STUDY OF DIOXIN LEVELS IN FATTY FISH FROM SWEDEN 2000 - 2001

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Introduction

In November 2001, the European Commission (EC) published a legislation aimed at achieving a reduction in human exposure to polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/DFs) and polychlorinated biphenyls (PCBs). One of the strategies to reduce the human exposure for PCDD/DFs and dioxin-like PCBs has been to set maximum levels for PCDD/DFs in foodstuffs[1] (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 legislation will come into effect from 1 July 2002. The Council Regulation also carries with it an obligation for Member States to monitor the levels of PCDD/DFs in foodstuffs and report to the EC these data that will ultimately be used to review the maximum limits and gauge the effectiveness of the reduction strategy, with a goal to subsequently reduce the maximum level.

PCDD/DFs and PCBs are still an environmental problem in Sweden, although the use and production of PCBs have been banned for decades and the release of PCDD/DFs have decreased significantly. Because of this, the concentrations in food have declined since the 1970s. However, in fish from some parts of the Baltic Sea, the decline of PCDD/DFs appears to have ceased in the 1990s[2]. Thus, certain fatty fish species are suspected to contain levels of PCDD/DF that might exceed the maximum level for fish and fish products, 4 pg WHO-PCDD/DF-TEQ / g fresh weight.

The Swedish National Food Administration (SNFA) has undertaken a survey to analyse the concentrations of PCDD/DFs and dioxin like PCBs in fatty fish in the Baltic Sea area. This study will report the result from the PCDD/DF analyses. The study's goal is to provide Sweden with: 1) a current base of supporting material for discussion of the maximum levels for PCDD/DF; 2) current data on the concentration of PCDD/DF for coming control programs; 3) current levels of PCDD/DFs and dioxin-like PCBs for covering of Swedish cost recommendations for fatty fish from the Baltic Sea. The study is also designed to examine how age, size, gender and region affect the PCDD/DFs levels in fish. A more detailed analysis of these variables will be carried out when the SNFA has access to the complete data (autumn 2002, presented on www.slv.se as 3 interim reports). More detailed analysis of the material regarding salmon and brown trout[3] and dioxin-like PCBs[4] are available at DIOXIN 2002.

Methods and materials

The study contains PCDD/DF results from analyses done on salmon (*Salmo salar*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*; farmed), herring (*Clupea harengus*), eel (*Anguilla anguilla*; silver and yellow eel), from several locations in the Baltic Sea and Lakes Vänern and Vättern as well as one location (herring) on Sweden's west coast. 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 and 2001. Analysis of salmon and brown trout from Gotland were done on individual samples (n=10 and n=8 respectively) while analysis of the other samples were carried out on pooled samples (see Table for details). The sampling design was intended to cover areas in Sweden were fatty fish are caught on commercial basis as well as in areas were the public perform sport fishing. 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.

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[5]. 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 results show that the concentration of PCDD/DF in salmon and brown trout from the Baltic Sea region, varies relatively little between the different regions studied (2.6-7.8 and 1.5-4.8 pg WHO-TEQ/g fresh weight, respectively), indicating that the exposure situation for PCDD/DF along the Swedish coast is similar (see a more detailed analysis of this in Lundstedt-Enkel Dioxin 2002). There is no indication that there is a sex dependent difference in concentration of PCDD/DF.

The herring result indicates a somewhat greater variation, both regarding catching area and between different year classes. It can be exemplified by the relatively large difference in PCDD/DF concentration between herring from Utlängan and SE Gotland (4-6 years and 7-9 years, respectively) with PCDD/DF values of 1.7 pg and 10.0 WHO-TEQ/g fresh weight, respectively. Earlier studies have shown that PCDD/DF levels in fish also from a single location can vary from year to year and season to season[6]. The continuing PCDD/DF survey will include also herring analyses from three other areas in the Baltic Sea area, with fish stocks of herring that is not believed to mix with the population analysed in the present paper[7]. The result from those analyses will indicate if the concentrations of PCDD/DF vary between the different fish stocks in the Baltic Sea region.

For the eel, the concentration of PCDD/DF is relatively even and independent of catching area and life status (i.e, silver or yellow eel), indicating a quite similar exposure regimens for the different areas along the south east and south coast of Sweden as well as in lakes Mälaren and Hjälmaren.

The results 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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Table 1. The fish samples used in the analysis of PCDD/DFs from the Baltic Sea region. The ”locations caught” are listed geographically from north to south with the lakes at the end for respective species. Y=yellow eel; S=silver eel; WC=West Coast

Species	Gender	Age (years)	Mean weight (g)	Fat content (%)	Location caught	Year caught	No. of analyses (indiv.)	PCDD/DF conc. (min-max)
Salmon	female	*1,8	6462	3,5	R. Luleälv	2001	1(5)	7,8
Salmon	male	*1,2	3425	3,0	R. Luleälv	2001	1(5)	3,1
Salmon	female	*1,4	4547	3,6	R. Ångermanälven	2001	1(5)	5,3
Salmon	male	*1,8	6039	2,6	R. Ångermanälven	2001	1(5)	4,8
Salmon	female	*1,2	3800	3,8	R. Dalälven	2001	1(5)	3,9
Salmon	female	*1,6	4760	4,0	R. Dalälven	2001	1(5)	3,7
Salmon	male	*1	3855	8.7	SE Gotland	2000	5(5)	3.2
(2,2- 4,2)								
Salmon	female	*1	4367	8.7	SE Gotland	2000	5(5)	2.6
(1,8- 3,1)								
Salmon	female	*1	3950	9.9	SE Gotland	2000	1(5)	3.1
Salmon	female	*2,2	7417	2,8	R. Mörrumsån	2001	1(5)	3,7
Salmon	male	*2,0	7986	3,2	R. Mörrumsån	2001	1(5)	3,8
Salmon	female +male	1,4	3574	4,0	S.Vättern	2001	1(10)	1,6
Salmon	Unknown	Unknown	5572	11.5	Farmed Norwegian	2001	1(5)	0.64
Brown trout	female	*3,8	2890	2,88	R. Luleälv	2001	1(5)	4,8
Brown trout	male	*2,6	3467	2,67	R. Luleälv	2001	1(5)	3,8
Brown trout	female	*2,2	4099	4,62	R. Ångermanälven	2001	1(5)	4,6
Brown trout	male	*2,2	3067	4,08	R. Ångermanälven	2001	1(5)	3,5
Brown trout	female	*1,8	2840	3,03	R. Dalälven	2001	1(5)	3,9
Brown trout	male	*1,2	3220	3,96	R. Dalälven	2001	1(5)	3,8
Brown trout	female	*1,3	1523	1,27	Gotland	2001	6(6)	1,5 (0,47-3,6)
Brown trout	male	*1,0	1796	1,91	Gotland	2001	2(2)	1,7 (1,2-2,2)
Brown trout	female	*2,2	5880	3,24	R. Mörrumsån	2001	1(5)	2,6
Brown trout	male	*2,6	7620	2,95	R. Mörrumsån	2001	1(5)	2,9
Brown trout	female	3,1	4868	1,77	N.Vänern	2001	1(9)	3,2
Brown trout	female	2,0	1781	1,29	S.Vättern	2001	1(7)	2,2
Rainbow trout	unknown	1,5	3485	9,16	Stockholm archipelag	2001	1(10)	0,43
Herring	male	4-6	39.6	9.4	Landsort	2000	1(9)	6.8
Herring	female	4-6	39.7	7.9	Landsort	2000	1(9)	4.6
Herring	male	7-9	114.4	11.3	Landsort	2000	1(8)	6.7
Herring	female	7-9	85.9	10.5	Landsort	2000	1(6)	5.3
Herring	male	4-6	32.4	9.4	SE Gotland	2000	1(9)	4.7
Herring	female	4-6	33.3	8.5	SE Gotland	2000	1(9)	4.5
Herring	male	7-9	111.3	13.7	SE Gotland	2000	1(8)	9.9
Herring	female	7-9	118.8	15.8	SE Gotland	2000	1(8)	10
Herring	male	12-13	234.2	11.4	SE Gotland	2000	1(4)	11
Herring	female	12-13	174.7	11.0	SE Gotland	2000	1(4)	7.2
Herring	male	4-6	41.3	4.2	Utlängan	2000	1(9)	1.7
Herring	female	4-6	40.7	5.6	Utlängan	2000	1(9)	1.9
Herring	male	7-9	89.15	6.8	Utlängan	2000	1(6)	2.9
Herring	female	7-9	97.7	6.1	Utlängan	2000	1(5)	2.6
Herring	male	3-4	52.6	7.0	Fladen (WC)	2000	1(4)	0.95
Herring	female	3-4	62.5	8.2	Fladen (WC)	2000	1(4)	0.99

Eel (Y)	female	Unknown	339	13.9	Kvädöfjärden	2000	1(19)	0.67
Eel (Y)	female	Unknown	369	17.3	Marsö	2000	1(21)	0.74
Eel (Y)	female	Unknown	360	14.6	Sturkö	2000	1(20)	0.70
Eel (Y)	female	Unknown	391	19.2	Valjeviken	2000	1(20)	0.64
Eel (Y)	female	7,8	85,3	8,96	West coast	2001	1(10)	0,51
Eel (S)	female	16,1	1088	24,73	Västervik	2001	1(20)	1,5
Eel (S)	female	10,3	661	21,05	Karlshamn	2001	1(10)	0,97
Eel (S)	female	12,8	688	21,23	L. Mälaren	2001	1(10)	0,84
Eel (S)	female	14,9	944	21,63	L. Hjälmaren	2001	1(10)	0,96

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

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