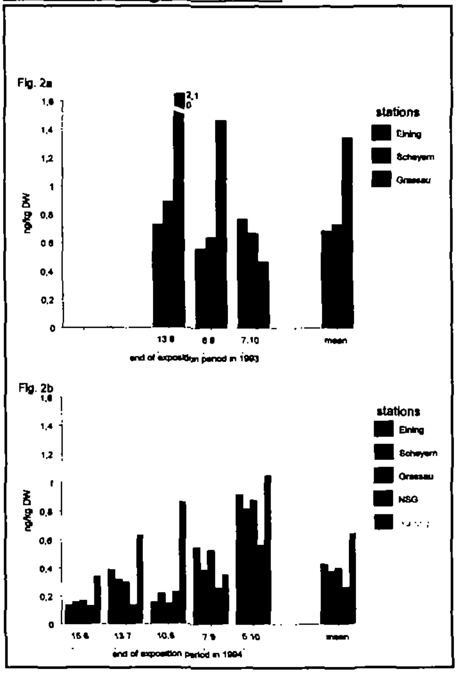

Fig. 2: PCDD/F-concentrations as TE (Int) in Standardized Grass Cultures at Background Stations

Fig. 2a and 2b show the results of active monitoring with grass cultures at background stations in Bavaria. In 1993 (Fig. 2a) only three exposition series could be carried out at three stations, whereas in 1994 (Fig. 2b) all of the five exposition series at now five stations could take place. The exposition period of each series took four weeks.

Kale

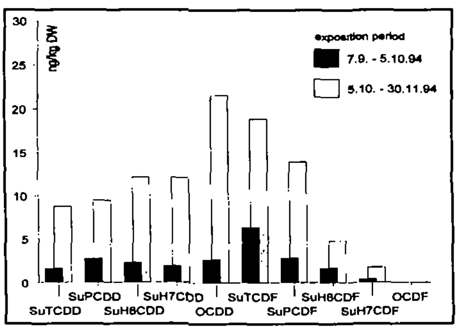

Fig. 3: PCDD/F-concentrations in Kale

In 1994 the background stations were equipped with two different expositions of kale. One exposition period took four weeks in September the other eight weeks during October/November. The differences between the two expositions at background station 'Scheyern' are shown in Fig. 3. From this it's obvious that the eight-week exposition in October/November accumulates by the factor 4 to 5 higher than the shorter exposition in September.

4. Discussion

PCDD/F-concentrations in spruce needles at locations *1* to *3* in Fig. 1 increased by the average factor of 2.5 during wintertime. This could be caused by the prolongation of exposition time by six month. Contrary to this effect at locations *4* and *5* there was no increase in PCDD/F. A raise in PCDD/F-concentrations due to a simple accumulation by time should include all locations, those with no additional load by house heating, too. Therefore these results could base on an equilibrium between atmosphere and the needle's cuticle dependent on the actual load of the environs.
The investigation with standardized grass culture at different background stations show that the location 'Grassau' near a housing area is loaded higher with emissions of house heating in the exposition periods until 7.9.94 and 5.10.94 (Fig. 2b) than a location in a nature reserve near by ('NSG'). Above that the location in the city of Munich 'Isarring' (Fig. 2b) is loaded with the highest PCDD/F-concentrations.
The exposition of kale in two different exposition periods has led to an increase by the factor 4 to 5. This is not only due to the longer exposition time but probably also to the influence of house heating during the exposition in October/November.

5. References

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