Dirasat, Pure Sciences, Volume **32**, No. **1**, 2005

Detection of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans in Some Environmental Samples from the Palestinian Territories (Research Note)

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ABSTRACT

Polychlorinated Dibenzo-*p*-Dioxin (PCDD) and Dibenzofuran (PCDF) congener levels from different sources such as cesspool waste, incinerator ash, and commercial 2,4-D herbicide in the Palestinian West Bank territories were detected. Results indicated the presence of high levels of both dioxins and furans in these sources.

INTRODUCTION

For about five decades, we have witnessed a dramatic increase in the manufacture and use of chlorinated organic chemicals and plastics. For chemicals, it was insecticides, germicides and herbicides. For plastics, it was primarily Polyvinyl Chloride (PVC). When these chemicals and plastics are burned in mass-burn incinerators, dioxins and furans are produced as unwanted, but inevitable by-product.

During the past five years, research has been initiated to explore the presence of dioxins and related persistent organic contaminants in the Palestinian territories. This effort has produced the first data now available concerning levels of dioxins, dibenzofurans and dioxin-like Polychlorinated Biphenyls (PCBs) in human milk, food, blood (Schecter et al., 1997). Certain herbicides have also been tested for their dioxin content, including the phenoxy herbicide 2,4-D from different sources in the Middle East, the former Soviet Union, and the United States (Schecter et al., 1997; 1998; 1993).

This work deals with the contamination levels of dioxin and furans in two ash samples from a Palestinian West Bank incinerator. The incinerator is located in an industrial area in the surroundings of the city of Nablus, northern part of the West Bank. It is worthwhile mentioning that this is the only operating incinerator in the Palestinian territories. According to a Nablus municipality survey that was carried out in 1993, the incinerator handles an uncontrolled dumping mixture of domestic, industrial and medical waste without sourcing procedures. According to a survey conducted by the World Service in November 1994, increasing cases of lung cancer were discovered among the inhabitants of Beit Dajan, the nearest village to the existing dumping site which contains waste of very similar composition to that introduced to the incinerator (Environmental Profiles for the West Bank, 1996).

In addition, we studied the levels of dioxins and furans in dried wastewater, from a collection cesspool on the campus of Al-Quds University in Abu-Dies and in a sample of commercial grade of the herbicide, 2,4-D that is used regularly in the West Bank.

EXPERIMENTAL

Materials

Commercial 2,4-Dichlorophenoxy acetic acid (2,4-D) herbicide was purchased from SANACHEM, South Africa.

Sampling

A sewage wastewater sample was collected from a domestic sewage (located in the campus of Al-Quds University in Abu-Dies) running in the area of the municipality of Jerusalem. One liter of sewage was dried and 2 grams of the powder was used for the analysis. Two samples (5 grams each) of incinerator ash powder

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were collected simultaneously but from different spots within the same major incinerator of Nablus in the West Bank. All the samples were freshly collected and directly shipped to ERGO laboratory, a World Health Organization certified dioxin laboratory, for dioxin analyses, Hamburg, Germany.

Sample Analysis

Analytical methodology involving spiking with ^{13}C-labeled internal standards, extraction, cleanup with multi-column systems and high resolution gas chromatography with high resolution mass spectrometry (HRGC/HRMS) has been previously described (Schecter et al., 1993). In addition to the results of dioxin, calculations of the Toxicity Equivalents (TEQ) according to the NATO/CCMS system were carried out.

RESULTS AND DISCUSSION

Tables (1-3) present dioxins and furans (PCDD/PCDF) congener levels and total Toxicity Equivalencies (TEQ) for all four samples in pg/g. These results document the contamination of the studied incinerator ash and cesspool wastewater samples by these compounds. The PCDD/PCDF concentrations in the incinerator ash were from 3954 to 6165 (pg/g) (TEQ). The total concentrations of PCDD/PCDF were between 221247 to 365708 pg/g. The large dioxin levels reported here are consistent with the fact that the composition of the waste dumped at the Nablus incinerator contains large quantities of medical and plastic material waste. The total tetra- and pentachlorinated dioxin and furan levels were higher than the hexa- and heptachlorinated dioxin and furan levels. This is a typical indication of the pyrolysis of PVC as found by Christmann et al. (1989). Moreover, Table (2) shows a higher TEQ contribution (five folds) from furans than from dioxins in these samples.

The results of the commercial 2,4-D herbicide sample (Table 2) showed contamination with certain dioxins and furans congeners, which has been previously reported using the same herbicide but produced by different manufacturers (Schecter et al., 1998). Moreover, dioxins and furans contamination was also found in cesspool waste solid samples. The level of contamination is quite similar to the results reported elsewhere (Alawi et al., 1995).

These samples represent the beginning of dioxin analysis of environmental samples that should be taken from the Palestinian areas. Our findings suggest that there may be more dioxin contamination in various environmental sources than has been previously recognized (Schecter et al., 1997; 1998; 1993; Environmental Profiles for the West Bank, 1996; Christmann et al., 1989; Alawi et al., 1995 and Wilken et al., 1992).

It appears that prompt action is necessary to reduce dioxin threat in Palestine. This can be achieved by adopting decisive and appropriate environmental, educational and legislative policies. Furthermore, introducing pollution control devices (spray dryers and fabric filters) can effectively remove dioxins from the incinerator exhaust gases.

Table 1. Measured Levels and TEQ of Dioxins and Furans in Incinerator Ash (Batch Number 1 and 2) from the Palestinian West Bank pg/g.

PCDDs	Incinerator 1st sample	Incinerator 2nd sample	1-TEF	1-TEQ 1st batch	1-TEQ 2nd batch
2,3,7,8-Tetra-CDD	393	268	1.000	393	268
Total Tetra-CDD	13506	10863	-	-	-
1,2,3,7,8-Penta-CDD	956	582	0.500	478	291
Total Penta-CDD	20858	11565	-	-	-
1,2,3,4,7,8-Hexa-CDD	620	342	0.100	62	34
1,2,3,6,7,8-Hexa-CDD	990	476	0.100	99	48
1,2,3,7,8,9-Hexa-CDD	817	399	0.100	82	40
Total Hexa-CDD	17954	8927	-	-	-
Total Hepta-CDD	6989	2808	-	-	-
OCDD	3141	1054	0.001	3	1
PCDFs					
2,3,7,8-Tetra-CDF	4454	3746	0.100	445	375
Total Tetra-CDF	87415	62671	-	-	-
1,2,3,7,8-Penta-CDF	5486	3874	0.050	274	194
2,3,4,7,8-Penta-CDF	4685	3324	0.500	2343	1662
Total Penta-CDF	106026	65136	-	-	-
1,2,3,4,7,8-Hexa-CDF	7731	4135	0.100	773	414
1,2,3,6,7,8-Hexa-CDF	5453	2934	0.100	545	293
1,2,3,7,8,9-Hexa-CDF	719	390	0.100	72	39
2,3,4,6,7,8-Hexa-CDF	4345	2297	0.100	434	230
Total Hexa-CDF	53492	27717	-	-	-
1,2,3,4,6,7,8-Hepta-CDF	10466	4315	0.010	105	43
1,2,3,4 ,7,8,9-Hepta-CDF	1945	835	0.010	19	8
OCDF	3347	1048	0.001	3	1
Total PCDDs	66225	37284		1150	695
Total PCDFs	299483	183962		5015	3259
Total PCDD/PCDF	365708	221247		6165	3954

1-TEQ, 1-TEF: International toxic equivalent/ -factor.

Table 2. Measured Levels and TEQ of Dioxins and Furans in Commercial 2,4-D Herbicide from the Palestinian West Bank pg/g.

PCDDs	2,4-D	1-TEF	1-TEQ	Detection limit
2,3,7,8-Tetra-CDD	n.d.	1.000	n.d.	4.0
Total Tetra-CDD	26.1	-	-	
1,2,3,7,8-Penta-CDD	n.d.	0.500	n.d.	5.0
Total Penta-CDD	32.8	-	-	
1,2,3,4,7,8-Hexa-CDD	n.d.	0.100	n.d.	5.0
1,2,3,6,7,8-Hexa-CDD	n.d.	0.100	n.d.	5.0
1,2,3,7,8,9-Hexa-CDD	n.d.	0.100	n.d.	5.0
Total Hexa-CDD	8.5	-	-	
Total Hepta-CDD	11.8	-	-	
OCDD	36.2	0.001	0.036	
PCDFs				
2,3,7,8-Tetra-CDF	26.6	0.100	2.660	
Total Tetra-CDF	837.2	-	-	
1,2,3,7,8-Penta-CDF	n.d.	0.050	n.d.	5.0
2,3,4,7,8-Penta-CDF	n.d.	0.500	n.d.	5.0
Total Penta-CDF	73.3	-	-	
1,2,3,4,7,8-Hexa-CDF	9.0	0.100	0.902	
1,2,3,6,7,8-Hexa-CDF	5.4	0.100	0.540	
1,2,3,7,8,9-Hexa-CDF	n.d.	0.100	n.d.	5.0
2,3,4,6,7,8-Hexa-CDF	9.2	0.100	0.919	
Total Hexa-CDF	19.1	-	-	
1,2,3,4,6,7,8-Hepta-CDF	8.4	0.010	0.084	
1,2,3,4 ,7,8,9-Hepta-CDF	n.d.	0.010	n.d.	
OCDF	14.4	0.001	0.014	5.0
Total PCDDs	115.3		0.106	
Total PCDFs	1002.6		5.118	
Total PCDD/PCDF	1117.9		5.224	

1-TEQ, 1-TEF: International toxic equivalent/ -factor.
n.d.: not detected.

Table 3. Measured Levels and TEQ of Dioxins and Furans in Dried Cesspool Waste from the Palestinian West Bank pg/g.

PCDDs	Cesspool waste	1-TEF	1-TEQ
2,3,7,8-Tetra-CDD	198	1.000	198
Total Tetra-CDD	27811	-	-
1,2,3,7,8-Penta-CDD	591	0.500	296
Total Penta-CDD	15753	-	-
1,2,3,4,7,8-Hexa-CDD	477	0.100	48
1,2,3,6,7,8-Hexa-CDD	631	0.100	63
1,2,3,7,8,9-Hexa-CDD	420	0.100	42
Total Hexa-CDD	10792	-	-
Total Hepta-CDD	4091	-	-
OCDD	1763	0.001	2
PCDFs			
2,3,7,8-Tetra-CDF	3664	0.100	366
Total Tetra-CDF	95237	-	-
1,2,3,7,8-Penta-CDF	4156	0.050	208
2,3,4,7,8-Penta-CDF	3150	0.500	1575
Total Penta-CDF	92208	-	-
1,2,3,4,7,8-Hexa-CDF	4174	0.100	417
1,2,3,6,7,8-Hexa-CDF	3113	0.100	311
1,2,3,7,8,9-Hexa-CDF	375	0.100	38
2,3,4,6,7,8-Hexa-CDF	2441	0.100	244
Total Hexa-CDF	32363	-	-
1,2,3,4,6,7,8-Hepta-CDF	5337	0.010	53
1,2,3,4 ,7,8,9-Hepta-CDF	961	0.010	10
OCDF	1636	0.001	2
Total PCDDs	62528		665
Total PCDFs	250872		3224
Total PCDD/PCDF	313400		3889

1-TEQ, 1-TEF: International toxic equivalent/ -factor.

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تقدير مستويات المواد السامة في متشكلات الداي بنزودايوكسين والداي بنزوفيوران عديدة الكلور في عينات بيئية من المناطق الفلسطينية (ملحوظة علمية)

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ملخص

في هذا البحث تم تقدير مستويات المواد السامة المتمثلة في متشكلات الداي بنزو دايوكسين والداي بنزوفيوران عديدة الكلور، المستخلصة من بعض عينات بيئية مثل مخلفات المياه العادمة، ورماد المحارق، ومبيد العشب التجاري (2,4-D) المستعمل في المناطق الفلسطينية. وأثبتت الفحوصات وجود كميات كبيرة من هذه المواد السامة في العينات قيد الدراسة.

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