LEVELS OF PCDD/Fs AND DL-PCBs IN BELGIAN RIVER EEL SPECIMEN

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Introduction

In recent years the environmental spread of toxic contaminants in European water bodies becomes more and more important in conservation policy and is a concern regarding the health and reproductive success of many freshwater species, including eels. Many of those pollutants are considered as potential carcinogens and some of them are believed to disrupt the metabolism and endocrine function of the human body[1]. Research has indicated that pollution of waterways with dioxins (PCDD/Fs) and dioxin-like chemicals, including the now banned industrial chemicals polychlorinated biphenyls (PCBs), may still be having a profound impact on reproductive development and spawning success in the European eel (*Anguilla anguilla* L.)[2]. Consumption of fatty food is the most important source of non-occupational human exposure to PCDD/Fs and PCBs. Meat, dairy products, fish, and other seafood products are the main contributors, for more than 90% of the daily intake[3,4].
Public concern over the adverse health effects of exposure to these toxicants has been enhanced by the Belgium dioxin episode in May 1999 in which a storage tank for animal fat was contaminated with PCBs and dioxins. The European Communion has determined by order that the standard for the sum of dioxins (WHO-PCDD/F TEQ is 4 pg TEQ g^{-1} and for the total-TEQ i.e. the sum of dioxins and (dioxin-like) DL-PCBs (WHO-PCDD/F-PCB TEQ) is 12 pg TEQ g^{-1} (Directive 2002/69/EC).

In 2007 a baseline study was conducted to assess the occurrence of dioxins (PCDD/Fs) and DL-PCBs in (yellow) eels from eight sampling sites from the INBO Eel Pollutant Monitoring Network, a widespread monitoring network for eel pollution in Flanders (the northern region of Belgium). Results give an indication on the current dioxin concentrations in Belgian river eels.

Materials and Methods

Field sampling

Between 2001 and 2005, eels were captured by elecrofishing, fykenets or a combination of both. Eels were always caught between June and October. Eels from sampling sites at the Itterbeek, Oude Durme, Congovaart, Canal of Beverlo, Canal Bocholt-Herentals, kreek van Nieuwendamme, klein Zuunbekken, Willebroekse vaart were chosen for the baseline study. After capture, eels were sorted according to life history stage and only yellow eel were placed in cooling units for live transport to the laboratory. At the lab, eel were measured, weighed and six samples of muscle tissue (10 g wet weight each) were removed, labelled and stored at -20°C. From each sampling location, tissues from 10 individual eels were pooled prior to homogenisation and analysis. Total sample weight ranged between 4.4 and 5 g from which approximately 5 g was taken for analysis. Fishes were of variable length and weight, ranging between 35.3 – 43.2 cm and 77.8 – 162.3 g, respectively.

Chemical analysis

Sample preparation, separation, and measurement were performed ion the CART laboratory of the University of Liège with strict QA/QC criteria under BELAC accreditation.

Results and Discussion

Eight pooled samples of eels from eight sites were investigated. Table 1 gives an overview of the dioxin concentrations (ΣPCDD/F; pg WHO TEQ g^{-1}), the sum of DL-PCB concentrations (ΣDLPCB; pg WHO TEQ g^{-1}), and the total-TEQ concentration (ΣPCDD/F and DL-PCB; pg WHO TEQ g^{-1}) for each site. The results are expressed as pg WHO TEQ ΣPCDDs+PCDFs g^{-1} product (wet weight) instead of on fat basis to reflect actual consumption concentrations. The mean eel length (cm) and mean weight (g) for the eels in each sample even as the fat percentage (%) is given. Results for total-TEQ in relation to the sampling sites also are presented graphically (Figure 1). From Table 1 is known that 50% of the samples exceeds the total-TEQ standard (12 pg g^{-1}) while the PCDD/F standard (4 pg g^{-1}) is never exceeded. DL-PCBs accounted for the highest percentage (96 %) to the total-TEQ value (Figure 2). Results of the PCB congener analyses show that PCB-126 is the most abundant congener in almost all samples, with also notable contributions of the 156- and 118-congeners. The 1,2,3,7,8-PentaCDD and the 2,3,4,7,8-PentaCDF congeners accounted for 62% and 92% respectively of the total PCDD/Fs congeners. The above results are also found by Karll and Ruoff[5], who report that the total toxicity in herring samples was mainly determined by the 2,3,4,7,8-PentaCDF congener.

There aren't enough data in the present study to check the influence of the eel size on the sum of dioxins in relation with the fat percentage.

It is not known whether the levels found in these eels are representative for all eels in the catchments in which they were collected, nor whether they are capable of causing detrimental health impacts and therefore acting as a further contributory factor in the decline of the European eel. Studies have identified adverse effects on reproductive success in eels relating to body burdens of dioxin-like compounds, including some PCBs[2].
Palstra et al. demonstrated that dioxin-like contaminants (including some PCBs) are capable of 'devastating effects' on the development and survival of eel embryos as a result of the high proportion of the contaminant-laden fat reserves being mobilised during spawning, potentially damaging the gonads of the adult fish and even the eggs themselves[6]. They also note that the current gonadal levels of dioxin-like contaminants alone in European eels from many locations are capable of interfering with normal embryonic development, and suggest that such contaminants may have contributed directly to the observed decline in populations. They also observed a correlation between embryo survival time and TEQ levels in the gonads implying TEQ-induced teratogenic effects. The disrupting effects occurred at levels below 4 ng TEQ kg^{-1} gonad, which are below the EU eel consumption standard.

The highest human exposure risk is the consumption of eel from contaminated locations as fish contains more contaminants than most other food products[7]. Baeyens et al. report that rough estimates made by the Belgian Health Council and based on a limited dietary questionnaire exercise, indicate that fish contributes to the assimilation of 10 % of those substances by 45 % of the population and of 50 % by 3 % of the population, respectively3. They also concluded that even a drastic measure, involving the removal of 25 % of the most contaminated fish species from the market, would have only a very limited impact on the daily intake of dioxin-like substances for the average individual. However, the impact would be much stronger for people regularly consuming fish and fish-derived products[3].

Table 1: Overview of the mean length (cm), mean weight (g), the dioxin concentrations (ΣPCDD/F; pg WHO TEQ g^{-1}), the sum of dioxin-like PCB concentration (ΣDLPCB; pg WHO TEQ g^{-1}), and the total-TEQ concentration (ΣPCDD/F and DLPCB; pg WHO TEQ g^{-1}) for each site (wet weight)

Code	Water	Sampling date	Mean length (cm)	Mean weight (g)	Fat %	ΣPCDD/Fs (pg WHO TEQ/g)	ΣDL-PCBs (pg WHO TEQ/g)	Total Σ(pg WHO TEQ/g)
COM	Congovaart + lagoon	10-aug-01	43.2	162.3	10.64	3	138.528	142
IB1	Itterbeek	01-jun-05	38.3	109.3	5.49	0.33	1.393	1.722
KB2	Canal of Bev-erlo	27-oct-05	41.2	110.1	3.58	0.304	2.043	2
KBH1B	Canal Bocholt-Herentals	07-oct-02	41.3	115.1	10.19	3	81.482	84
KNN	Creek of Nieu-wendamme	06-nov-02	35.3	77.8	9.96	0.259	1.61	2
KZ	klein Zuunbek-ken	24-sep-02	39.6	107.0	15.01	2	23.39	25
ODU	Oude Durme	24-oct-02	38.6	99.6	8.93	0.624	3.978	5
WBV6	Willebroekse vaart	14-oct-02	39.7	103.1	10.1	0.687	24.035	25

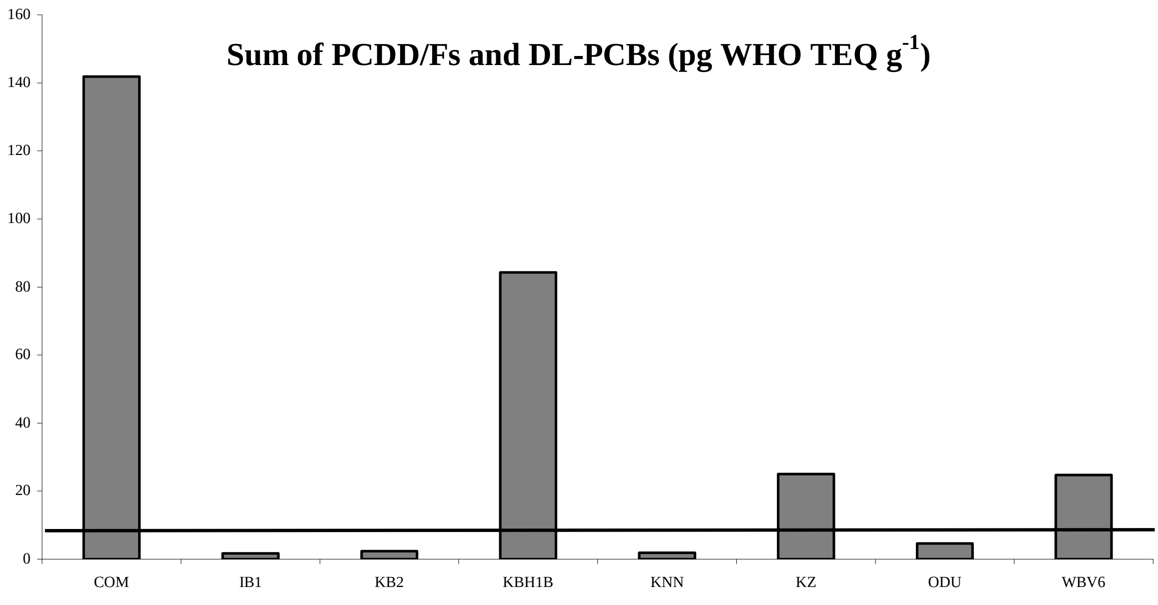

Figure 1: Concentration of sum of PCDD/Fs and DL-PCBs (pg WHO TEQ g^{-1}) in eel muscle for eight pole samples (2001-2005). The bar present the European standard of 12 pg TEQ g^{-1} (Directive 2002/69/EC) in eel muscle (wet weight).

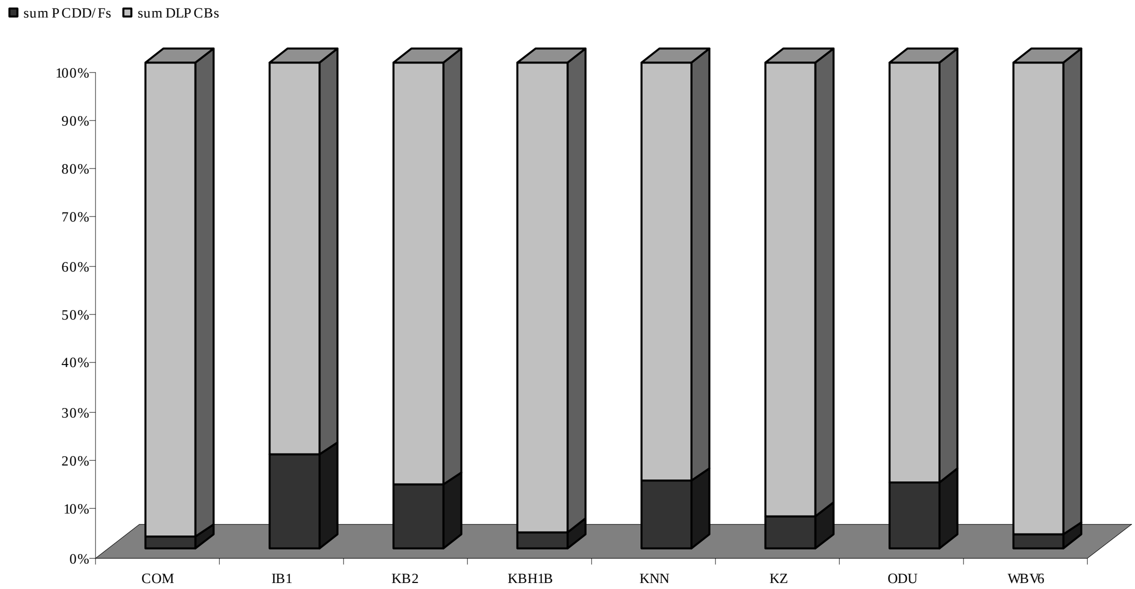

Figure 2: Comparison of the percentage of the sum of PCDD/Fs and DL-PCBs (pg WHO TEQ g^{-1}) in eel muscle in eight pole samples. It is clear that the overrunning of the total-TEQ standard (12 pg WHO TEQ g^{-1}) on those four sites is due to dioxin-like PCBs (wet weight).

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