Temporal Variation of PCDD/F Concentrations in Soil Samples Collected Near to a Municipal Solid Waste Incinerator

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Introduction

Municipal solid waste incinerators (MSWs) are important contributors to emissions of polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) into air. PCDD/F emissions from these facilities are responsible for the presence of these organic pollutants in all environmental compartments (air, soils, sediments, vegetation and water). Given the persistent nature and relative immobility of these compounds, terrestrial and aquatic organisms are liable to exposure (1,2). Consequently, food consumption constitutes the main route of human exposure to PCDDs and PCDFs, which are highly toxic environmental pollutants (3-5).

In order to assess the temporal variation in the levels of PCDD/Fs in soil and vegetation in the vicinity of a new MSW incinerator (Tarragona, southern Catalonia, Spain), in 1996 (6,7) and again in 1997 soil and vegetation samples were collected and PCDD/F concentrations were determined. PCDD/F levels in soil samples are here presented. The results of the 1996 and 1997 studies are also compared.

Materials and Methods

In May 1997, one year after the first soil sampling, 24 soil samples were collected in the vicinity of the MSWI in the same points in which samples had been also taken in the 1996 survey (6). Soil samples were clayey and sandy. The organic carbon content ranged between 0.30 and 8.28%. Duplicate soil samples were collected at 250, 500, 750, 1000, 1250 and 1500 m from the stack in each of the four main directions of the wind rose in the area (NE, NW, SE, SW). Soil samples were dried and sieved (2 mm mesh).

The extraction and clean-up procedures, as well as the analytical determination of PCDD/Fs were carried out as previously reported (6). Samples were analyzed for each of the five chlorinated dibenzo-p-dioxin and dibenzofuran congener groups by HRGC/HRMS with a

Fisons 8060 Gas Chromatograph equipped with a 60 m DB-5 (J & W Scientific) fused silica capillary column (0.25 mm ID, 0.25 μm film) coupled to a VG-AutoSpec Ultima Mass Spectrometer operating in the EI mode at 10.000 resolving power. Detection limit was between 0.013 ng/kg to 0.188 ng/kg from isomers tetra- to octachloro PCDD/Fs. For I-TEQ calculations, in the case of values under the detection limit the congener was assumed to be present at one-half of the detection limit. Kruskal-Wallis test and Principal Component Analysis (PCA) were used for data comparison.

Results and Discussion

PCDD/F concentrations in soil samples ranged from 0.11 to 3.88 ng I-TEQ/kg (dry matter), with a median value of 0.88 ng I-TEQ/kg and a mean value of 1.17 ng I-TEQ/kg. In the 1996 survey, PCDD/F concentrations ranged between 0.22 and 5.80 ng I-TEQ/kg (dry matter), with a median value of 0.80 ng I-TEQ/kg and a mean value of 1.08 ng I-TEQ/kg. Most Cl_4-Cl_8 PCDD/Fs could be detected in all samples. In the previous survey, 2,3,7,8-TCDD was identified in 18 of the 24 samples, with the highest concentration being 0.07 ng/kg (dry matter) (6). In the present survey, 2,3,7,8-TCDD was detected in 20 of the 24 samples, with the highest level being 0.13 ng/kg (dry matter) (detection limit: 0.01-0.05 ng/kg).

Figure 1 shows the calculated total I-TEQ in the area in the 1996 and 1997 monitoring programs for the four main wind directions. With the exception of the samples at NE direction, in which a slightly decrease could be observed, PCDD/F levels increased during the last year. Increases were especially notorious at the SW direction (24%). However, the differences did not reach the level of statistical significance ($p < 0.05$).

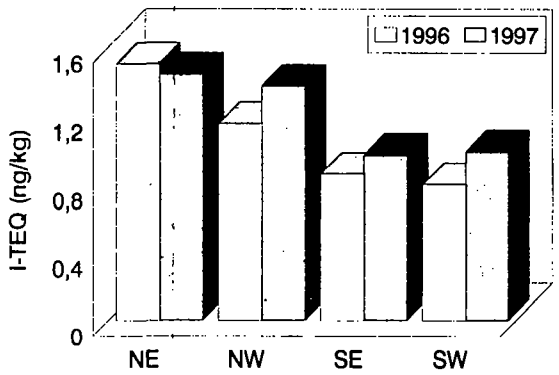

Fig. 1. PCDD/F levels in soils collected in the vicinity of a new MSWI (Tarragona, Spain) according to the main wind directions in the area.

The concentrations of PCDD/Fs in soil samples according to the different distances from the stack are given in Figure 2. In the 1997 sampling, the highest mean (I-TEQ) concentration in soil was found at 1000 m from the MSWI (1.95 ng I-TEQ/kg, dry matter). High PCDD/F levels were also observed at 1500 m from the stack (1.62 ng I-TEQ/kg, dry matter) and near the incinerator, 250 m (1.46 ng I-TEQ/kg, dry matter). In the 1996 survey, the highest

PCDD/F level was found at 250 m from the stack (1.11 ng I-TEQ/kg, dry matter), followed by samples collected at 1500 m (0.96 ng I-TEQ/kg, dry matter). Notwithstanding, no significant differences in PCDD/F concentrations between samples taken at different distances could be observed.

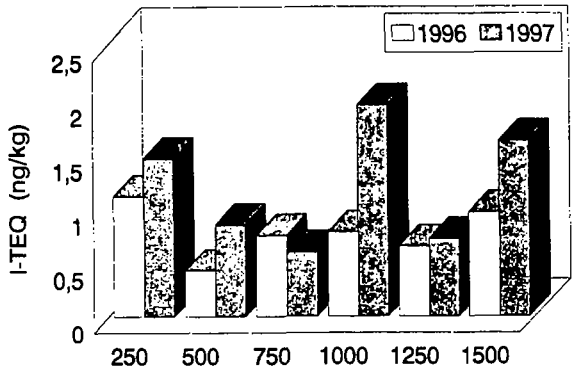

Fig. 2. PCDD/F levels in soils collected at increasing distances from a new MSWI (Tarragona, Spain).

In order to correlate the PCDD/F data for soil samples during the two monitoring periods, as well as to evaluate potential changes in the isomer distribution, PCA was applied to the 24 soil samples collected during 1997 survey, together with those (24 samples) taken at the same points during the 1996 sampling. This analysis provided a single two-dimensional model, which would explain 78.4% of the variance in the data. The first main PC (which would explain 47.6% of the variance) was strongly and positively correlated with the PCDFs, while the second PC (30.8% of the variance) was correlated with TCDD, PeCDD and all the HxCDDs. The scatterplot of the component scores of both PC is depicted in Figure 3.

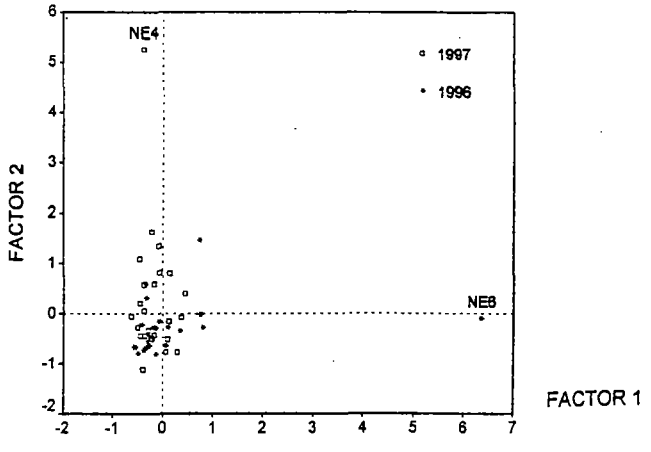

Fig. 3. Principal component analysis: plot for soil samples collected in the vicinity of a new MSWI (Tarragona, Spain) in 1996 and again in 1997.

In summary, the results of the current survey show that, in general terms, PCDD/F concentrations in soils collected in the vicinity of the MSWI did not increase considerably during the last year. Moreover, a new technological equipment that has been recently installed in the plant, should reduce future PCDD/F emissions.

Acknowledgements

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References

1. Bruzy LP and Hites RA; *Environ. Sci. Technol.* **1995**, 29, 39.
2. Rappe C, Andersson R, Bonner M, Cooper K, Fiedler H, Howell F, Kulp SE and Lau C; *Chemosphere* **1997**, 34, 1297.
3. Pohl H, DeRosa C and Holler J; *Chemosphere* **1995**, 31, 2437.
4. Hansen LG and O'Keefe PW; *Arch. Environ. Contam. Toxicol.* **1996**, 31, 271.
5. Hendriks AJ, Wever H, Olie K, van de Gutche K, Liem AKD, van Oosterom RAA and van Zorge J; *Arch. Environ. Contam. Toxicol.* **1996**, 31, 263.
6. Schuhmacher M, Granero S, Xifró A, Domingo JL, Rivera J and Eljarrat E; *Organohalogen Compd.* **1996**, 28, 330.
7. Schuhmacher M, Domingo JL, Llobet JM, Müller L and Jager J; *Sci. Total Environ.* **1997**, 201, 53.