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PCDD/F Levels in Vegetation Samples in the Vicinity of a Modern and an Old Municipal Solid Waste Incinerator from Catalonia, Spain

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Abstract

PCDD/F concentrations were analyzed by GC/MS in vegetation samples collected in the vicinity of a modern and an old MSW incinerator from Catalonia (Spain). As expected, total TEq levels were higher in the samples taken near to the old incinerator, with median values of 0.33 and 1.88 ng TEq/kg (dry matter) for the modern and old plant, respectively. The present results show that vegetation samples can be a suitable environmental indicator to assess PCDD/F deposition from MSW incinerators.

Introduction

Due to the lack of available landfills and the environmental degradation resulting from municipal waste landfills, in recent decades incineration has been proposed (and continues being proposed) as the treatment of choice for processing municipal solid waste (MSW). Although it is expected that the use of MSW incinerators may increase in coming years, where new incinerators are proposed people are often fearful that it will adversely affect their health. Consequently, it is of great concern to know the physical and chemical characteristics of emissions, to estimate potential human exposure to particular pollutants, and to compare the concentrations of those pollutants with levels from other pollution sources that can also affect to a community.¹⁾

Since 1977, when Olie et al.²⁾ reported PCDD/F emissions from a MSWI, a large number of studies have been performed around MSWIs since the stack emissions are a very common argument against the incineration of MSW. While it has been reported that an old incinerator has a very local impact on the environment, the effects of modern incinerators, if any, are can be difficult to identify.³⁾ However, although PCDDs and PCDFs are released into the environment from various combustion processes, at the present time the major sources of atmospheric contamination by PCDD/Fs are municipal and hospital waste incinerators, metallurgical processes and possibly coal combustion.⁴⁾

LEVELS IN THE ENVIRONMENT

The objective of this study was to compare the PCDD/F levels in vegetation samples collected in the neighbourhood of an old and a modern MSWI from Catalonia (Spain). Because of the operation periods of those MSWIs are substantially different, in order to establish comparisons between the environmental impact of PCDD/F emissions of both plants, vegetation rather than soil samples were chosen as a better indicator of recent atmospheric deposition.

Experimental Methods

During 1996, 24 grass and weed samples (*Boutelova gracilis*) were collected in the vicinities of a modern and an old MSWI located in Tarragona and Montcada (Catalonia, Spain), which began operating in 1991 and 1975, respectively. Both plants are placed in urban areas with a notorious industrial activity in the surroundings, and affected by a heavy traffic. Samples of approximately 120-150 g (dry weight) were obtained by cutting at a height of approximately 4 cm from the soil. When grasses and weeds were collected they were about 25 cm high. Samples were immediately packed in aluminum foils. Subsequently, they were dried at room temperature, kept in a double aluminum foil and packed in labelled plastic bags until analysis. About 100 g (dry weight) were used for analytical purposes.

Selection of the sampling points was made according to dispersion models, which were used to predict the longest distance where the exhaust could be expected to arrive the ground. In the area of Tarragona, duplicate grass and weed samples were collected between 250 and 1500 m from the stack in each of the four main wind directions (NE, NW, SE, SW). In the area of Montcada samples were taken between 100 and 3000 m from the stack in each of the three main directions of the wind (S, NE, NW). Analytical methods including chemicals, sample extraction and clean-up, and instrumental equipment were previously described.⁵⁾

Results and Discussion

Tables 1 and 2 summarize the PCDD/F concentrations in vegetation samples at increasing distances from the MSWIs. In the samples collected near to the modern plant, median and mean values for PCDD/F were 0.33 and 4.11 ng TEq/kg (dry matter), respectively. In turn, in samples taken in the vicinity of the older facility total TEq levels for PCDD/Fs ranged between 1.07 and 3.49 ng/kg (dry matter), with median and mean values of 1.88 and 1.92 ng/kg (dry matter), respectively.

In vegetation samples from both areas, OCDD/Fs and 1,2,3,4,6,7,8-HpCDD/Fs were the predominant congeners and contributors to TEq (Fig. 1). There was an apparent concentration gradient for the PCDD/Fs levels in the samples from the modern MSWI in relation to the distance from the stack, with a maximum at 1250 m. The highest PCDD/F concentrations in samples collected near to the old MSWI were found at distances lower than 250 m from the stack (with the exception of TeCDD/Fs and PeCDFs).

Dioxin '97, Indianapolis, Indiana, USA

Table 1. Levels of PCDD/Fs in vegetation samples collected at increasing distances (meters) from an old MSWI (Montcada, Spain)*

	100	250	500	750	1000	1500	2000	3000
2,3,7,8-TeCDD	0.09	0.10	0.11	0.13	0.08	0.12	0.10	0.08
1,2,3,7,8-PeCDD	0.45	0.45	0.45	0.43	0.38	0.40	0.46	0.38
1,2,3,4,7,8-HxCDD	0.40	0.32	0.30	0.29	0.30	0.26	0.16	0.29
1,2,3,6,7,8-HxCDD	2.40	3.60	3.30	1.10	1.90	1.80	2.40	2.80
1,2,3,7,8,9-HxCDD	1.10	1.50	1.40	0.56	0.77	0.93	1.00	1.10
1,2,3,4,6,7,8-HpCDD	6.70	6.40	5.00	6.00	4.40	4.40	4.20	4.10
OCDD	20.00	14.00	13.00	14.00	13.00	14.00	8.80	8.70
2,3,7,8-TeCDF	1.20	1.20	1.30	1.20	0.96	1.80	1.60	1.30
1,2,3,7,8-PeCDF	0.83	1.00	1.30	0.82	1.00	1.40	0.96	0.80
2,3,4,7,8-PeCDF	1.00	0.94	0.89	0.69	0.95	1.30	0.95	0.80
1,2,3,4,7,8-HxCDF	1.10	1.20	1.10	0.77	0.97	1.20	1.10	0.77
1,2,3,6,7,8-HxCDF	1.20	1.30	0.85	0.84	1.00	1.20	0.70	0.57
2,3,4,6,7,8-HxCDF	0.10	0.09	0.03	0.03	0.03	0.03	0.03	0.03
1,2,3,7,8,9-HxCDF	2.20	1.90	1.10	1.30	1.40	1.40	1.00	0.76
1,2,3,4,6,7,8-HpCDF	7.60	5.50	3.90	3.10	4.10	5.20	2.90	2.40
1,2,3,4,7,8,9-HpCDF	0.50	0.44	0.30	0.37	0.25	0.18	0.32	0.34
OCDF	4.40	3.10	1.40	2.30	1.70	2.70	1.30	1.40
TEq PCDDs	0.80	0.99	0.88	0.64	0.60	0.62	0.74	0.73
TEq PCDFs	1.15	1.16	0.99	0.88	1.00	1.34	1.06	0.81
Total TEq	1.95	2.15	1.87	1.52	1.60	1.96	1.80	1.54

*Results (ng/kg dry matter) are given as median values.

The median PCDD/F concentrations in vegetation, an environmental indicator of recent atmospheric deposition, was about 6-times higher in the samples collected in the neighbourhood of the older MSWI. Since both facilities are placed in urban areas with a considerable industrial activity and they are also under the influence of a heavy traffic, this considerable difference should be attributed to the substantial technical differences between both MSWIs.

In contrast to the relatively important number of reports on atmospheric deposition of PCDD/Fs in soils, data about the influence of atmospheric deposition on the levels of those chemicals in vegetation samples collected in the vicinity of MSWIs are very scarce. However, since the levels of PCDD/Fs in soils should take much longer to decline due to the great persistence of these chemicals in this environmental matrix,⁶ vegetation would be a more suitable indicator than soil to assess the environmental impact of future declines in atmospheric emissions of PCDD/Fs.⁷

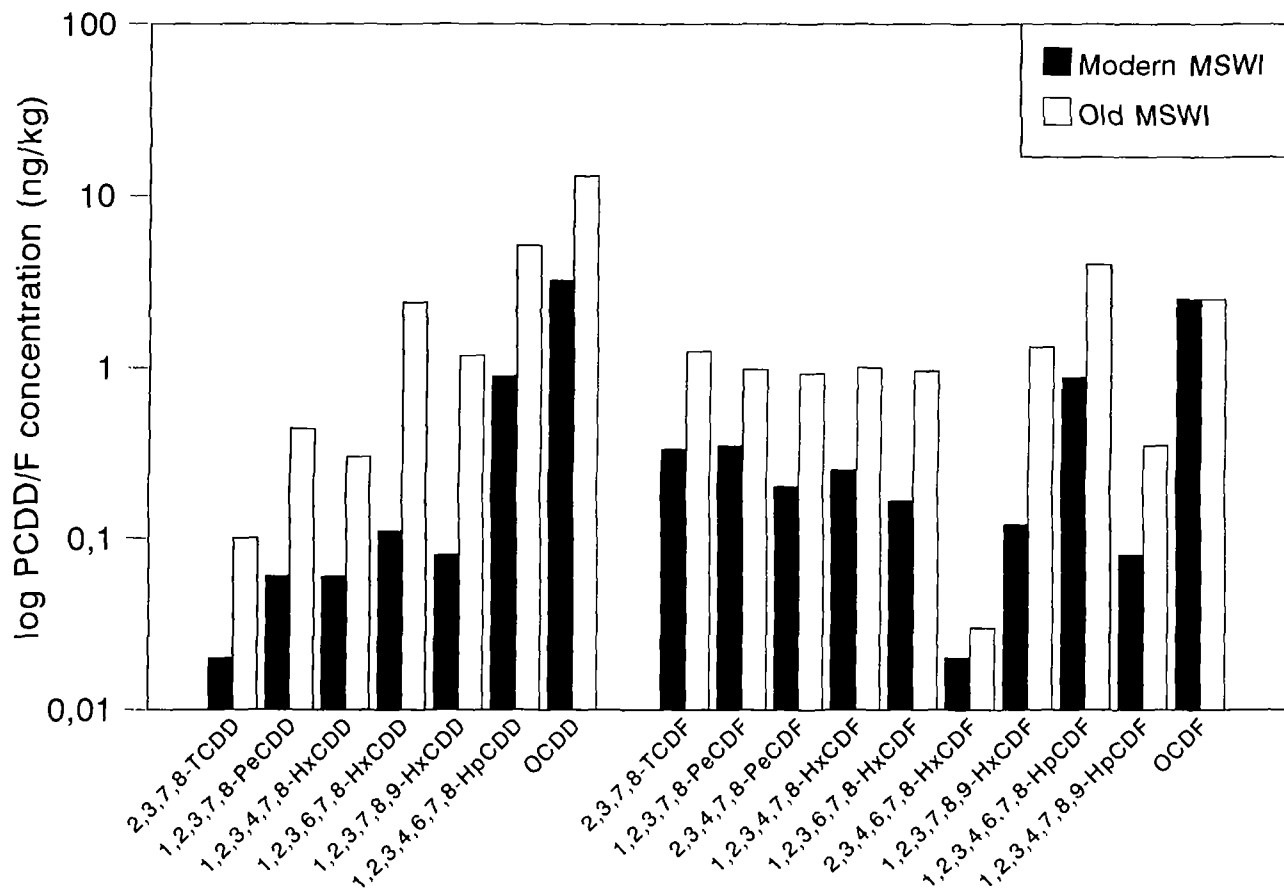


Fig 1. Median congener group profiles (PCDD/F) in vegetation samples

Dioxin '97, Indianapolis, Indiana, USA

Table 2. Levels of PCDD/Fs in vegetation samples collected at increasing distances (meters) from a modern MSWI (Tarragona, Spain)*

	250	500	750	1000	1250	1500
2,3,7,8-TeCDD	0.02	0.02	0.02	0.06	0.02	0.02
1,2,3,7,8-PeCDD	0.10	0.05	0.05	0.04	0.02	0.04
1,2,3,4,7,8-HxCDD	0.06	0.04	0.05	0.02	0.04	0.06
1,2,3,6,7,8-HxCDD	0.12	0.12	0.09	0.12	0.11	0.07
1,2,3,7,8,9-HxCDD	0.12	0.08	0.06	0.07	0.02	0.07
1,2,3,4,6,7,8-HpCDD	1.62	1.13	0.69	0.82	0.80	0.75
OCDD	6.13	3.99	2.38	3.70	2.63	2.77
2,3,7,8-TeCDF	0.38	0.30	0.35	0.38	3.43	0.35
1,2,3,7,8-PeCDF	0.33	0.37	0.51	0.49	7.80	0.50
2,3,4,7,8-PeCDF	0.20	0.18	0.16	0.19	1.98	0.17
1,2,3,4,7,8-HxCDF	0.20	0.21	0.36	0.33	20.67	0.28
1,2,3,6,7,8-HxCDF	0.17	0.18	0.24	0.24	4.00	0.23
2,3,4,6,7,8-HxCDF	0.02	0.02	0.02	0.02	0.15	0.02
1,2,3,7,8,9-HxCDF	0.19	0.15	0.12	0.10	0.27	0.10
1,2,3,4,6,7,8-HpCDF	1.06	0.83	0.74	0.73	5.41	0.86
1,2,3,4,7,8,9-HpCDF	0.08	0.07	0.06	0.09	1.89	0.08
OCDF	3.30	2.96	3.06	3.84	6.53	1.99
Teq PCDDs	0.119	0.088	0.071	0.103	0.057	0.069
Teq PCDFs	0.218	0.204	0.222	0.236	4.308	0.217
Teq TOTAL	0.337	0.292	0.293	0.339	4.365	0.286

*Results (ng/kg dry matter) are given as median values.

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