

PCDD/PCDF levels in farmed eels at different stages of growth

Gianfranco Diletti¹, Alessandro Ripani¹, Roberta Ceci¹, Alfonso De Benedictis¹, Giampiero Scortichini¹

¹Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise

Introduction

In 2000, the Co-operation on Questions Relating to Food Scientific Committee (SCOOP) has published results of the average PCDDs and PCDFs contamination levels found in food of animal origin and vegetables in European Countries. Fish, whether farmed or wild, were the most contaminated food, with an average level of 10 ng I-TEQ/kg of fat¹. In the same year, the Scientific Committee on Animal Nutrition (SCAN) published results of dioxin contamination levels in raw materials for animal feeds and their contribution to the accumulation of such substances in food of animal origin². The main SCAN conclusions report that fish meal and fish oil are the most heavily PCDDs and PCDFs contaminated feed materials, with levels of 1.2 and 4.8 ng WHO-TEQ/kg respectively. Therefore, carnivorous farmed fish are particularly exposed to dioxin contamination, because the typical feeds used for their production are mainly composed by fish meal (50%) and fish oil (25%)². Numerous studies regarding the levels and the profiles of contamination by dioxin in some fishing species can be found in literature, while information on eels are limited³⁻⁶. The aim of this study was to evaluate PCDD/Fs levels and congener distribution patterns in farmed eels at different stages of growth, and in the feed used during the fattening period.

Materials and methods

Farm's characteristics

The eel samples were taken from a farm located in Puglia region (Italy). The farm uses basins with continuously circulating ground spring water that is electrically pumped. Elvers, fished along the French coasts, are weaned in special basins for 2-3 months. During this stage, elvers are fed with floating mangers filled with feeds and sardines. Feed composition was as follows: water 48%, fat 6%, ash 5%, protein 25%, fiber 0.5%. In the following fattening stage, eels are moved into circular selection basins and fed solely on feeds. They can be marketed after they reach 150-400 g of weight.

Sample selection

In August 2004, a total number of 30 eels to be sampled were fished by square fishnet in the different selection basins. Eels were immediately frozen using dry ice and transported to the laboratory. A sample each of weaning and fattening feed was also taken. All animals were divided into 5 groups according to weight (see table 1). Feeds and eels samples were homogenized and analysed to determine their dioxin concentration.

Table 1. Biometric data relevant to the 5 eel groups

Eel group	Number of eels	Weight (g) average	Weight (g) range
Group 1	7	19.2	17.5 - 20.1
Group 2	7	52.9	47.5 – 55.4
Group 3	7	76.3	73.0 – 78.4
Group 4	7	103.4	97.3 – 109
Group 5	2	246	201 – 293

Chemical analysis

After fat extraction and acid/base partitioning a further purification was performed according to EPA Method 1613 Rev B that was adapted to food samples and associated contamination levels^{7, 8}. All samples were analysed by high-resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS); the mass spectrometer was operated with EI ionisation in the selected ion monitoring (SIM) mode at a resolution of 10000. The HRGC/HRMS system consisted of a ThermoFinnigan MAT 95XL spectrometer coupled to a ThermoQuest Trace Series 2000 gas chromatograph. TEQ values were calculated using WHO-TEFs. According to the European legislation, WHO-TEQs were calculated as upper bound concentrations assuming that all values of specific dioxins congeners below the limit of determination (LOD) are equal to the respective LOD. The quality control included the regular participation in internationally recognized proficiency testing schemes with positive outcomes (FAPAS - Central Science Laboratory UK, "Dioxins in Food" - Norwegian Institute of Public Health).

Result and discussion

In table 2 the results relating to the levels and profiles of contamination of eel groups and feed are presented. The highest WHO-TEQ value, 0.230 ng-WHO TEQ/kg fresh product, was found in group 4, while the lowest value, 0.067 ng-WHO TEQ/kg fresh product, was found in group 1. The highest contribution to the TEQ, taking into account the mean value of the 5 groups, was due to the 2,3,4,7,8 – PeCDF (46%), followed by 1,2,3,7,8 – PeCDD (23%) and 2,3,7,8 – TCDD (17%), 1,2,3,6,7,8 – HxCDD (3%), and 2,3,7,8 – TCDF (3%). Dioxin concentration found in feed was 0.425 ng-WHO TEQ/kg. Furthermore, feed contamination level was comparable to that found in another study carried out in Italy⁹. Although the available data does not allow an evaluation of the correlation between WHO-TEQs vs. weight of eels from a statistical point of view, an increase in WHO-TEQ values was observed in relation to the increase in weight of eels. The qualitative distribution of contamination profiles of feed and of the five fish groups is shown in figure 1. The five groups of data show the same congener profiles, as the eel weight increased. This profile is similar to those found in recent studies in Spain¹⁰ and Germany⁵. The most abundant congeners, taking into consideration the average value of the five groups, were 2,3,4,7,8 –PeCDF (18%), OCDD (17%), OCDF (12%), 1,2,3,4,6,7,8 – HpCDD (11%), 1,2,3,6,7,8 – HxCDD (6%) and 2,3,7,8 – TCDF (5%). The qualitative profile of feed can be overlapped with that of eels at different stages of growth. Only two congeners, 2,3,7,8 – TCDF and 2,3,4,7,8 – PeCDF, show different contamination percentages. This study is the first investigation on the dioxin contamination condition of farmed eels in Italy. Data obtained could be used to carry out further research focused on the identification of transferring mechanisms of these toxic micropollutants from feeds to eels.

References

1. European Commission: Opinion of the SCF on the Risk Assessment of Dioxins and Dioxin-like PCBs in food, adopted on 22 November 2000.
2. European Commission: Opinion of the Scientific Committee on Animal Nutrition (SCAN) on the dioxin contamination of feedingstuffs and their contribution to the contamination of food of animal origin, adopted on 06 November 2000.
3. Mayer R. 2002. PCDD/PCDF levels in freshwater fish from Southern Germany. *Organohalogen Compounds*. 57: 181-184.
4. Shelepchikov AA, Kluyev NA, Shenderyuk VV, Baholdina LP, Brodsky ES. 2003. Contamination of Russian Baltic fish by PCDD/F. *Organohalogen Compounds*. 62: 152-156.
5. Wiesmuller T. Schlatterer B. 1999. PCDDs/PCDFs and coplanar PCBs in eels (*Anguilla anguilla*) from different areas of the rivers Havel and Oder in the state of Brandenburg (Germany). *Chemosphere* 38:325-334.
6. van der Oost R., Opperhuizen A., Satumalay K., Heida H., Vermeulen N. P. E. 1996. Biomonitoring aquatic pollution with feral eel (*Anguilla anguilla*). *Bioaccumulation: biota-sediment ratios of PCBs, OCPs, PCDDs and PCDFs*. *Aquatic Toxicology* 35:21-46.
7. U.S.EPA (United States Environmental Protection Agency) 1994. Method 1613 Rev. B: "Tetra through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS".
8. Diletti G., Spinosi V., Scarpone R., Di Viesti M., Scortichini G. 2003. Food and animal feed contamination by PCDDs-PCDFs in Italy in year 2001. *Organohalogen Compounds* 64: 179-182.
9. Ceci R., Diletti G., Torreti L., De Benedictis A., Scortichini G. 2004. Animal feed contamination by PCDDs-PCDFs in Italy in years 2002-2003. *Organohalogen Compounds*, 64: 2041-2045
10. Bordajandi L. R., Gomez G., Fernandez M. A., Abad E., Rivera J., Gonzalez M. J. 2003. Study on PCBs, PCDD/Fs, organochlorine pesticides, heavy metals and arsenic content in freshwater fish species from the River Turia (Spain). *Chemosphere* 53:163-171.

Table 2. PCDD/Fs concentrations in eels and feed

Compounds	Group 1	Group 2	Group 3	Group 4	Group 5	Feed*
	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)	(ng/kg)
2378-TCDD	0.013	0.043	0.018	0.032	0.019	0.061
12378-PeCDD	0.015	0.050	0.023	0.035	0.045	0.065
123478-HxCDD	0.019	0.028	0.009	0.036	0.009	0.042
123678-HxCDD	0.013	0.045	0.034	0.096	0.043	0.104
123789-HxCDD	0.014	0.019	0.006	0.034	0.009	0.035
1234678-HpCDD	0.053	0.114	0.027	0.129	0.091	0.361
OCDD	0.084	0.103	0.100	0.255	0.117	0.663
2378-TCDF	0.015	0.035	0.035	0.060	0.052	0.718
12378-PeCDF	0.005	0.003	0.013	0.003	0.025	0.113
23478-PeCDF	0.048	0.084	0.105	0.251	0.193	0.347
123478-HxCDF	0.025	0.020	0.012	0.039	0.013	0.091
123678-HxCDF	0.013	0.018	0.014	0.031	0.012	0.035
123789-HxCDF	0.015	0.016	0.008	0.008	0.007	0.057
234678-HxCDF	0.021	0.029	0.009	0.034	0.010	0.062
1234678-HpCDF	0.011	0.011	0.034	0.090	0.013	0.086
1234789-HpCDF	0.016	0.013	0.009	0.029	0.012	0.055
OCDF	0.044	0.039	0.048	0.237	0.089	0.459
PCDD/F WHO-TEQ	0.067	0.157	0.108	0.230	0.178	0.425

* referred to 12% moisture content

Figure 1. Comparison of contamination patterns in eels (average of 5 groups) and fish feed.