PCDD/PCDF CONTRIBUTE WITH HALF OF THE TOTAL TEQ FOUND IN FATTY FISH FROM THE BALTIC SEA

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Introduction

The European Commission (EC) has published legislation aimed at achieving a reduction in human exposure to dioxins, furans and dioxin-like PCBs. One of the strategies to reduce the human exposure for these persistent contaminants has been to set maximum levels for 17 polychlorinated dibenzo-p-dioxins and dibenzofurans PCDD/DFs) in foodstuffs[1]. The maximum levels for PCDD/DF will come into effect from 1 July 2002. In addition, the member states have been requested to collect and report data for dioxin-like PCBs since the Commission is planning to set maximum levels for these dioxin-like PCB congeners in 2004.

In some member states, including Sweden, certain fatty fish species are suspected to contain levels of contaminants that might exceed the maximum level for fish and fish products, 4 pg WHO-PCDD/DF-TEQ / g fresh weight. Sweden and Finland currently have an exemption from the Council regulation that allows national marketing of fish that exceed the maximum level for PCDD/DF.

The Swedish National Food Administration (SNFA) has undertaken a survey to analyse the concentration of PCDD/DFs and dioxin-like PCBs in fatty fish from the Baltic Sea region. In another paper we present the results from this survey (Bjerselius et al., Dioxin 2002). This study focuses on a limited number of the analysed fish from some of the areas of the Baltic Sea from which PCDD/DFs and dioxin-like PCBs have been analysed. The result shows the contribution of dioxin-like PCBs to the total TEQ compared to the PCDD/DF. We also discuss the large differences between species in the distribution pattern of the analysed contaminants.

Methods and Materials

The study comprises specimen of herring (*Clupea harengus*), salmon (*Salmo salar*) and eel (yellow eel, *Anguilla anguilla*) from a limited number of locations in the Baltic proper. For all fish species, analyses were carried out on muscle tissue except for herring, where the muscle including fish skin was analysed. All fish were caught in fall 2000. Analysis of salmon were done on individual samples (n=10; one sampling area), while analyses of herring and eel were carried out on pooled samples (n=4-9, three sampling areas and n=19-21, four sampling areas, respectively) (see Table for details). Herring was sampled in the northern (Landsort), middle (Gotland) and southern (Utlängan) Baltic proper. From each area, a pooled sample of 4-6 year old females and males (2 groups) and 7-9 year old females and males (2 groups) were analysed for PCDD/DFs and dioxin-like PCBs (see Table for details). In fig. 1, males and females from each area and year class are pooled. From all individuals were taken equal amounts of tissue (in weight) from the area around the dorsal fin. The tissue was pooled and mixed by homogenisation.

Table 1. The fish samples used in the analysis of PCDD/DFs and dioxin-like PCBs. In the statistical presentation of the WHO-TEQ in figures 1 and 3, males and females from each area and year class are pooled.

Species	Gender	Age (years)	Mean weight (g)	Fat content (%)	Location caught	Year caught	No. of analyses (indiv.)
Salmon	Male	*1	3855	8.7	SE Gotland	2000	5(5)
Salmon	Female	*1	4367	8.7	SE Gotland	2000	5(5)
Herring	Male	4-6	39.6	9.4	Landsort	2000	1(9)
Herring	Female	4-6	39.7	7.9	Landsort	2000	1(9)
Herring	Male	7-9	114	11.3	Landsort	2000	1(8)
Herring	Female	7-9	85.9	10.5	Landsort	2000	1(6)
Herring	Male	4-6	32.4	9.4	SE Gotland	2000	1(9)
Herring	Female	4-6	33.3	8.5	SE Gotland	2000	1(9)
Herring	Male	7-9	111.3	13.7	SE Gotland	2000	1(8)
Herring	Female	7-9	118.8	15.8	SE Gotland	2000	1(8)
Herring	Male	4-6	41.3	4.2	Utlängan	2000	1(9)
Herring	Female	4-6	40.7	5.6	Utlängan	2000	1(9)
Herring	Male	7-9	89.15	6.8	Utlängan	2000	1(6)
Herring	Female	7-9	97.7	6.1	Utlängan	2000	1(5)
Eel (Y)	Female	Unknown	339	13.9	Kvädöf.	2000	1(19)
Eel (Y)	Female	Unknown	369	17.3	Marsö	2000	1(21)
Eel (Y)	Female	Unknown	360	14.6	Sturkö	2000	1(20)
Eel (Y)	Female	Unknown	391	19.2	Valjeviken	2000	1(20)

* = The salmon had been in the sea for one year (after two-three years in the river).

Extraction, clean-up and analysis were done according to validated methods at Environmental Chemistry, Umeå University, Sweden. The PCDD/DF and dioxin-like PCBs levels are expressed in pg WHO-TEQ/g fresh weight according to the WHO TEFs for human risk assessment[2]. In calculating the WHO-TEQ values, the upper-bound level has been used for non-detectable levels. The results presented are those for 17 toxic PCDD/DF, 4 non-ortho PCBs (CB 77, 81, 126, 169) and 8 mono-ortho PCBs (CB 105, 114, 118, 123, 156, 157, 167, 189).

Results and Discussion

The distribution pattern of PCDD/DFs and dioxin-like PCBs vary largely between the different species analysed. Biggest difference is noted between the yellow eel and the herring, where the average ratio in percent of the total WHO TEQ for PCDD/DF:non-ortho PCB:mono-ortho PCB is 18:58:24 %

and 54:33:12 %, respectively (Figs. 1, 2). Thus, in the yellow eels, PCDD/DF only contribute with 18 % of the total WHO TEQ while in the herring the corresponding number is as high as 54 %. For salmon it is noteworthy that PCDD/DF contribute with only 36 % of the total WHO TEQ analysed (corresponding ratio 36:48:16) (fig. 3). The result indicates that the contribution of the PCDD/DF is less than half of the total WHO TEQ when the dioxin-like PCBs are incorporated in the total TEQ measured. A comparison between current maximum level for PCDD/DF in fish and the PCDD/DF concentrations found in fish show that the inclusion of TEQs from dioxin-like PCBs will result in TEQ concentrations that in many cases markedly will exceed the present maximum level set for fish.

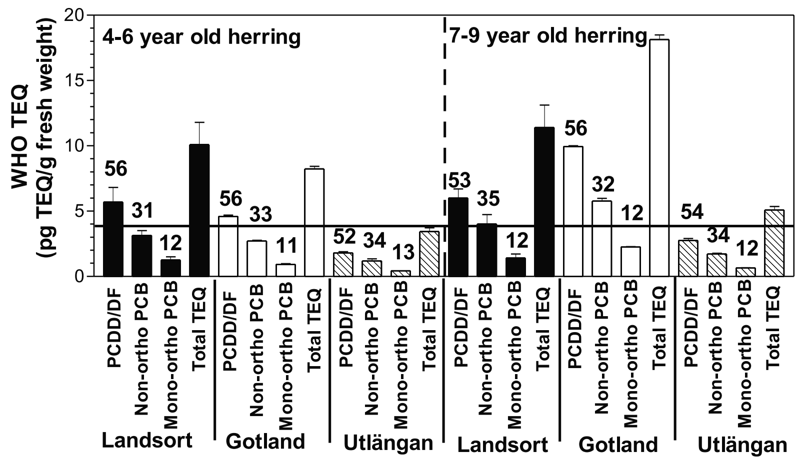
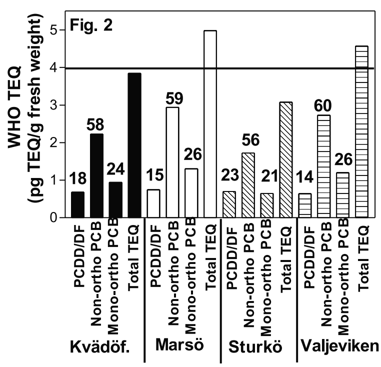


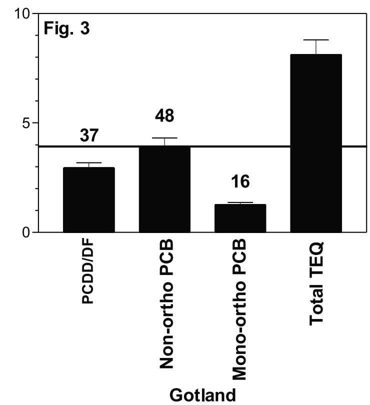
Figure 1. Average WHO-TEQ (pg/g fresh weight) levels of PCDD/DF, non-ortho and mono-ortho PCBs and the total TEQ levels in herring in 2000 from the Baltic proper area. The maximum level for PCDD/DF of 4 pg/g fresh weight is indicated. Numbers above bars indicate percent of total TEQ. See Methods and Material and Table for further details.

While the relative contribution of each of the three groups of contaminants varied considerably among species, the intraspecific variation was surprisingly low. For herring, regardless of catching area and year class, the distribution pattern is almost identical (fig. 1) for the six different categories of herring sampled (i.e. three areas and two year classes from each area). Also the yellow eel show a homogenous pattern between the four different locations sampled (Fig. 2). For herring, one possible explanation could be that herring from the three different sampling areas originate from the same fish stock[3]. On the other hand, it is indicated that the actual concentrations of analysed contaminants varies markedly, both between different year classes at the same catching area (e.g. Gotland area, 4.6-10 pg WHO TEQ/g fresh weight) and regions (e.g. Utlängan vs. Gotland, 1.8 and 10.0 pg WHO TEQ/g fresh weight, respectively). The continuing PCDD/DF survey by SNFA will include also herring analyses from three other areas in the Baltic Sea, with fish stocks of herring that is believed not to mix with the population analysed in the present paper. The result from those analyses will indicate if the pattern of contaminant exposure varies between the different sub-populations in the Baltic Sea region.

For yellow eel, the situation is similar concerning the distribution pattern of analysed contaminants, with a similar picture regardless of catching area, implying similar exposure regimens for the different areas along the south east and south coast of Sweden. However, the result showing that the WHO TEQ in eel derive mainly from the dioxin-like PCBs indicate a quite different source of exposure, alternatively different metabolic capacity, of the eel, a bentic species

living in coastland area, when compared to pelagic species like herring and salmon. Earlier studies have shown that PCDD/DF levels in fish from a single location can vary from year to year and season to season[4]. It is also important to note that the concentrations of environmental organic contaminants can vary considerably in individuals from the same location, depending on factors such as fat content, age, gender, etc.





Figures 2-3. Yellow eel and salmon results. See Figure 1 for explanations.

In a legislative perspective the result shows the importance of getting data for the total concentration of certain groups of contaminants before maximum levels are set. It also illustrates the difficulties for food control authorities to measure and correctly decide if certain batches of fish are exceeding or are below the maximum level, e.g. when the concentration of contaminants in one species (herring) varies between different year classes and regions of the same sub-population.

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