Monitoring of PCDD/F with Kale

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1. Introduction

As polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/F) occur as unwanted by-products of thermal processes the major part of their atmospheric distribution is due to human activity[1]. Besides chlorine and paper industry, melting processes, waste incineration, car traffic, and house heating are the most important sources of emission[2]. Several PCDD/F compounds are extremely toxic. For man possible risks result from the uptake of contaminated food via the food chain. As a consequence transfer from air to plants and the accumulation in plants is considered in investigations concerning the surveillance of emissions. With bioindicators it is possible to give indications about the input of these emissions into the environment. Spruce needles[3] and kale[4] for example are able to accumulate organic substances in their lipophilic cuticle.
The onset of wintertime is accompanied by a measurable increase of immissions of PCDD/F from various sources. Exposing the indicator plants at different locations and during certain periods offers a description of regional and seasonal PCDD/F-immissions. Furthermore the amount of PCDD/F in kale plants can be directly compared to immission concentration measurements by a high volume sampler.

2. Experimental

2.1 Exposition

The standardized kale cultures were grown according to the applied method of TÜV Südwest and exposed at 8 locations with different environments concerning the load of immission. Five stations are sited at background locations in more or less rural areas (Ismaning, Weißenstadt, Weibersbrunn, Scheyern, Eining). One station is sited at a park near a high density traffic road in the city of Munich (Isarring). The other two stations (Schirnding and Waidhaus) are installed directly in urban areas. The exposition period was 8 weeks each time (exposition period I: calendar week 32 to 40; exposition period II: calendar week 40 to 48).

2.2 Immission measurements

The sampling was carried out according to the VDI guideline 3498 page 1[5]. Air samples were taken according to the guideline VDI 2463 page 4[6]

2.3 Clean-up and GC/MS analysis

The kale samples were freeze-dried and worked up for PCDD/F. The clean-up was carried out using the method of Hagenmaier et al[7].
The following HRGC/HRMS analysis was done by a high resolution mass spectrometer VG autospec:

temperature program:	100°C, 3 min isothermal rate 1: 20°C/min to 180°C, rate 2: 5°C/min to 250°C
injector:	KAS 3, splitless
carrier gas:	Helium
capillary column:	SP 2331, 60m, 0.32 mm inside diameter, 0.2 µm film thickness

The analyses were carried out in the SIM mode.

3. Results

3.1 Kale

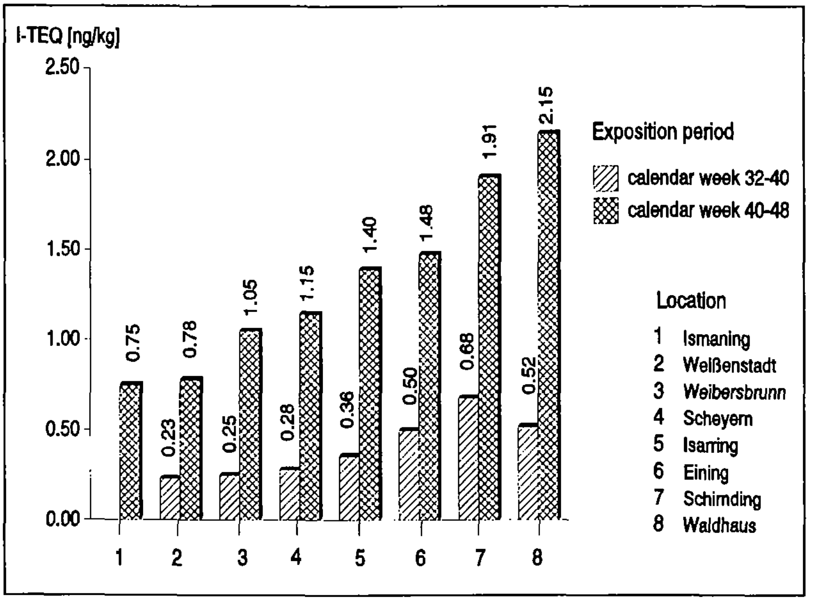

Fig.1: PCDD/F-concentrations in kale

background station	ratio calendar week 40 to 48 / 32 to 40
Ismaning	---
Weißenstadt	3.39
Weibersbrunn	4.20
Scheyern	4.10
Isarring	3.88
Eining	2.96
Schirnding	2.81
Waidhaus	4.13

PCDD/F-concentrations in kale are dependent on the time of the exposition and on the location (Fig. 1). During the first exposition period (calendar week 32 to 40) the PCDD/F-concentrations in kale are very low. During the second exposition period (calendar week 40 to 48) there is a measurable increase of PCDD/F-concentration at all locations with a higher concentration in urban areas than at rural locations.
As seen in Table 1 the PCDD/F-concentrations increased by the factor 2.81 to 4.20.

Table 1: Ratios of the PCDD/F concentrations in kale

3.2 Immission measurements

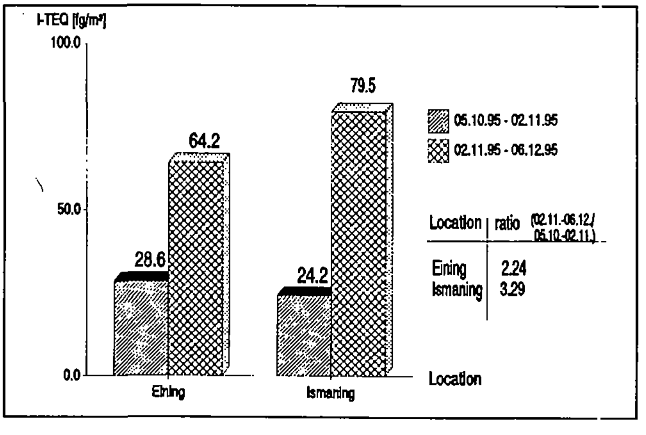

Fig. 3: Immission Measurements

The increase of the emission concentrations is supported by the immission measurements (Fig. 3). At the two background stations Eining and Ismaning an increase of the PCDD/F-concentrations by the factor 2.24 and 3.39 could be detected from October to November 1995.

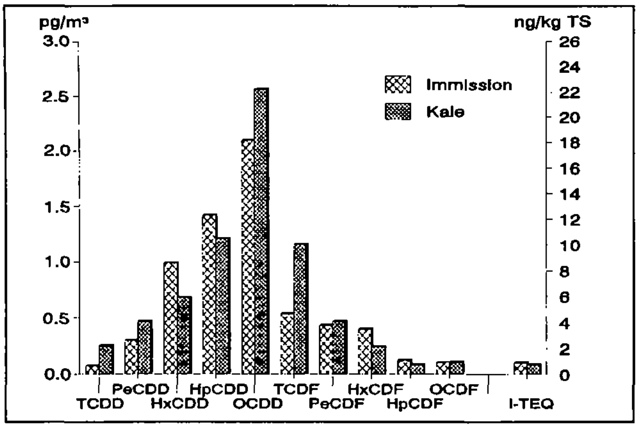

Fig. 4: PCDD/F-Pattern in Kale and Immission

In Figure 4 the results of the immission measurements and the kale investigation are compared. The homologue sums show the same pattern with the bioindicator kale and the immission.

4. Conclusion

The PCDD/F-concentrations in kale increased at 8 differently loaded locations by the factor 2.81 to 4.20. These data show that in autumn and winter further PCDD/F sources are added, especially at urban areas. If all other incineration sources (municipal waste incinerators, chemical processes) should have a constant immission over the year, house heating could be the critical additional source.
The immission pattern of PCDD/F is sufficiently represented by the bioindicator kale. This supports the use of biomonitoring as the adequate method describing the toxic effects of PCDD/F on humans via the food chain.

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5. References

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