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CHEMISTRY

Monitoring of polychlorinated dibenzo-*p*-dioxins, polychlorinated dibenzofurans, and polychlorinated biphenyls in Estonian food

Ott Roots[a,b*], Hannu Kiviranta[c], Tagli Pitsi[d], Panu Rantakokko[c], Päivi Ruokojärvi[c], Mart Simm[b], Raivo Vokk[d], and Leili Järv[b]

[a] Estonian Environmental Research Institute (under Estonian Environmental Research Centre), Marja 4D, 10617 Tallinn, Estonia
[b] Estonian Marine Institute, University of Tartu, Mäealuse 10a, 12618 Tallinn, Estonia
[c] Laboratory of Chemistry, Department of Environmental Health, National Public Health Institute (KTL), P.O. Box 95, FI-70701 Kuopio, Finland
[d] Department of Food Processing, Tallinn University of Technology, Ehitajate tee 5, 19086 Tallinn, Estonia

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Abstract. Persistent organic pollutants are mainly compounds that include chlorine, which are posing a threat to human health and impairing living organisms and ecosystems due to their toxicity, persistence, and bioaccumulation. National authorities have the responsibility and obligation to ensure that toxic chemicals are not present in food at levels that may adversely affect the health of the consumers. The concentrations of polychlorinated dibenzodioxins/polychlorinated dibenzofurans and dioxin-like polychlorinated biphenyls in food samples (pork, mutton, beef, poultry, butter, milk, eggs, fish preserves, and rape oil) were analysed and compared to overall food consumption data in Estonia. The results indicated that the food consumed in Estonia was safe concerning these chemicals and that the recommended two servings of fish a week would not be harmful to Estonian people's health.

Key words: polychlorinated dibenzodioxins, polychlorinated dibenzofurans, dioxin-like polychlorinated biphenyls, Estonian food, food control.

INTRODUCTION

In order to generate reliable background occurrence data on polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and dioxin-like polychlorinated biphenyls (DL-PCBs), the Commission of the European Communities recommends the member countries to monitor these substances in foodstuffs. A minimum number of analysed samples per country per year in different food categories is recommended by the Commission Recommendation 2006/794/EC. For Estonia the number of annual samples is 24. On the basis of this information, recommendations how to improve chemical food safety management in Estonia will be prepared. This will be achieved by the activities planned in two paths: one aimed at gathering knowledge on sources of dietary data (Pomerleau et al., 2001; Vaask et al., 2006) and the other focussing on strategies/approaches and capabilities of monitoring food chemical contamination with persistent organic pollutants (Maggioni et al., 2009), such as polychlorinated dibenzo-*p*-dioxin (PCDD), PCDFs, DL-PCBs, and other polychlorinated biphenyls (other PCBs).

On 30 May 2001 the Scientific Committee for Food (SCF) adopted an Opinion on the Risk Assessment of Dioxins and Dioxin-like PCBs in Food, updating its Opinion of 22 November 2000 on this subject on the basis of new scientific information that had become available since the latter was adopted. The SCF fixed a tolerable weekly intake (TWI) of 14 pg WHO-TEQ/kg body weight for dioxins and DL-PCBs.

So far, dangerous compounds have been found mainly as a result of chemical monitoring. Residues of chemicals may affect all major organs of the body,

* Corresponding author, ott.roots@klab.ee

causing serious health problems such as cancer, birth defects, and brain damage. The contamination of food by potentially hazardous substances is a worldwide public health concern. Persistent organic pollutants are accumulated in fats; therefore, primary attention has to be paid to high-fat food, first and foremost to butter (Weiss et al., 2001; Malisch and Dilara, 2004) and fish. The dioxin content in fish has been fairly thoroughly studied in Estonia (Roots et al., 2003, 2004, 2008; Roots and Zitko, 2004, 2006; Simm et al., 2006; Pandelova et al., 2008). Therefore, as to fish, the present overview treats the concentrations of toxins only in the Baltic Sea herring. For instance, in Finland fish and fish products contribute about 80% and the Baltic herring alone about 52% to the total intake of dioxins (Kiviranta et al., 2001, 2004; Parmanne et al., 2006).

In the present study the content of PCDD/DFs, DL-PCBs, and other PCBs in food samples was determined and for the first time in Estonia comparison with food consumption data was performed. The results will serve as basis for further chemical monitoring in Estonia.

MATERIALS AND METHODS

Daily nutrient intakes and composition of the market baskets

Data from a survey conducted in Estonia in 1997 were used (Pomerleau et al., 2001). The survey sought to include representative samples of the national population aged between 19 and 64 years using the National Population Registers as the sampling frames. All individuals with missing information on age were excluded from the analyses, as were pregnant and lactating women. After excluding 70 individuals who did not provide information for the 24 hours recall, the samples included 2015 respondents in Estonia (Pomerleau et al., 2001). Information was collected using a 24 hours recall of dietary intake and an interviewer-administered questionnaire. The dietary information was converted into daily nutrient intakes using the Finnish Micro-Nutrica Nutritional Analyses program adapted to include Estonian foods (Estonian Version 2, 1997, Food Processing Institute, Tallinn University of Technology). This program includes over 1150 food items and dishes and 66 nutrients. Data were analysed using statistical package STATA version 6.0 (College Station, Texas).

Ten individual market baskets, as in Finland (Kiviranta et al., 2004), were created: liquid milk products, fish, meat and eggs, fats and oils, cereal products, potato products, vegetables, fruits, solid milk products, and others. Alcoholic beverages were omitted from the market baskets and also from the total diet basket. Table 1 shows the mean daily intakes of food (six individual market baskets) by sex and age groups in Estonia.

The agreement on the calculation of the Estonian subsistence minimum (ESM) was signed at the tripartite negotiations of the Government of Estonia, Confederation of Estonian Trade Unions, and Estonian Employers Confederation. The ESM is the smallest amount of

Table 1. Daily intakes (g) of food by sex and age groups in Estonia (Pomerleau et al., 2001)

Food	All ages		19–34 years		35–49 years		50 + years	
	Men	Women	Men	Women	Men	Women	Men	Women
Milk & milk products								
Mean (SD)	328 (383)	296 (296)	331 (389)	301 (296)	304 (385)	284 (258)	360 (365)	306 (263)
Median	233	250	244	250	200	243	264	250
Meat & meat products								
Mean (SD)	198 (172)	123 (123)	223 (184)	134 (119)	188 (168)	126 (115)	163 (140)	102 (98)
Median	166	100	188	104	150	100	150	81
Fish								
Mean (SD)	24 (72)	22 (22)	21 (65)	21 (55)	21 (61)	19 (66)	37 (96)	30 (74)
Median	0	0	0	0	0	0	0	0
Potatoes								
Mean (SD)	231 (201)	177 (165)	261 (214)	172 (156)	211 (198)	191 (185)	203 (169)	165 (148)
Median	202	150	240	150	200	159	200	150
Vegetables (excl potatoes)								
Mean (SD)	220 (195)	192 (166)	225 (207)	193 (171)	218 (186)	191 (151)	213 (182)	192 (178)
Median	187	160	185	154	187	159	198	163
Fruit								
Mean (SD)	135 (255)	168 (168)	151 (291)	211 (270)	145 (242)	172 (253)	87 (176)	94 (155)
Median	0	0	5	147	0	37	0	12
No. of persons analysed	900	1115	396	459	319	376	185	280

means of subsistence needed by a person that allows them to preserve and restore their working ability. The subsistence minimum consists of two parts estimated by different methods: (1) the estimated minimum food basket and (2) manufactured goods and services of primary importance (including dwelling). Change of subsistence minimum over time has to be treated together with different indicators characterizing the development of society. Since the 3rd quarter of 1998 the minimum wages and salaries are higher than the subsistence minimum.

Preparation of food samples for analyses of PCDD/Fs and PCBs

Commission Recommendation 1883/2006 lays down the sampling methods and methods of analysis for official control of dioxins and the determination of DL-PCBs in foodstuffs. Commission Recommendation 2006/794/EC demands Estonia to collect 24 samples per year. Estonian food samples for determining the concentrations of PCDD/Fs and PCBs in 2006–2009 were chosen by the Ministry of Agriculture, Veterinary and Food Board, Health Protection Inspectorate, Estonian Environmental Research Centre, and by experts from the Estonian Marine Institute at the University of Tartu, taking into account the 2002–2005 results of dioxin analysis of food (mainly Baltic Sea fish (Fig. 1) from Estonian coastal waters; see Roots et al., 2003, 2004; Roots and Zitko, 2004; Simm et al., 2006; Pandelova et al., 2008).

Fish samples

Baltic herring (*Clupea harengus membras*) was selected for the study as the most important commercial fish species in Estonia. The sampled Baltic herring were subjected to biological analysis in which their length, weight, sex, and age were determined. Then, the samples were arranged according to the different size/age of the fish (the number of fish was such that the weight of one sample would be ca 300 g). The head, caudal fin, and viscera of the fish were removed. The content of toxicants was therefore determined from the sum of all the parts of the fish typically used for human food (Roots et al., 2003, 2004; Roots and Zitko, 2004; Simm et al., 2006).

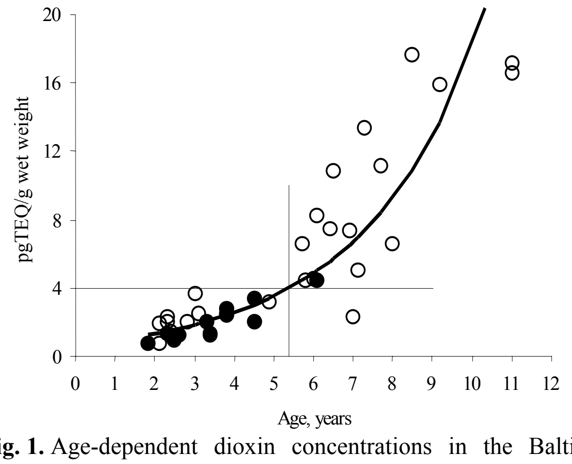

Fig. 1. Age-dependent dioxin concentrations in the Baltic herring muscle tissues of Estonian (black) and Finnish (white circles) catches (Roots et al., 2003).

Food product samples

From 2006 to 2009 the toxicant levels in the following Estonian food products were analysed: meat (pork, mutton, beef, poultry), butter, milk, eggs, fish preserves, and rape oil. For milk and dairy products, samples of raw milk and samples of butter were taken, which were collected directly from either a place of production, from a corresponding farm, or dairy industry. In the case of meat, pork samples collected from slaughter houses were analysed (Roots, 2007; Roots et al., 2008). The purchased food samples were stored mainly frozen at –25 °C before sending them to the National Health Institute (Kuopio) for analyses. The chemical analyses of samples took place at an accredited laboratory in Finland (National Public Health Institute, Department of Environmental Health, Laboratory of Chemistry, Neulaniementie 4, FI-70 210 Kuopio, Finland).

Analyses of PCDD/Fs, DL-PCBs, and other PCBs

The determination of PCDD/Fs, DL-PCBs, and other PCBs was done according to the standard operation procedure in the laboratory of Chemistry in the National Public Health Institute (KTL) (SOP called "Determination of PCDD/PCDFs, PCBs, DL-PCBs, and other POPs in tissue samples, KEM MO3"). The method is in part described in previously published papers (Kiviranta et al., 2001, 2004; Isosaari et al., 2006; Parmanne et al., 2006).

Samples were extracted in 33 mL stainless steel extraction cells from the freeze-dried sample with an ASE 300 Accelerated Solvent Extractor (Dionex Sunnyvale, California). The extraction solvent was 50 : 50 acetone–hexane and 3×5 min extraction cycles, 120 °C temperature, 1500 psi pressure, and 80% flush volume were used. The solvent was evaporated and fat percentage was determined gravimetrically. Fat was decomposed with the ASE extraction from the sample in 100 mL stainless steel clean-up extraction cells filled with sulphuric acid impregnated silica gel. Hexane was the clean-up extraction solvent; 5×1 min extraction cycles, 40 °C temperature, 1500 psi pressure, and 100% flush volume were used. After the fat removal the sample was fractionated and further purified on carbon and activated alumina columns as described earlier (Kiviranta et al., 2004; Parmanne et al., 2006). Internal ^{13}C PCDD/F standards (altogether 16 standards) were used to determine the concentrations of PCDDs/Fs. As internal standards for PCBs and DL-PCBs ^{12}C PCB 30 and 12 ^{13}C-labelled PCB congeners (PCB 80, 101, 105, 118, 138, 153, 156, 157, 170, 180, 194, and 209), and 4 ^{13}C-labelled co-planar (co-PCB) congeners (PCB 77, 81, 126, and 169) were used.

PCDD/Fs and PCBs were analysed by high resolution gas chromatography–high resolution mass spectrometry (Hewlett-Packard 6890-VG 70-250SE) using selective ion recording (resolution 10 000). The congeners of PCDD/F and PCB were separated on a DB-Dioxin capillary column (J&W Scientific: 60 m, 0.25 mm, 0.15 µm). The method is accredited (Testing Laboratory T077 by FINAS; http://www.finas.fi).

The limits of quantification (LOQ) for PCDD/Fs, DL-PCBs, and other PCBs varied between 0.0007 and 0.63, 0.0007 and 0.13, and 0.035 and 13 pg/g fresh weight, respectively, depending on each individual congener and on the individual foodstuff (Kiviranta et al., 2004). Results were calculated as upper bound, medium bound, and lower bound values per gram fresh and lipid weight. Recoveries for all internal standards were more than 50% for all congeners. Fresh weight concentrations were calculated with both lower bound and upper bound methods. In the lower bound method, the results of congeners with concentrations below LOQ were designed as nil, while in the upper bound method they were denoted as the LOQ (Kiviranta et al., 2004).

RESULTS AND DISCUSSION

In order to generate reliable background occurrence data on PCDD/Fs and PCBs the Commission of the European Communities has adopted a recommendation for member countries to monitor these substances in foodstuffs.

According to the information provided by the Estonian Institute of Economic Research (2003), the average annual per capita consumption of fish and fish products in Estonia during 2000–2002 was 16.6 kg, of which in 2002 chilled or frozen fresh fish and seafood constituted 9.9 kg. For comparison, the corresponding amount in Estonia in the years 1937–1938 was significantly larger – 28.5 kg. But in Finland and Sweden the annual per capita consumption of fish products is twice as much as in Estonia today, namely 30–34 kg. Taking for the basis of calculation the fact that the dioxin content of most of the Baltic herring in Estonia does not exceed half of the EU standard, while in perch, pike-perch, flounder, wild eel, and aquaculture species (rainbow trout and eel) dioxin and PCBs do not extend over one fifth of the standard (Roots et al., 2008), and the maximum weekly per capita amount of fish consumption is 200 g at the most, we may confirm that the dioxin quantity acquired from fish in a week could under no circumstances exceed the dioxin standard per human body weight for a week established by the Scientific Committee for Food (Roots, 2007; Roots et al., 2008). The Atlantic salmon, sea trout, and eel caught in the Baltic Sea have not been adequately examined so far because these fish species are caught (eaten) in Estonia to a relatively small extent and their proportion in human consumption is inconsiderable.

As for Baltic herring, the consumption of large specimens with a length of more than 17 cm (and age of more than five years) should be avoided or constrained (especially by pregnant women) because of its rather large dioxin content (Fig. 1). At the present time the age of the Baltic herring in the coastal waters of Estonia is mostly 2–4 years. The annual studies of the Estonian Marine Institute have shown that fish of an age over five years are rather rare in catches – only 7–8%. The last studies before 2009 indicate that herring with a length of over 22 cm (and age of more than eight years) should be avoided due to its dioxin content (Fig. 2).

In all studied Estonian food samples (meat (pork, mutton, beef, poultry), butter, milk, eggs, fish preserves, and rape oil) the upper bound values of WHO-PCDD/F-TEQ and also combined WHO-PCDD/F-PCB-TEQ were below the maximum limits set in Commission Regulation (EC) No. 1881/2006 (Roots, 2007). According to an earlier study (Roots and Zitko, 2006) the same is true about the Baltic Sea wild fish (including Baltic herring of length not more than 22 cm and age not more than eight years, perch, eel, pikeperch, and flounder) as well as aquaculture species rainbow trout and eel.

Wild fatty fish are good indicators for the contamination with persistent organic pollutants (POPs) in the food chain (Tables 2 and 3). The dioxin content of

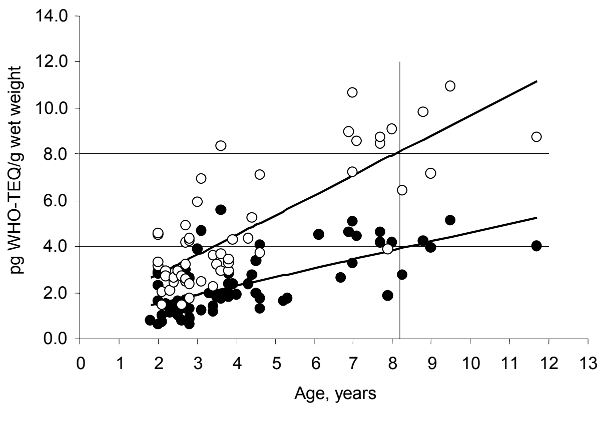

Fig. 2. Age-dependent dioxin concentrations (pg WHO-TEQ/g wet weight) in the Baltic herring PCDD/F (black) and PCDD/F+DL-PCP (white circles) catches before 2009.

Table 2. Content of PCDD/F and DL-PCB compounds in herring samples from the Gulf of Finland in 2006

Compound	Number of sample							
	1		2		3		4	
	a	b	a	b	a	b	a	b
PCDD	1.1	0.63	1.1	0.61	0.8	0.43	0.8	0.48
PCDF	6.5	1.78	6.3	1.75	5.2	1.38	5.2	1.43
PCDD/F	7.6	2.40	7.4	2.36	6.0	1.81	6.0	1.91
Non-ortho PCB	50	1.40	52	1.41	39	1.03	42	1.12
Mono-ortho PCB	3718	0.52	3859	0.55	2921	0.41	3052	0.43
DL-PCB	3768	1.92	3911	1.96	2960	1.44	3094	1.55
Total	3775	4.33	3919	4.32	2966	3.25	3100	3.46

a, pg/g fresh weight; b, pg WHO-TEQ/g fresh weight.

Table 3. Content of PCDD/F and DL-PCB compounds in herring samples from the Gulf of Finland in 2009

Compound	Number of sample									
	1		2		3		4		5	
	a	b	a	b	a	b	a	b	a	b
PCDD	0.42	0.19	0.38	0.17	0.71	0.39	0.51	0.25	0.68	0.35
PCDF	2.77	0.69	2.51	0.58	5.37	1.46	3.40	0.92	5.46	1.38
PCDD/F	3.19	0.88	2.89	0.75	6.08	1.85	3.91	1.16	6.13	1.74
Non-ortho PCB	27	0.56	27	0.49	54	1.29	30	0.70	56	1.19
Mono-ortho PCB	2247	0.30	1834	0.25	5467	0.77	2995	0.41	5771	0.79
DL-PCB	2274	0.87	1861	0.74	5521	2.06	3025	1.11	5827	1.97
Total	2277	1.74	1863	1.49	5527	3.91	3029	2.27	5833	3.71

a, pg/g fresh weight; b, pg WHO-TEQ/g fresh weight.

Baltic herring and sprat sampled in 2006 did not exceed the EU limits. The average PCDD/F and summary dioxin (PCDD/F + DL-PCB) concentrations in herring and sprat samples were respectively 2.12 and 3.84 and 1.94 and 3.82 pg WHO-TEQ/g of fresh weight. These results are comparable with our earlier data concerning the content of dioxins in three- to four-year old herring and two- to three-year old sprat (Roots et al., 2008).

Milk and milk products (Table 4) are also good indicators for the contamination with POPs in the food chain. Thus, butter has been used for comparison of the PCDD/F contamination in several countries (Weiss et al., 2001; Malisch and Dilara, 2004; Roots, 2007; Roots et al., 2008). Since 2006 the dioxin content of dairy products (milk and butter), meat, fish, etc. has also been examined in Estonia (Tables 4 and 5). According to the literature, the range of PCDD/F concentrations in 65 butter samples from 39 countries was found to be between 0.02 and 2.02 pg WHO-PCDD/F-TEQ/g fat (Weiss et al., 2001) and in butter from 24 countries between from 0.06 to 4.80 pg WHO-PCDD/F-TEQ/g fat (Santillo et al., 2001).

To get an indication whether exposure to PCDD/Fs and DL-PCBs might cause a problem in the new European Union Member States, a study of their levels in 16 butter samples coming from eight new EU countries (Cyprus, Czech Republic, Estonia, Lithuania, Poland, Romania, Slovakia, Slovenia) was commissioned. An important conclusion was that all butter samples were below the EU maximum tolerances and EU action levels for PCDD/Fs and DL-PCBs (Malisch and Dilara, 2004). In all butter (Table 4) and meat (Tables 5 and 6) samples the TEQ values were below the maximum limit values.

According to the Estonian nutrition recommendations (Vaask et al., 2006) people should eat two servings of fish two to three times a week. One serving is 50 g of fatty or 75 g of less fatty fish. In the light of the findings about the content of PCDD/Fs and DL-PCBs in fish consumed in Estonia the recommended two servings of fish a week could be approved.

Table 4. Content of PCDD/F and DL-PCB compounds in butter samples in 2009

Compound	Number of sample							
	1		2		3		4	
	a	b	a	b	a	b	a	b
PCDD	1.6	0.39	1.3	0.24	1.8	0.34	1.5	0.23
PCDF	2.2	0.29	1.4	0.18	1.7	0.20	1.7	0.17
PCDD/F	3.8	0.67	2.6	0.41	3.5	0.54	3.2	0.40
Non-ortho PCB	9	0.44	7	0.33	10	0.56	6	0.25
Mono-ortho PCB	993	0.13	617	0.08	1234	0.16	482	0.06
DL-PCB	1002	0.57	624	0.41	1244	0.72	488	0.31
Total	1006	1.24	627	0.82	1247	1.26	491	0.71

a, pg/g per lipids; b, pg WHO-TEQ/g per lipids.

Table 5. Content of PCDD/F and DL-PCB compounds in meat samples in 2007–2009

Compound	Mutton		Beef, sample 1		Beef, sample 2		Poultry	
	a	b	a	b	a	b	a	b
PCDD	1.5	0.41	1.4	0.25	2.8	0.26	1.5	0.25
PCDF	1.4	0.20	1.7	0.19	1.5	0.17	1.3	0.10
PCDD/F	2.9	0.61	3.1	0.44	4.3	0.42	2.8	0.35
Non-ortho PCB	9	0.29	8	0.33	7	0.18	5	0.03
Mono-ortho PCB	650	0.12	791	0.10	427	0.05	238	0.03
DL-PCB	659	0.41	800	0.43	435	0.23	243	0.06
Total	662	1.03	803	0.87	439	0.66	246	0.41

a, pg/g per lipids; b, pg WHO-TEQ/g per lipids.

Table 6. Content of PCDD/F and DL-PCB in pork and mutton samples in 2009

Compound		Pork (Harju County)		Pork (Lääne-Viru County)		Mutton (Rapla County)	
		a	b	a	b	a	b
PCDD/F	Lower bound	0.81	0.00	0.16	0.02	0.67	0.17
	Medium bound	1.63	0.10	1.30	0.12	1.17	0.26
	Upper bound	2.45	0.19	2.44	0.22	1.67	0.35
DL-PCB	Lower bound	46	0.01	80	0.02	590	0.47
	Medium bound	56	0.01	90	0.02	593	0.47
	Upper bound	66	0.02	99	0.03	595	0.47

a, pg/g fat; b, pg WHO-TEQ/g fat.

CONCLUSIONS

All the studied Estonian food samples – meat (pork, mutton, beef, poultry), butter, milk, eggs, fish preserves, and rape oil – had WHO-PCDD/F-TEQ and also combined WHO-PCDD/F-PCB-TEQ upper-bound values below the maximum limits set in Commission Regulation (EC) No. 1881/2006. At the present time the age of the Baltic herring in the coastal waters of Estonia is mostly 2–4 years. The annual studies of the Estonian Marine Institute have shown that fish older than five years are rather rare in catches, making up only 7–8%. For that reason there is no risk to the health of people who are used to eating small or medium-sized Baltic herring that is ordinarily traded with at the stores and on the markets. Two servings of fish (one fatty, one less fatty) a week as recommended are beneficial to human health rather than harmful.

Only marketing without further examination of the so-called unchecked fish on which there is no information about the fishing area and country of origin should be avoided. However, a research on the content of toxic compounds (especially dioxins) in the foodstuffs exported to the countries of the European Union, including Estonia, by non-contracting parties should be definitely conducted in the immediate future. We recommend increasing the share of perch, pike-perch, and flounder as well as fish originating from inspected fish farms and imported from other states of the European Union in the daily food intake.

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Polüklooritud dibenso-*p*-dioksiinide, dibensofuraanide ja bifenüülide seire Eesti toidus

Ott Roots, Hannu Kiviranta, Tagli Pitsi, Panu Rantakokko, Päivi Ruokojärvi, Mart Simm, Raivo Vokk ja Leili Järv

Püsivad orgaanilised saasteained (POS) on põhiliselt halogeene sisaldavad ühendid, mis oma mürgisuse, püsivuse ja bioakumuleeruvuse tõttu ohustavad inimese immuun-, närvi- ning sisesekretsioonisüsteemi ja paljunemisfunktsiooni, põhjustades kasvajate teket. POS kahjustavad ka teisi elusorganisme ja ökosüsteeme. Kuna Eestis puuduvad võimalused analüüsida polüklooritud dibenso-*p*-dioksiine (PCDD) ja furaane (PCDF) ning dioksiinidesarnaseid polüklooritud bifenüüle (DL-PCB), telliti analüüsid Soomest Riigi Terviseuuringute Instituudist (National Public Health Institute).

Toiduainete proovide võtmisel lähtuti Euroopa Liidu õigusaktidest: Komisjoni soovitus 2006/794/EÜ PCDD-de, PCDF-ide, DL-PCB-de ja muude PCB-de taustanivoode seire kohta toiduainetes; Komisjoni määrus (EÜ) nr 1883/2006, millega sätestatakse proovivõtu- ja analüüsimeetodid PCDD/F-ide ning DL-PCB-de ametlikuks kontrolliks teatavates toiduainetes. Saadud tulemusi võrreldi Komisjoni määruses (EÜ) nr 1881/2006 sätestatud saasteainete piirväärtustega toiduainetes.

Analüüsitud Eesti toiduainete proovides – sea-, lamba-, linnu-, loomalihas, võis, piimas, munades ja Soome ning Riia lahe räimes ja rapsiõlis – olid PCDD-de, PCDF-ide ning DL-PCB-de sisaldused oluliselt väiksemad Komisjoni määruses (EÜ) nr 1881/2006 sätestatud piirväärtustest ja ilmselt ei kujuta ohtu Eesti elanike tervisele.

Läänemere-äärsete maade inimesed saavad dioksiine põhiliselt kalast. Eestis tarbiti 2000. aastate algul 16,6 kg kalatooteid keskmiselt ühe elaniku kohta. Võrdluseks oli 1937/38. aastal vastav kogus Eestis 28,5 kg. Üldiselt arvatakse, et kala on inimese tervisele kasulik, kuid soovitatav oleks riske hajutada. See tähendab, et kogu tarbitav kala ei tohiks olla rasvane. Räime puhul tuleks vähesel määral vältida (seda eriti rasedatel naistel) “suurt räime”, kelle pikkus ületab 17 cm (ja vanus on üle viie aasta), 2009. aasta andmetel 22 cm (vanus on üle 8 aasta). Käesoleval ajal on Eesti rannikumere räime vanus põhiliselt 2–4 aastat ja üle viieaastaste räimede protsent püükides jääb 7–8% piiresse. Saadud tulemused näitavad, et kaks toidukorda kalast, üks vähem rasvasest, teine rasvasest, nädalas ei ole ohtlik Eesti inimeste tervisele, pigem vastupidi.