



## Dietary intake of PCDD/Fs and dioxin-like PCBs of the Belgian population

I. Windal<sup>a</sup>, S. Vandevijvere<sup>a</sup>, M. Maleki<sup>a</sup>, S. Goscinny<sup>a</sup>, C. Vinkx<sup>b</sup>, J.F. Focant<sup>c</sup>, G. Eppe<sup>c</sup>,  
V. Hanot<sup>a</sup>, J. Van Looco<sup>a,\*</sup>

<sup>a</sup>Scientific Institute of Public Health, 14 rue J. Wytsman, B-1050 Bruxelles, Belgium

<sup>b</sup>Federal Public Service Health, Food Chain Safety and Environment, Eurostation II, Place Victor Horta, 40 Box 10, B-1060 Brussels, Belgium

<sup>c</sup>Centre of Analysis of Residues in Traces, University of Liège, B6c, 3, allée de la chimie, Sart-Tilman, B-4000 Liège, Belgium

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### ABSTRACT

The World Health Organization recommends assessing human exposure to contaminants on a regular basis. In order to assess the current dietary exposure of the Belgian adult population to PCDD/Fs and dioxin-like PCBs and to update exposure estimates of 2000–2001, a total diet study was designed. The mean dietary intake of PCDD/Fs and dioxin-like PCBs in the Belgian adult population in 2008 was estimated to be 0.72 pg TEQ kgbw<sup>-1</sup> d<sup>-1</sup> (middle bound concentrations, TEF of 1998) based on occurrence data of 2008 and national food consumption data of 2004. This value is clearly below the Tolerable Weekly Intake (TWI) of 14 pg TEQ kgbw<sup>-1</sup> week<sup>-1</sup> set by the Scientific Committee on Food of the European Commission and below the provisional tolerable monthly intake of 70 pg TEQ kgbw<sup>-1</sup> month<sup>-1</sup> set by the Joint FAO/WHO Expert Committee on Food Additives. Considering the cumulative distribution, the intake was less than 1 pg TEQ kgbw<sup>-1</sup> d<sup>-1</sup> for more than 80% of the population, and less than 2 pg TEQ kgbw<sup>-1</sup> d<sup>-1</sup> for the entire population. When using the 2005 TEF instead of the 1998 TEF, the mean dietary intake in the Belgian adult population was estimated to be 0.61 pg TEQ kgbw<sup>-1</sup> d<sup>-1</sup>.

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### 1. Introduction

The World Health Organization (WHO) recommends assessing human exposure to contaminants on a regular basis. This assessment is required for the evaluation of the health risks associated with the population exposure, the evaluation of time trends of exposure and the assessment of the effectiveness of specific management measures.

Performing a total diet study (TDS) is a very cost-effective way to measure human exposure to contaminants which can be ingested through the diet. Many commonly consumed food items are purchased and combined into food composite samples. Each composite sample is then analyzed to determine the background concentrations. In this way, the number of required analyses is significantly reduced compared to a sample by sample approach and a larger number of matrices can therefore cost-effectively be screened. Through the combination of the concentrations measured and the data from the national food consumption survey, the dietary intake is estimated.

Dioxin-like compounds (polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and dioxin-like polychlorinated biphenyls (DL-PCBs)) are among the priority contaminants defined by WHO to be followed by a TDS. They include

seven 2,3,7,8-substituted PCDDs, ten 2,3,7,8-substituted PCDFs, four *non-ortho* PCBs, and eight *mono-ortho* PCBs. Consumption of food is considered as the major source of non-occupational human exposure to PCDD/Fs (Travis and Hattermer-Frey, 1991; Fries, 1995). A first estimation of the PCDD/Fs and *non-ortho* PCBs dietary intake in Belgium was done by Focant et al. (2002). An estimation of the exposure of the Belgian population was done at the same time by Vrijens et al. (2002). A more recent study from Bilau et al. (2008) used CALUX data from the Belgian Federal monitoring program in Belgium to estimate intake of dioxin and dioxin-like compounds. CALUX is a reporter gene-based cell bioassay that uses genetically-modified cells that respond to chemicals that activate the Aryl hydrocarbon receptor (AhR) such as dioxins and dioxin-like compounds (Garrison et al., 1996). An estimation of the dietary intake of dioxins using CALUX data is however questionable and cannot really be compared to previous studies or studies from other countries due to the many differences between bioassay and chemical analysis data. (Liem, 1999; Van Wouwe et al., 2003; Comité scientifique de l'AFSCA, 2008a).

To assess the current dietary exposure to PCDD/Fs and DL-PCBs in the Belgian adult population and to update exposure estimates of 2000–2001, a TDS was designed: PCDD/Fs and DL-PCBs were measured in 43 composite samples, most of them divided into three main groups: meat and meat products, fish and fish products, and dairy and dairy products. A risk assessment was performed using data from the 2004 national food consumption survey.

\* Corresponding author. Tel.: +32 2 642 53 53; fax: +32 2 642 53 27.  
E-mail address: [Joris.Vanloco@iph.fgov.be](mailto:Joris.Vanloco@iph.fgov.be) (J. Van Looco).

## 2. Materials and methods

### 2.1. Sampling

Since Belgium is a small country, no distinction was made between the different regions. The study focused on food products of animal origin, plus one composite sample of vegetable oil. A total of 529 food samples were purchased in supermarkets representing the five most popular retailer brands in Belgium and in some fish and butcher's shops in Brussels during Fall 2008. Samples were homogenized and mixed to prepare 43 composite samples as described in Table 1. The percentage of each food item within one composite sample was set to represent the proportions of intake as

described in the Belgian food consumption survey performed in 2004: *Game meat*: hind (19%), pheasant (20%), guinea hen (21%), wild boar (11%), quail (12%), pigeon (17%); *Mixed meat preparation and products*: sausage (41%), salami (21%), pie (14%), meatloaf (17%), pudding (1%), horse filet (5%); *Liver and liver products*: liver of veal (34%), pork (18%), rabbit (23%), foie gras (25%); *Other fishes*: trout (56%), halibut (15%), sole (11%), monkfish (10%), Pollock (6%), hake (3%); *Crustacean*: scampi (35%), crab (18%), crayfish (9%), shrimp (30%), prawn (8%); *Mollusk*: mussels (83%), oyster (10%), scallop shell (7%); *Fishery products salads*: tuna salad (33%), crab salad (22%), fish salad (22%), surimi salad (22%); *Other fishery products*: fish stick (33%), surimi (66%); *Vegetable oil*: olive oil (43%), peanuts oil (6%), sunflower oil (4%), salad oil (1%), corn oil (3%), margarine (43%).

**Table 1**  
Concentrations measured in the composite samples.

Composite samples	n <sup>a</sup>	Consumed <sup>b</sup> g d <sup>-1</sup>	Middle bound concentration						% of the PCDD/F + DL-PCB dietary intake (TEF 1998)
			PCDD/F (pg TEQ g fat <sup>-1</sup> )		DL-PCB (pg TEQ g fat <sup>-1</sup> )		PCDD/F + DL-PCB (pg TEQ g fat <sup>-1</sup> )		
			TEF 1998	TEF 2005	TEF 1998	TEF 2005	TEF 1998	TEF 2005	
<b>Dairy products</b>									
Milk	19	89.1	0.87	0.75	1.13	0.98	1.99	1.74	<b>50.7</b>
Belgian cheese	23		0.72	0.63	1.03	0.89	1.75	1.52	6.6
Netherlands cheese	10		0.37	0.37	0.55	0.47	0.92	0.85	
French cheese	23		0.62	0.58	0.65	0.55	1.27	1.14	
Italian cheese	17		0.30	0.30	0.66	0.62	0.96	0.92	
Goat cheese	10		0.30	0.30	0.27	0.23	0.56	0.53	
Butter	12	6.9	0.51	0.43	0.75	0.68	1.25	1.10	13.2
Cream		2.1							2.8
Cheese		39.5							20.5
Dairy-based dessert		56.9							6.9
<b>Meat and meat products</b>									
Beef meat	10	21.5	0.61	0.52	1.93	1.26	2.54	1.78	<b>21.7</b>
Veal meat	10	3.6	0.50	0.41	1.31	0.84	1.81	1.25	6.4
Pork meat	10	30.2	0.13	0.14	0.26	0.14	0.40	0.28	2.7
Sheep meat	10	4.7	1.36	1.26	0.63	0.60	1.99	1.85	2.4
Turkey meat	10	3.6	0.60	0.58	1.99	1.08	2.59	1.66	3.0
Horse meat	10	1.3	1.50	1.28	4.51	4.25	6.00	5.53	0.6
Chicken meat	10	18.4	0.32	0.30	0.76	0.51	1.08	0.81	0.4
Duck meat	10	0.4	0.13	0.13	0.13	0.08	0.26	0.21	1.8
Rabbit meat	10	1.4	0.13	0.13	0.15	0.09	0.28	0.22	0.0
Game meat	18	1.2	0.87	0.78	0.80	0.60	1.67	1.38	0.1
Mix meat prep and products	23	27.3	0.13	0.13	0.13	0.08	0.26	0.21	0.4
Liver and liver products	10	2.1	1.40	1.08	1.86	1.81	3.26	2.89	2.8
<b>Eggs</b>									
Caged eggs	10	9.6	0.41	0.41	0.48	0.24	0.89	0.64	3.3
Eggs free range hens	10	-	0.45	0.45	0.56	0.31	1.00	0.75	
Organic eggs	10	-	0.75	0.66	0.79	0.49	1.54	1.14	
<b>Fish and fishery products</b>									
Salmon <sup>c</sup>	14	2.7	0.23	0.19	0.74	0.62	0.97	0.81	<b>17.8</b>
Tuna <sup>c</sup>	10	1.5	0.00	0.00	0.01	0.01	0.02	0.01	5.3
Cod <sup>c</sup>	10	3.0	0.00	0.00	0.02	0.01	0.02	0.01	0.0
Herring <sup>c</sup>	8	0.7	0.76	0.61	0.89	0.74	1.64	1.35	0.1
Sardine <sup>c</sup>	7	0.3	0.10	0.10	1.36	1.06	1.46	1.16	2.3
Mackerel <sup>c</sup>	8	0.5	0.10	0.09	0.42	0.36	0.52	0.45	0.9
Other fishes <sup>c</sup>	16	7.5	0.05	0.05	0.22	0.18	0.27	0.22	0.5
Crustacean <sup>c</sup>	12	2.6	0.09	0.08	0.08	0.07	0.17	0.15	4.0
Mollusk <sup>c</sup>	10	1.8	0.40	0.34	0.59	0.52	0.99	0.86	0.9
Fishery products salads <sup>c</sup>	9	3.3	0.01	0.01	0.01	0.00	0.02	0.02	3.6
Other Fishery products <sup>c</sup>	14	1.3	0.01	0.01	0.01	0.01	0.03	0.02	0.1
<b>Other</b>									
Animal deep frying fat	4	0.0	0.13	0.13	0.13	0.08	0.26	0.21	<b>4.8</b>
Croissant	20	5.9	0.08	0.07	0.05	0.05	0.13	0.12	0.0
Cake, pies, pastry	30	22.4	0.08	0.07	0.05	0.05	0.13	0.11	0.3
Biscuit	30	16.1	0.06	0.06	0.05	0.05	0.11	0.10	0.8
Pizza	10	12.1	0.13	0.13	0.32	0.09	0.45	0.22	0.7
Vegetable oil	25	-	0.13	0.13	0.13	0.08	0.26	0.21	1.1
Choco pasta	9	4.6	0.28	0.13	0.25	0.22	0.53	0.51	-
									1.9

<sup>a</sup> n = Number of food items in the composite sample.

<sup>b</sup> Standard deviation of the consumption data are summarized in Table S3 of the Supplementary material.

<sup>c</sup> Results expressed in pg TEQ g fresh weight<sup>-1</sup>.

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