Identification of PCDD/PCDF and PCB levels in ambient air by using moss and kale as biomonitors

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Abstract

Polychlorinated dibenzo-p-dioxins and -dibenzofurans (PCDD/PCDF) and polychlorinated bipenyls (PCB) were determined in moss (brachythecium rutabulum) and curly kale (brassica oleracea) samples from 11 industrial and rural areas in Central Europe. The sampling was carried out during 1995 to 1997 in different seasons. As expected the I-TEQ values of the PCDD/PCDF and the concentrations of PCB show a correlation to the sampling sites and different biomonitors. Higher values of PCDD/PCDF and PCB were found near industrial areas (2-15 ng/kg dry matter (dm) I-TEQ and 2-22 µg/kg dm of PCB). All results are part of an still running air quality network.

Introduction

For the control of ambient air quality and especially the environmental impact of industrial zones a most common method is the use of continuously working ambient air monitoring systems. In this case the contribution of dust-related contaminations to the total immission has to be measured with an additional system e.g. by using deposition samplers. In some cases more expressive information concerning air pollution and environmental risk can be obtained with a biomonitoring network. As representative plants resp. biomonitors e.g. grass[1,3,4], needles/leaves[2] and moss are known. In this paper we are presenting kale as another alternative. The present program includes the investigation of PCDD/PCDF, PCB, PAH and heavy metals.

Sampling

In the present study 9 locations in the surrounding of a municipal solid waste incinerator, steel plants and other industries releasing pollutants into the atmosphere were selected for sampling. In order to find a ground level of contamination two sampling areas with more or less rural character were selected. For each campaign all sites were investigated simultaneously.

moss: The moss samples (brachythecium rutabulum) were collected from natural places. For each site a volume of 4 litres of moss-material was collected and prepared for the chemical analysis.

kale: The kale plants were raised up in standard soil under greenhouse conditions. Selected plants were placed into flowerpots and transferred to the sites of investigation. Each site was equipped with 6 to 8 single plants. After two month the green part of the plants were collected and prepared for the chemical analysis.

Pretreatment and Analysis

Samples were prepared by drying, grinding them with a cutting machine to fine material, and using them for extraction.

PCDD/PCDF-Analysis: The prepared sample was extracted using soxhlet extraction with toluene. A mixture of $^{13}C_{12}$-labelled standards were added prior to extraction. A multistep clean-up procedure followed. The analysis was carried out using HRGC/HRMS (Fisons Autospec Ultima system). Detailed descriptions of the procedures are presented elsewhere [3,4]

PCB-Analysis: Samples were prepared as described for the dioxins. Decachlorobiphenyl was added as an internal standard prior to extraction with toluene.

For the clean-up procedure the samples passed through a multilayer silicagel column with hexane. The eluate was concentrated to about 1ml and as a second clean-up step fractionated on alumina (Al_2O_3 basic, Super I). The fraction containing the PCB was concentrated, brought to a defined end volume and analysed by a Fisons/CE MEGA5300 GC equipped with an ECD HT40 system. The GC column used was a 60m 0,32mm i.D. DB5 column with a 0,1µm dF coating.

Results and Discussion

Table 1-4 and figure 1-4 summarise the PCDD/PCDF I-TEQ levels and the PCB concentrations for moss and kale of different sampling sites. The PCB values given are the sums of 6 PCB's with the Ballschmiter/IUPAC-No. 28, 52, 101, 138, 153 and 180. As expected the I-TEQ values of the PCDD/PCDF and the concentrations of PCB show a correlation to the sampling sites and different biomonitors. Higher values of PCDD/PCDF and PCB were found near industrial areas (2-15 ng/kg dm I-TEQ and 2-22 µg/kg dm of PCB). Concerning PCDD/PCDF typical pattern of the isomer sums were found for the different industrial sites. With respect to the presented results it can be concluded that moss and kale are suitable biomonitors of atmospheric contaminations like PCDD/PCDF and PCB.

References

1) Schuhmacher M, Domingo J.L, Granero S, Meneses M, Xifró A and Llobet J.M; Organohalogen Compounds **1997**, 32, 150-154.

2) Osomu Aozasa, Ikeda M, Nakao T, Ohta S, Miyata H, Huang C.-W, Tsai H; Organohalogen Compounds **1996**, 28, 181-186.

3) Schuhmacher M, Domingo J.L, Llobet J.M, Müller L and Jager J; Sci. Total Environ. **1997**, 201, 53-62.

4) Schuhmacher M, Domingo J.L, Llobet J.M, Müller L, Sünderhauf W and Jager J; Chemosphere **1998**, 36, 2581-2591.

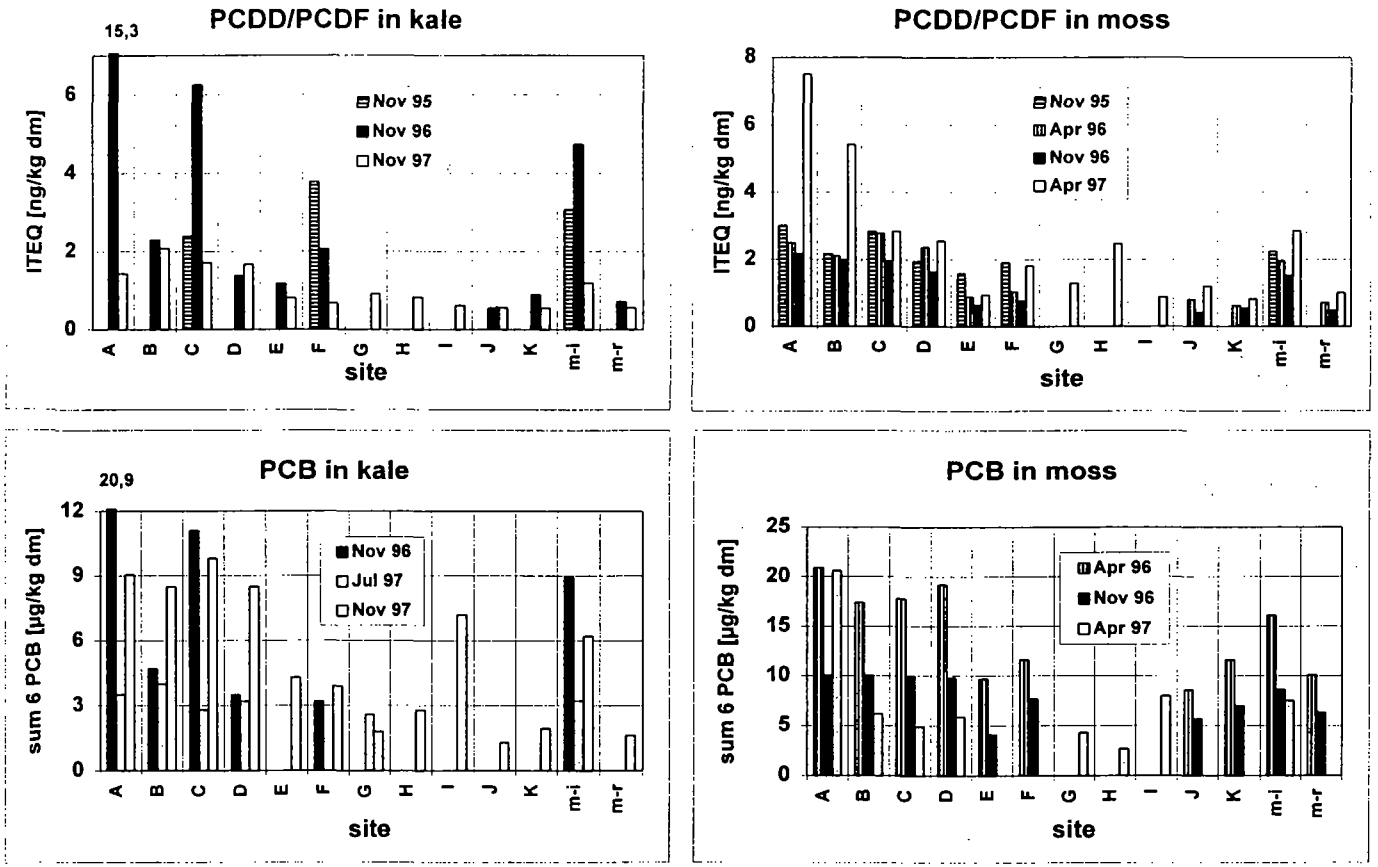

figure 1-4: levels of PCDD/PCDF and PCB in moss and kale samples collected at different sites

kale PCDD/PCDF ITEQ [ng/kg dm]						
	site	Nov 95	Nov 96	Jul 97	Nov 97	mean
A	industrial	n.a.	15,3	n.a.	1,44	8,37
B	industrial	n.a.	2,3	n.a.	2,08	2,19
C	industrial	2,39	6,26	n.a.	1,71	3,45
D	industrial	n.a.	1,38	n.a.	1,67	1,53
E	industrial backgr	n.a.	1,18	n.a.	0,82	1,00
F	urban-ind.backg	3,78	2,06	n.a.	0,68	2,17
G	industrial	n.a.	n.a.	n.a.	0,92	0,92
H	industrial	n.a.	n.a.	n.a.	0,83	0,83
I	industrial	n.a.	n.a.	n.a.	0,62	0,62
J	rural	n.a.	0,55	n.a.	0,56	0,56
K	rural	n.a.	0,89	n.a.	0,56	0,72
m-i	mean ind.	3,09	4,75	n.a.	1,19	
m-r	mean rur.	n.a.	0,72	n.a.	0,56	

moss PCDD/PCDF ITEQ [ng/kg dm]						
	site	Nov 95	Apr 96	Nov 96	Apr 97	mean
A	industrial	3,01	2,50	2,17	7,51	3,80
B	industrial	2,17	2,11	1,99	5,42	2,92
C	industrial	2,83	2,78	1,95	2,84	2,60
D	industrial	1,94	2,37	1,63	2,56	2,13
E	industrial backgr	1,59	0,89	0,64	0,95	1,02
F	urban-ind.backg	1,91	1,04	0,76	1,81	1,38
G	industrial	n.a.	n.a.	n.a.	1,29	1,29
H	industrial	n.a.	n.a.	n.a.	2,47	2,47
I	industrial	n.a.	n.a.	n.a.	0,88	0,88
J	rural	n.a.	0,80	0,42	1,20	0,81
K	rural	n.a.	0,62	0,54	0,82	0,66
m-i	mean ind.	2,24	1,95	1,52	2,86	
m-r	mean rur.	n.a.	0,71	0,48	1,01	

kale PCB 6 Isomers [µg/kg dm]						
	site	Nov 95	Nov 96	Jul 97	Nov 97	mean
A	industrial	n.a.	22,10	3,50	9,05	11,55
B	industrial	n.a.	4,70	4,00	8,50	5,73
C	industrial	n.a.	11,10	2,80	9,80	7,90
D	industrial	n.a.	3,50	3,20	8,50	5,07
E	industrial backgr	n.a.	n.d.	n.d.	4,30	4,30
F	urban-ind.backg	n.a.	3,20	n.d.	3,90	3,55
G	industrial	n.a.	n.a.	2,60	1,80	2,20
H	industrial	n.a.	n.a.	n.d.	2,80	2,80
I	industrial	n.a.	n.a.	n.d.	7,20	7,20
J	rural	n.a.	n.d.	n.d.	1,30	1,30
K	rural	n.a.	n.d.	n.b	1,95	1,95
m-i	mean ind.	n.a.	8,92	3,22	6,21	
m-r	mean rur.	n.a.	n.d.	n.d.	1,63	

moss PCB 6 Isomers [µg/kg dm]						
	site	Nov 95	Apr 96	Nov 96	Apr 97	mean
A	industrial	n.a.	20,90	10,10	20,60	17,20
B	industrial	n.a.	17,40	10,10	6,20	11,23
C	industrial	n.a.	17,80	10,00	4,90	10,90
D	industrial	n.a.	19,20	9,80	5,90	11,63
E	industrial backgr	n.a.	9,70	4,10	n.d.	6,90
F	urban-ind.backg	n.a.	11,60	7,70	n.d.	9,65
G	industrial	n.a.	n.a.	n.a.	4,30	4,30
H	industrial	n.a.	n.a.	n.a.	2,70	2,70
I	industrial	n.a.	n.a.	n.a.	8,00	8,00
J	rural	n.a.	8,60	5,70	n.d.	7,15
K	rural	n.a.	11,60	7,00	n.d.	9,30
m-i	mean ind.	n.a.	16,10	8,63	7,51	
m-r	mean rur.	n.a.	10,10	6,35	n.d.	

table 1-4: PCDD/PCDF and PCB levels in moss and kale

n.a. = not analysed; n.d.= not detected at an detection limit of 1µg/kg for each PCB congener.