Food contamination with polychlorinated biphenyls and dioxins in Belgium. Effects on the body burden

N Van Larebeke, A Covaci, P Schepens, L Hens

The core paper of this debate shows that persistent organic pollutant residues of the 12 chemicals targeted for a phase out under the Stockholm Convention are present in almost all categories of food in the US food supply. For dioxins, the study does not use measured data, but is based upon potential dioxin residues in selected food items. Polychlorinated biphenyls are not included in the study. In this paper we discuss selected data of polychlorinated biphenyl and dioxin concentrations in Belgian food. Some of these exposures are chronic, others are attributable to incidents. Both result in high body burdens in Belgium. The paper also compares the current concentrations in food with the recent standards launched by the EU for dioxins in food, and discusses whether these values adequately protect European citizens.

**CHRONIC EXPOSURE**

Background emissions of dioxins in Belgium are high. Although the emissions of primary sources are decreasing, concentrations in the food chain remain among the highest worldwide. In 1995, 1.151 g I-TEQ of dioxins were emitted in Belgium. A comparison of dioxin and furan inventories for 15 countries shows that the per capita emission in Belgium is the second highest after Japan. Sixty per cent of this value is attributable to emissions into the air.

Quantitative data on PCB fluxes for the country as a whole are not available, but some data point to an important diffuse chronic background contamination of these foodstuffs with polychlorinated biphenyls (PCBs).

In a study that aimed at monitoring Belgian chicken and pork intended for export, produced by farms not suspected of being involved in the PCB/dioxin crisis in early 1999, seven marker PCBs (IUPAC numbers 28, 52, 101, 118, 138, 153, and 180) were analysed in 1850 samples. It was found that in 88% of the samples concentrations of PCBs were below 50 ng PCBs/g fat, while 12% of these chicken or pork samples contained more than 50 ng PCBs/g fat. Some 1.2% of the samples even contained more than 200 ng PCBs/g fat. Two per cent of the samples exceeded the limit set by the Belgian authorities.

**ACUTE EXPOSURE**

To these background emissions are added PCBs and dioxins, which are incidentally admixed to the food chain. During the period 1998–2001, three incidents of contamination of the Belgian food chain through PCB/dioxin contamination of animal feed were reported. The most dramatic one occurred in 1999. In January that year, approximately 50 kg of mineral oil containing PCBs and almost 1 gram of dioxins (the most likely source being discarded transformers originating from a waste recycling centre) was admixed to the fat delivered to 10 animal feed producers. The resulting 300 tons of contaminated animal feed were distributed to poultry farms and, to a lesser extent, also to rabbit, calf, cow, and pig breeding and raising farms, mostly in Belgium, but also in the neighbouring countries. Through the animals the PCBs and dioxins spread over the whole food chain. Chicken, pork, and eggs were the most contaminated products. The authorities only started to act convincingly on the issue after 27 May, when the media made the incident known to the public. One of the actions taken was a large scale monitoring project of PCB and dioxins in food. During the period May to August 1999, 20 491 food samples were analysed. During the period after August 1999, over 40 000 samples were analysed as a direct response to the incident.

The highest dioxin concentrations were found in poultry fat and eggs. In 6.5% of the poultry samples and 8.1% of the egg samples, concentrations above 200 ng PCBs/g fat were found. For dioxins, concentrations above 2 pg/g fat were found in 41.9% of the poultry samples and 63.6% of the egg samples. Of core importance is whether these types of separate incidents have an effect on the body burden of the population. Table 1 shows the results of measurements of three marker PCBs in bloodfat for three groups of Belgian women. One group was monitored before the 1999 incident. The two other groups were studied after the crisis. The data suggest that the crisis caused an important increase in PCB body burden. Although these figures need to be interpreted with caution (for example, because the three groups are not directly comparable), any increase is worrisome as body burdens of PCBs and dioxins of the magnitude found in Belgium have been associated with adverse effects both in animals and in humans.

**NEW EU STANDARDS**

As a partial response to the 1999 PCB/dioxin incident in Belgium, the Health and Consumer

**Abbreviations:** POPs, persistent organic pollutants; PCBs, polychlorinated biphenyls
Protection division of the European Commission has established new maximum limits for dioxins in food. The regulation entered into force on 1 July 2002. Maximum levels range between 0.75 pg WHO-PCDD/F TEQ/g fat (for vegetable oil) to 6 pg TEQ/g fat (for liver and derived products). For fish and fishery products, the standard is 4 pg TEQ/g fresh weight. Through this expression of concentration per gram fresh weight, the sum of dioxins TEQs in fish will exceed 10 to 20 times the maximum residual limits set for animal meat or dairy products.

Table 1: PCB body burdens in Belgium women before and after the contamination crisis early in 1999

<table>
<thead>
<tr>
<th>PCB 138 (ng/g fat)</th>
<th>PCB 153 (ng/g fat)</th>
<th>PCB 180 (ng/g fat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996–1998</td>
<td></td>
<td></td>
</tr>
<tr>
<td>106 infertile women (aged 24–42) [mean age 31.9] *</td>
<td>69.9</td>
<td>94.5</td>
</tr>
<tr>
<td>Second half of 1999</td>
<td></td>
<td></td>
</tr>
<tr>
<td>120 girls [mean age 17.4] 10</td>
<td>75.9</td>
<td>101.6</td>
</tr>
<tr>
<td>197 women aged 50–65 [mean age 58.5] 10</td>
<td>125.4</td>
<td>171.1</td>
</tr>
<tr>
<td>Body burden increase in 1999, after correction for age * as percentage of the body burden found during 1996–1998 in infertile women</td>
<td>33.6</td>
<td>33.5</td>
</tr>
</tbody>
</table>

*Correction for age was performed through linear extrapolation based on the measurements done in 1999. This linear extrapolation can be expected to underestimate the body burden at age 31.9 years, as it is likely that a proportionally greater increase in body burden with age will occur between age 17.4 and age 31.9 than between age 31.9 and age 58.5. The real age corrected increase between the two periods might thus be higher than the one shown in the table.

Table 2: Maximum daily intake, stemming from an average Belgian diet, of PCDD+PCDF, tolerated according to the new European Council regulation (EC) no 2375/2001 of 29 November 2001 (in pg WHO-PCDD/F-TEQ)

<table>
<thead>
<tr>
<th>Food item</th>
<th>Average daily intake in Belgium (g)</th>
<th>Amount of fat (g fat/100g product)*</th>
<th>Average daily consumption of fat from corresponding food item in Belgium (g)</th>
<th>EU standard (PCDD+PCDF) (pgWHO-PCDD/F-TEQ/g fat of product)*</th>
<th>Maximum daily intake of PCDD+PCDF tolerated according to new regulation (pgWHO-PCDD/F-TEQ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovine meat</td>
<td>54</td>
<td>3.3</td>
<td>1.8</td>
<td>3/g fat</td>
<td>5.4</td>
</tr>
<tr>
<td>Pig meat</td>
<td>56.6</td>
<td>10.7</td>
<td>6.1</td>
<td>1/g fat</td>
<td>6.1</td>
</tr>
<tr>
<td>Poultry meat</td>
<td>53</td>
<td>9.4</td>
<td>5.0</td>
<td>2/g fat</td>
<td>10</td>
</tr>
<tr>
<td>Fish</td>
<td>30</td>
<td></td>
<td></td>
<td>4/g fresh weight</td>
<td>120</td>
</tr>
<tr>
<td>Hen eggs and egg products</td>
<td>30</td>
<td>10.6</td>
<td>3.2</td>
<td>3/g fat</td>
<td>9.6</td>
</tr>
<tr>
<td>Milk</td>
<td>200</td>
<td>3.5</td>
<td>7</td>
<td>3/g fat</td>
<td>21</td>
</tr>
<tr>
<td>Butter</td>
<td>20</td>
<td>83.4</td>
<td>16.7</td>
<td>3/g fat</td>
<td>50.1</td>
</tr>
<tr>
<td>Cheese</td>
<td>30</td>
<td>31.5</td>
<td>9.5</td>
<td>3/g fat</td>
<td>28.5</td>
</tr>
<tr>
<td>Edible (mixed) animal fat</td>
<td>10</td>
<td>100</td>
<td>10</td>
<td>2/g fat</td>
<td>20</td>
</tr>
<tr>
<td>Edible vegetable oils</td>
<td>10</td>
<td>100</td>
<td>10</td>
<td>0.75/g fat</td>
<td>7.5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>278.2</td>
</tr>
</tbody>
</table>

*The value for a popular food item of the corresponding type was taken; as to edible oils and edible fats, the intake of which is 20 g/day, it is assumed that 50% stems from a vegetable source.

REFERENCES


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