

LEVELS OF PCDD/PCDF IN AGRICULTURAL MATERIALS IN THE REGION OF OPORTO, PORTUGAL

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Introduction

In the municipal solid waste (MSW) management plan adopted for Oporto, in Portugal, it was built a MSW incinerator with the capacity of 400 000 ton.a⁻¹ commonly referred as LIPOR II. This waste treatment facility is under operation since January 2000, being located in the boarder between the municipalities of Maia and Matosinhos. An External Monitoring Plan (EMP) for the LIPOR II was designed with the objective of assessing the potential impact over the environment of the construction and operation of this facility¹.

One of the main concerns of the EMP is to fulfil the lack of information about the environmental levels of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD and PCDF). The EMP includes a set of monitoring stations in a radius of approximately 10 km from the incinerator, covering a large set of environmental matrices namely, air, water and river sediments, as well as mother milk and human blood samples. PCDD and PCDF levels in these matrices have been presented elsewhere^{2,3,4}. The present discussion focuses on PCDD and PCDF levels found in agricultural material data, such as rural soils, vegetables, chicken eggs and cow milk produced locally from rural stations. These data correspond to samples collected from 1998 until September 2001.

Results and Discussion

Since 1998, the Institute of Environment and Development (IDAD) performed an extensive monitoring campaign of PCDD and PCDF levels in the agricultural material from the region of Oporto. A set of 6 rural monitoring stations in a radius of approximately 10 km from LIPOR II was selected. A short description of the sites is summarized in Table 1. The majority of the monitoring stations are located near the incinerator in the suburbs of Oporto, between the municipalities of Maia and Matosinhos. PCDD and PCDF levels in agricultural material have been measured in soils, vegetable material (forage and cabbage leaves), chicken eggs and cow milk. A total of 38 rural soil samples, 43 vegetable material samples, 36 chicken eggs samples and 36 cow milk samples are reported in the present paper.

PCDD and PCDF levels

PCDD/PCDF data from vegetable food is scarce. However, values found by the EMP show some stations where the average is higher than typical values found in similar materials from several countries^{5,6}. Due to the absence of portuguese guidelines, this paper discusses the results based in the guidelines of the former Federal Health Office of Germany. According to these regulations, typical PCDD/PCDF background level of soil samples should be lower than 5 ng I-TEQ/kg dry matter. PCDD/PCDF levels significantly higher than that value are an indication of a contamination. Results found by the EMP show a monitoring station (ST5) whose average appear higher than that value, in a range where it is advisable to identify the dioxin sources and reduce the emissions. A similar situation

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appears for chicken eggs samples, for the majority of the monitoring stations, whose average indicates higher values than German legal standards (5 pg TEQ(WHO)/g, lipid based)⁷. However, those results can't be related with the operation of LIPOR II, because they correspond to values obtained since 1998, prior to LIPOR II operation. The cow milk samples presents an average that is lower than German legal values (3 pg TEQ(WHO)/g, lipid based). Both chicken eggs and cow milk samples have a wide range of values. Tables 2, 3 and 4 summarize the results obtained by the EMP.

Table 1. Characteristics of the rural monitoring stations of the EMP of LIPOR II.

ID	Name	Distance (m)	Direction	Land-use	Material
ST1	Cabreira	300	ESE	Sub-urban	Forage, Soil
ST2	Carvalhas	1000	S	Sub-urban	Forage, Cabbage leafs, Chicken eggs, Cow milk, Soil
ST3	Gandra	1250	NNW	Rural	Forage, Cabbage leafs, Chicken eggs, Cow milk, Soil
ST4	Gemunde	4500	N	Rural	Forage, Cabbage leafs, Chicken eggs, Cow milk, Soil
ST5	Leça Balio	2500	SE	Sub-urban	Forage, Cabbage leafs, Chicken eggs, Cow milk, Soil
ST6	Moreira	900	NNE	Sub-urban	Forage, Soil

Table 2. Levels of dioxin and furans in vegetable material samples and rural soil in the region of Oporto (average).

Congener <i>N of samples</i>	Vegetable material						Rural soil					
	ST1 <i>4</i>	ST2 <i>9</i>	ST3 <i>7</i>	ST4 <i>10</i>	ST5 <i>10</i>	ST6 <i>3</i>	ST1 <i>6</i>	ST2 <i>7</i>	ST3 <i>6</i>	ST4 <i>7</i>	ST5 <i>6</i>	ST6 <i>6</i>
2,3,7,8TD	0,05	0,08	0,19	0,08	0,09	0,07	0,14	0,09	0,08	0,10	0,32	0,13
1,2,3,7,8 PD	0,09	0,24	0,55	0,19	0,18	0,29	0,53	0,29	0,47	0,39	1,30	0,56
1,2,3,4,7,8 HxD	0,11	0,15	0,34	0,17	0,15	0,42	0,60	0,34	0,34	0,20	3,02	0,87
1,2,3,6,7,8 HxD	0,29	0,38	0,77	0,35	0,50	0,83	2,71	1,79	1,80	1,80	22,06	2,80
1,2,3,7,8,9 HxD	0,15	0,23	0,49	0,25	0,26	0,52	2,17	1,38	2,01	2,54	11,22	2,21
1,2,3,4,6,7,8 HpD	3,78	5,77	5,41	6,09	13,35	10,11	49,68	31,93	11,90	6,53	943,67	44,60
OD	22,79	15,58	7,51	17,60	28,93	43,06	307,1	243,4	57,40	29,0	4241,4	276,52
2,3,7,8 TF	0,32	0,91	1,37	0,71	0,68	0,53	2,64	1,67	1,57	1,24	5,07	3,51
1,2,3,7,8 PF	0,11	0,47	0,71	0,34	0,31	0,20	0,71	0,50	0,45	0,43	1,18	1,09
2,3,4,7,8 PF	0,11	0,38	0,61	0,26	0,25	0,22	0,83	0,53	0,48	0,41	1,33	1,36
1,2,3,4,7,8 HxF	0,22	0,37	0,63	0,33	0,29	0,32	1,78	1,23	0,85	0,79	2,05	3,15
1,2,3,6,7,8 HxF	0,12	0,24	0,47	0,20	0,19	0,21	0,83	0,52	0,42	0,41	0,92	1,33
1,2,3,7,8,9 HxF	0,22	0,01	0,01	0,00	0,01	0,01	1,78	0,10	0,08	0,17	0,11	0,25
2,3,4,6,7,8 HxF	0,14	0,32	0,47	0,22	0,20	0,26	0,86	0,62	0,46	0,44	1,15	1,77
1,2,3,4,6,7,8 HpF	1,03	0,94	1,54	0,98	1,98	0,84	5,43	4,27	1,58	1,40	8,62	8,15
1,2,3,4,7,8,9 HpF	0,13	0,10	0,11	0,15	0,19	0,15	0,67	0,44	0,17	0,26	0,83	0,98
OF	1,68	2,53	2,01	2,55	4,56	2,75	12,88	12,56	2,95	3,37	31,68	16,32
Total D	35,52	60,26	103,50	57,20	75,42	108,60	409,00	313,86	105,92	68,56	5770,58	393,17
Total F	10,84	45,87	77,69	32,11	33,73	20,07	58,12	46,39	28,90	25,97	128,70	91,78
D/F ratio	3,28	1,31	1,33	1,78	2,24	5,41	7,04	6,77	3,66	2,64	44,84	4,28
total D+F	46,36	106,13	181,19	89,31	109,15	128,67	467,12	360,24	134,82	94,53	5899,28	484,95
WHO-TEQ	0,39	0,9	1,6	0,7	0,8	0,91	2,88	1,8	1,7	1,6	16,9	3,58
I-TEQ	0,37	0,77	1,3	0,64	0,74	0,80	2,91	1,91	1,5	1,40	20,06	3,56

Table 3. Levels of dioxin and furans in chicken eggs samples in the region of Oporto (36 samples)

Congener	Range	Average	Standard deviation	Minimum I-TEQ sample	Maximum I-TEQ sample
2,3,7,8TD	0,15 - 2,01	0,85	0,43	0,23	1,09
1,2,3,7,8 PD	0,32 - 9,69	2,46	1,72	0,32	4,55
1,2,3,4,7,8 HxD	0,22 - 5,58	1,43	1,16	0,22	4,19
1,2,3,6,7,8 HxD	0,5 - 10,75	3,85	2,58	0,5	7,43
1,2,3,7,8,9 HxD	0,2 - 4,46	1,40	1,04	0,2	3,43
1,2,3,4,6,7,8 HpD	0,81 - 34,67	7,94	7,28	0,81	9,43
OD	n.d. - 120,9	20,9	26,5	4,00	49,3
2,3,7,8 TF	0,37 - 17,63	5,86	3,34	0,37	8,93
1,2,3,7,8 PF	0,21 - 8,75	3,27	1,91	0,21	7,40
2,3,4,7,8 PF	0,47 - 8,83	3,43	2,22	0,47	8,83
1,2,3,4,7,8 HxF	0,59 - 17,3	3,77	3,86	0,59	17,3
1,2,3,6,7,8 HxF	0,31 - 8,75	2,10	2,11	0,33	8,75
1,2,3,7,8,9 HxF	n.d - 0,82	0,24	0,23	n.d	0,82
2,3,4,6,7,8 HxF	0,26 - 11,24	2,28	2,74	0,42	11,2
1,2,3,4,6,7,8 HpF	n.d - 16,97	2,97	3,53	0,45	16,9
1,2,3,4,7,8,9 HpF	n.d. - 2,21	0,43	0,50	n.d	1,80
OF	n.d. - 16,1	3,43	3,92	n.d	16,1
Total D	6,27 - 154,5	38,9	34,5	6,27	79,4
Total F	3,34 - 98,15	27,9	19,8	3,34	98,2
D/F ratio	1,88 - 1,57	1,40	1,74	1,88	0,81
total D+F	9,61 - 177,6	66,8	42,8	9,61	177,6
WHO-TEQ	1,1 - 16,9	7,40	4,00	1,10	16,9
I-TEQ	0,9 - 14,7	6,19	3,39	0,90	14,7

Table 4. Levels of dioxin and furans in cow milk samples in the region of Oporto (37 samples)

Congener	Range	Average	Standard deviation	Minimum I-TEQ sample	Maximum I-TEQ sample
2,3,7,8TD	n.d - 1,41	0,40	0,33	0,1	1,31
1,2,3,7,8 PD	0,24 - 3,6	0,95	0,74	0,24	3,27
1,2,3,4,7,8 HxD	0,16 - 5,94	0,61	0,93	0,16	5,94
1,2,3,6,7,8 HxD	0,38 - 24,34	1,97	3,91	0,38	24,34
1,2,3,7,8,9 HxD	0,18 - 8,94	0,74	1,43	0,19	8,94
1,2,3,4,6,7,8 HpD	0,32 - 84,12	4,79	13,67	0,32	84,12
OD	n.d. - 58,5	5,54	10,16	3,1	58,5
2,3,7,8 TF	n.d. - 6,91	0,57	1,15	0,31	0,45
1,2,3,7,8 PF	n.d. - 3,65	0,21	0,59	0,12	0,19
2,3,4,7,8 PF	0,35 - 2,4	1,05	0,55	0,35	1,51
1,2,3,4,7,8 HxF	0,34 - 3,52	0,77	0,54	0,37	3,52
1,2,3,6,7,8 HxF	n.d. - 2,97	0,52	0,46	0,21	2,97
1,2,3,7,8,9 HxF	n.d. - 0,61	0,03	0,12	n.d.	n.d.
2,3,4,6,7,8 HxF	n.d. - 2,61	0,47	0,40	0,26	2,61
1,2,3,4,6,7,8 HpF	n.d. - 6,71	0,60	1,16	0,46	6,71
1,2,3,4,7,8,9 HpF	n.d. - 0,92	0,10	0,19	n.d	0,92
OF	n.d - 13,78	1,29	2,40	0,5	4,31
Total D	2,68 - 41,88	14,98	30,34	6,18	186,4
Total F	1,48 - 23,95	5,63	5,29	3,94	23,2
D/F ratio	1,81 - 1,75	2,66	5,73	1,57	8,04

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total D+F	4,44 - 65,83	15,36	13,17	7,07	209,6
WHO-TEQ	0,70 - 11,1	2,50	2,10	0,70	11,1
I-TEQ	0,60 - 9,60	2,04	1,74	0,60	9,60

Conclusions

This paper presents the levels of PCDD and PCDF found in agricultural material from monitoring stations of Maia and Matosinhos, in the region of Oporto, Portugal.

Data obtained since 1998 shows high background levels in soil, vegetable material and chicken eggs samples. That happens in all the monitoring stations considered in case of the chicken eggs.

As far as soil samples are concerned, one of the monitoring stations shows results indicating a background contamination, according to the guidelines of the former Federal Health Office of Germany. Levels found in vegetable material samples are higher than typical values found in similar materials from several other countries.

There is no evidence of any influence of the operation of the MSW incinerator LIPOR II.

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