Estimation of long-term dietary exposure of the inhabitants of Slovak Republic to polychlorinated biphenyls

DANKA ŠALGOVIČOVÁ

Summary

Long-term mean exposure of the inhabitants of Slovak Republic to polychlorinated biphenyls (PCBs) was estimated. Calculations were based on inspection and monitoring data of PCBs in animal foodstuffs (expressed as a sum of congeners PCB-28, PCB-52, PCB-101, PCB-138, PCB-153 and PCB-180) and on individual food commodities consumption data between 1994 and 2005. The mean human exposure within the country represented approximately 0.04 μg.kg^{-1} to 0.10 μg.kg^{-1} of the Tolerable Daily Intake (TDI) value (0.4 μg.kg^{-1} bw). Considering actual dietary habits and nutrition sources of polluted locality inhabitants (especially fresh-water fish and domestic animals), a higher dietary exposure was evident. This exceeded the TDI value by 100% on average and by 350% at about 5% of consumers. In addition, theoretical exposure data were calculated assuming that food intake was in full accordance with scientific recommendations. Also in that case, the mean theoretical exposure remained fairly low. Linking to actual nutrition sources in the polluted locality, the mean exposure would be much higher representing thus even ten multiple of the TDI value due to increased consumption of fish. The study demonstrates the need for arrangements for decontamination of the polluted area and disposal of PCB-contaminated foodstuffs to protect the consumers.

Keywords

food consumption; PCB intake; dietary recommendations

Polychlorinated biphenyls (PCBs) produced in thermal processes and released from various equipments (e.g. transformers) can contaminate the environment (air, land, water, sediments) and enter the food chain. Totally, about 1.2 to 1.5 million tons of PCBs have been produced since 1929 in the world. New emissions are mainly via the air route. Due to a very slow decomposition process, PCBs persist in the environment for very long periods of time. Therefore, a large part of current exposure is due to releases of PCBs in the past.

The negative impact of PCBs on public health has been known since 1968. In northern Kyushu in Japan, about 2000 people were poisoned by PCBs and polychlorinated dibenzofurans (products of PCBs pyrolysis) which contaminated rice oil. The disease was named "Yusho". The major symptoms were dermal and ocular lesions, but some of the symptoms, such as irregular menstrual cycles and altered immune responses, were notable with respect to the endocrine-disrupting activities of PCBs and related compounds [1].

PCBs enter the human body by various ways. Continual loading results in accumulation and thus a time period of their influence is crucial. The key problem of PCBs is their chronic toxicity. Increased PCB levels in blood may affect target body organs (such as liver, kidney, and milt) that may lead to changes in enzymatic activities and even to death [2]. It is known that PCB levels in mother milk are two to five times higher than in the human serum, however, they can be deposited into fat tissue resulting in concentrations 20 to 50 times higher than in the serum [3].

Foodstuffs of animal origin, meat and milk products, represent the main source (about 95%) of PCB exposure [4]. Mostly contaminated are animals that contain large proportion of fat, raised in polluted localities [5]. Another considerable dietary source of PCB is fresh-water fish, venison and feather from those localities [6]. Many studies refer to possibly higher PCB exposure from fish and necessity to protect health of consumers [7-10]. On the other hand, fish consumption is important for the human health due to the contents of *n*-3-polyunsaturated fatty acids, minerals (Ca, P), iodine in marine fish and vitamins A, B, D, E [11, 12].

Level of animal products contamination depends on the pollution of the environment and feed (such as fish oil, fish meal) as well as on the

Danka Šalgovičová, VÚP Food Research Institute, Department of Risk Assessment and Food Composition Data Bank, Priemyselná 4, P. O. Box 25, SK - 824 75 Bratislava 26, Slovakia. Tel.: +421 2 50237225, e-mail: salgovicova@vup.sk

production process (e.g. artificial drying). The Joint FAO/WHO Expert Committee on Food Additives and Contaminants defined for chlorinated dibenzodioxins, dibenzofurans and coplanar PCB toxic equivalents a Tolerable Daily Intake (TDI) of 0.4 μg.kg^{-1} body weight. Results of several studies indicate that the actual intake of dioxins and PCBs by a part of population can exceeds the TDI value [13].

Reduction of PCB sources, prevention of accidents and improvement of waste and oil management represent essential prerequisites for the re-

Tab. 1. Mean consumption of main food groups of animal origin (g per person a day).

Commodities	Fat content [%]	Actual consumption	Model consumption
Beef and veal	11.7	6.046	42.608
Pork	21.4	27.976	16.082
Mutton	12.9	0.040	–
Other meat	6.0	0.666	–
Guts and bones	4.7	0.998	–
Chicken meat	3.2	24.496	22.024
Hen meat	1.8	1.592	–
Goose meat	21.7	0.337	–
Duck meat	25.4	1.029	–
Turkey meat	3.1	1.896	–
Poultry guts	10.5	3.048	2.571
Poultry products	9.2	3.018	–
Preserved meat	26.9	4.126	–
Semi-preserved meat	17.9	0.219	–
Preserved poultry	13.3	0.227	–
Sausages of long duration	34.0	4.706	–
Sausages of short duration	23.6	11.068	9.800
Small meat products	23.2	13.134	–
Boiled meat products	19.8	4.477	–
Special meat products	29.0	0.984	–
Smoked meat	34.9	3.478	7.457
Other meat products	27.4	2.054	–
Sea fish	1.9	3.074	19.335
Fresh-water fish	2.2	0.669	4.215
Smoked fish products	16.7	0.257	–
Marinated fish products	12.5	1.079	–
Preserved fish products	17.3	3.357	–
Fish specialities	15.4	0.970	14.146
Milk	1.9	184.603	221.686
Hard cheese	24.7	4.659	13.429
Soft cheese	10.0	0.214	–
Mould cheese	22.6	1.404	–
Processed cheese	19.2	4.655	5.429
Other cheese	20.2	1.361	–
Fermented milk products	8.5	24.793	50.000
Ice creams	11.8	6.171	–
Curds	5.4	6.174	31.700
Cream	23.7	6.671	1.271
Milk tins	7.9	1.370	–
Flavoured milks	8.0	0.729	17.143
Dehydrated milk products	17.8	0.442	–
Baby food	26.6	0.619	–
Eggs	9.0	19.779	44.250
Egg products	59.5	1.395	–
Edible oils	73.5	22.356	18.743
Hardened fats	81.1	13.370	1.429
Butter	68.5	6.438	23.700
Lard	89.4	1.781	1.486

duction of the contamination. Control measures, such as Good Agricultural Practice, Good Animal Feeding Practice, Good Manufacturing Practice and measures to effectively reduce PCBs in feed should be introduced [14].

PCBs in the Slovak Republic were produced in a plant Chemko Strážske in a total amount of 21 500 tons in 1959–1984. The adjacent locality was polluted.

A national database of the Slovak Republic has collected and processed results of the food inspection and food chain contaminants monitoring (including PCBs) since 1986. The database is located in the VÚP Food Research Institute, Bratislava, and serves as a base for risk minimizing decisions.

This study represents a component part of risk assessment. Its aim was to find out PCB distribution in individual groups of foodstuffs and estimate the long-term dietary PCB exposure (1994–2005) of the mean Slovak population as well as inhabitants of polluted locality in the district of Michalovce. Hereby, an expected population exposure was estimated in case of meeting scientifically recommended principles of rational nutrition. Conclusions of this study are a base for defining measures to protect the health of the consumers.

MATERIALS AND METHODS

The study was based on analyses of total contents of 6 PCB congeners (PCB-28, PCB-52, PCB-101, PCB-138, PCB-153, and PCB-180) in 66 542 samples of foodstuffs of animal origin belonging to 48 basic groups (Tab. 1). The samples covered all important dietary sources and were taken from various areas. Results of inspection and monitoring within 1994–2005 were considered.

Mean findings, median findings and the values of 95th percentile figured the PCB distribution in the individual groups of food products sampled from primary production and food industry at various parts of the country and separately in food sampled from retail network and households. In the polluted locality, a part of food samples represented those produced directly by households (farming and production meat, milk and eggs) as well as local meat of venison, feather, and fish.

Consecutively, the following was taken into account:

a) statistics on actual food consumption data in the Slovak Republic based on food balance sheets as processed by the Slovak Statistic Bureau [15],
b) model food consumption based on the rational menu as derived by the nutrition software Alimenta 4 (VÚP Food Research Institute, Bratislava, Slovakia) from scientifically recommended daily nutrition allowances.

Utilizing data on actual and model food consumption available for: a) the whole country but Michalovce district; b) the district of Michalovce the PCB exposure values of mean consumers (outside and in the polluted locality) were calculated from the following equation:

$$E = \sum_{1}^{n} \frac{I_{1-n} \times C_{1-n}}{w} \quad (1)$$

where E is exposure in μg.kg^{-1} body weight per day, I - consumption [kg], C - concentration of PCB [μg.kg^{-1}], w - average body weight of the inhabitants [kg], (1–n) - the order of particular commodities and the respective findings (the mean, median and 95th percentile values of PCBs concentration).

Estimated exposure values were compared to the Tolerable Daily Intake of PCBs = 0.4 μg.kg^{-1} body weight a day. A mean body weight of 70 kg was assumed.

Considering control and monitoring results of the above mentioned time period, we estimated the mean exposure of polluted locality inhabitants consuming only foodstuffs from the retail network and of inhabitants consuming both domestic and retail foodstuffs, and compared it to the mean exposure of people living outside the polluted locality. At the same time, we estimated the likely exposure of people consuming locally-produced as well as retail foodstuffs in case of respecting scientifically recommended rules of rational nutrition.

RESULTS AND DISCUSSION

PCB occurrence in animal foodstuffs

Since this study was aimed to estimate dietary exposure, the PCB content in fat was expressed as the PCB content of the total foodstuff. Mean and median values as well as the 95th percentile of the PCB values in food were calculated. Data on PCB content in specific foodstuffs in 1994–2005 are summarized in Tab. 2 (meat products), Tab. 3 (fish products), and Tab. 4 (milk products, eggs and fats). Environmental pollution of Michalovce district was reflected by increased PCB contents in venison, feather, fish and in of home-made products from locally-farmed animals fed with contaminated fodder resources.

Tab. 2. PCBs contents and distribution in meat and meat products.

Commodities	Findings [mg.kg^{-1}]											
	Michalovce district			Michalovce district (retail network)			Slovak Republic			Slovak Republic (retail network)		
	Mean value	Median value	95th percentile	Mean value	Median value	95th percentile	Mean value	Median value	95th percentile	Mean value	Median value	95th percentile
Beef and veal	0.039	0.026	0.106	0.034	0.024	0.099	0.028	0.006	0.090	0.021	0.005	0.085
Pork	0.024	0.015	0.077	0.026	0.017	0.093	0.010	0.004	0.055	0.010	0.004	0.055
Mutton	0.045	0.045	0.045	0.045	0.045	0.045	0.186	0.020	0.174	0.031	0.018	0.103
Other meat	9.729	0.194	54.908	0.201	0.014	0.503	0.096	0.009	0.203	0.038	0.007	0.155
Guts and bones	0.008	0.005	0.019	0.008	0.005	0.019	0.024	0.009	0.027	0.006	0.002	0.024
Chicken meat	0.039	0.042	0.089	0.040	0.043	0.090	0.010	0.004	0.049	0.010	0.004	0.050
Hen meat	0.055	0.008	0.176	0.055	0.008	0.176	0.021	0.005	0.089	0.021	0.005	0.089
Goose meat	0.018	0.018	0.022	0.018	0.018	0.022	0.011	0.004	0.050	0.011	0.004	0.050
Duck meat	0.019	0.018	0.071	0.003	0.000	0.027	0.008	0.003	0.054	0.008	0.003	0.054
Turkey meat	0.017	0.016	0.032	0.017	0.016	0.032	0.009	0.004	0.048	0.009	0.004	0.048
Poultry guts	0.015	0.005	0.042	0.015	0.005	0.042	0.006	0.002	0.032	0.006	0.002	0.032
Poultry products	0.020	0.007	0.072	0.020	0.007	0.072	0.010	0.004	0.052	0.010	0.004	0.052
Preserved meat	0.016	0.019	0.020	0.016	0.019	0.020	0.011	0.004	0.051	0.011	0.004	0.051
Semi-preserved meat	0.010	0.004	0.045	0.010	0.004	0.045	0.004	0.000	0.017	0.004	0.000	0.017
Preserved poultry	0.045	0.041	0.090	0.045	0.041	0.090	0.011	0.004	0.049	0.011	0.004	0.049
Sausages of long duration	0.031	0.017	0.081	0.031	0.017	0.081	0.011	0.004	0.049	0.011	0.004	0.049
Sausages of short duration	0.039	0.032	0.098	0.039	0.032	0.098	0.012	0.002	0.052	0.012	0.002	0.052
Small meat products	0.037	0.025	0.098	0.037	0.025	0.098	0.013	0.003	0.057	0.013	0.003	0.057
Biled meat products	0.034	0.029	0.100	0.034	0.029	0.100	0.011	0.004	0.050	0.011	0.004	0.050
Special meat products	0.024	0.018	0.044	0.024	0.018	0.044	0.010	0.004	0.041	0.010	0.004	0.041
Smoked meat	0.029	0.019	0.093	0.029	0.019	0.093	0.012	0.005	0.052	0.012	0.005	0.052
Other meat products	0.021	0.021	0.026	0.021	0.021	0.026	0.010	0.001	0.048	0.010	0.001	0.048

Tab. 3. PCB content and distribution in fish and fish products.

Commodities	Findings [mg.kg^{-1}]											
	Michalovce district			Michalovce district (retail network)			Slovak Republic			Slovak Republic (retail network)		
	Mean value	Median value	95th percentile	Mean value	Median value	95th percentile	Mean value	Median value	95th percentile	Mean value	Median value	95th percentile
Sea fish	0.025	0.000	0.072	0.024	0.000	0.069	0.025	0.000	0.072	0.024	0.000	0.069
Fresh-water fish	73.876	11.328	144.002	0.112	0.026	0.477	0.116	0.003	0.187	0.111	0.000	0.185
Smoked fish products	0.024	0.010	0.092	0.024	0.010	0.092	0.024	0.010	0.092	0.024	0.010	0.092
Marinated fish products	0.017	0.007	0.064	0.017	0.007	0.064	0.017	0.007	0.064	0.017	0.007	0.064
Preserved fish products	0.009	0.008	0.012	0.009	0.008	0.012	0.022	0.002	0.088	0.022	0.002	0.088
Fish specialities	0.021	0.008	0.114	0.021	0.008	0.114	0.021	0.008	0.114	0.021	0.008	0.114

Tab. 4. PCB content and distribution in milk, milk products, eggs, fats, and oils.

Commodities	Findings [mg.kg^{-1}]											
	Michalovce district			Michalovce district (retail network)			Slovak Republic			Slovak Republic (retail network)		
	Mean value	Median value	95th percentile	Mean value	Median value	95th percentile	Mean value	Median value	95th percentile	Mean value	Median value	95th percentile
Milk	1.717	1.004	6.523	0.030	0.019	0.070	0.188	0.012	1.180	0.016	0.005	0.065
Hard cheese	0.031	0.034	0.052	0.031	0.034	0.052	0.012	0.005	0.053	0.012	0.005	0.053
Soft cheese	0.014	0.014	0.029	0.014	0.014	0.029	0.015	0.007	0.061	0.015	0.007	0.061
Mould cheese	0.011	0.005	0.057	0.011	0.005	0.057	0.011	0.005	0.057	0.011	0.005	0.057
Processed cheese	0.030	0.027	0.070	0.030	0.027	0.070	0.012	0.005	0.053	0.012	0.005	0.053
Other cheese	0.016	0.006	0.067	0.016	0.006	0.067	0.016	0.006	0.067	0.016	0.006	0.067
Fermented milk products	0.012	0.005	0.038	0.012	0.005	0.038	0.010	0.004	0.053	0.009	0.004	0.053
Ice creams	0.005	0.002	0.026	0.005	0.002	0.026	0.005	0.002	0.026	0.005	0.002	0.026
Curds	0.003	0.001	0.021	0.003	0.001	0.021	0.003	0.001	0.021	0.003	0.001	0.020
Cream	0.024	0.025	0.039	0.024	0.025	0.039	0.012	0.005	0.051	0.012	0.005	0.051
Milk tins	0.008	0.003	0.042	0.008	0.003	0.042	0.008	0.003	0.042	0.008	0.003	0.042
Flavoured milks	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.003	0.040	0.007	0.003	0.040
Dehydrated milk products	0.020	0.005	0.081	0.020	0.005	0.081	0.005	0.002	0.022	0.005	0.002	0.019
Baby food	0.013	0.005	0.061	0.013	0.005	0.061	0.001	0.000	0.005	0.001	0.000	0.005
Eggs	0.019	0.015	0.034	0.021	0.017	0.034	0.026	0.010	0.045	0.014	0.006	0.039
Egg products	0.006	0.002	0.041	0.006	0.002	0.041	0.006	0.002	0.041	0.006	0.002	0.041
Edible oils	0.009	0.009	0.009	0.009	0.009	0.009	0.006	0.001	0.020	0.006	0.001	0.020
Hardened fats	0.007	0.003	0.030	0.007	0.003	0.030	0.007	0.003	0.030	0.007	0.003	0.030
Butter	0.027	0.022	0.057	0.028	0.025	0.062	0.013	0.001	0.048	0.011	0.004	0.047
Lard	0.039	0.033	0.105	0.039	0.033	0.105	0.032	0.013	0.079	0.013	0.005	0.057

Meat and meat products

Tab. 2 indicates increased contamination of venison and feather included in the category of "other products". Products sampled from the primary production, processing plants and households exhibited the following PCB values of mean content, median value, and 95th percentile of the mean content: 0.096 mg.kg^{-1}, 0.009 mg.kg^{-1} and 0.203 mg.kg^{-1} respectively. The values of this meat product category sampled from retail were 0.038 mg.kg^{-1}, 0.007 mg.kg^{-1} and 0.155 mg.kg^{-1}, respectively. The mean value of the sum of individual PCB congeners in retailed meat products of this category was below the maximum permissible limit. However, the meat products sampled from other sources exceeded the limit by approximately 1.5 times [16].

Slightly less contaminated was mutton exhibiting mean values of 0.186 mg.kg^{-1} in samples from primary plants, processing plants and households and 0.031 mg.kg^{-1} in samples from the retail network. Considering the actual production process, it can be stated that this contamination comes from the environmental pollution, however, it represents no risk for consumers. The mean value of the sum of individual PCB congeners in retail mutton was below the maximum limit as well.

Extensive contamination of more species of meat and meat products was observed within Michalovce district, especially in the category of venison and feather. Retail meat exhibited the PCB mean value of 0.201 mg.kg^{-1} (the maximum limit was exceeded by more than 3 times). However, the PCB mean value of meat sampled beyond the retail network reached up to 9.729 mg.kg^{-1}, representing thus a 160 multiple of the limit. Regarding the 95th percentile, the value of 54.908 mg.kg^{-1} may be regarded as alarming.

Surprisingly lower contamination of mutton sampled in the polluted locality, compared to the rest of the country, indicates the fact that meat in the processing industry and retail network is supplied from other localities.

Fish and fish products

Contamination of sea-water fish in the industry is similar to that in the retail network since Slovak Republic is no seaside country and all sea-water fish is imported. Higher contamination of fresh-water fish, involving mainly local production, could be seen. The PCB mean value of retailed fish was 0.111 mg.kg^{-1}, which was a 3.7 multiple of the permissible limit. The mean value of 0.116 mg.kg^{-1} in fish sampled from the primary production, processing industry and households represents a 3.8 multiple of the limit.

Mean contamination of fresh-water fish sampled in the retail network of the affected locality of Michalovce was similar to that in other localities of the country (mean value of 0.112 mg.kg^{-1}); nevertheless, contamination of locally-produced fish was extremely high. The PCB mean value within the given time period reached 73.876 mg.kg^{-1} representing thus a value nearly 2500 times higher than the limit. The 95th percentile value of 144.002 mg.kg^{-1} was even a 4800 multiple of the limit.

Milk, milk products, eggs, and fats

This category of products available in retail showed fairly low PCB contamination that laid below the limit, e.g. PCB concentration in retailed milk was 0.016 mg.kg^{-1} on average. On the other hand, milk products sampled from primary and household productions exhibited the mean PCB concentration of 0.188 mg.kg^{-1}, i.e. approximately 3 times more than the limit.

Contamination of milk at farms, food industry plants and households was much more extensive within the polluted locality (1.717 mg.kg^{-1} on average), while retail milk was comparable to that from other localities (0.030 mg.kg^{-1} on average).

A special case is the baby food production, where an exceptional attention is paid to the selection of refined raw materials. Thus, contamination of baby food by PCBs is strictly controlled and kept to a very low level. The only exception represented the polluted locality where this value was moderately higher (0.013 mg.kg^{-1} on average). Values slightly above the limit, representing a 1.1 multiple of the limit, could be observed at 95th percentile (0.061 mg.kg^{-1}).

Dietary exposure of average Slovak consumers to PCB

Long-term mean exposure in 1994–2005

Considering the contamination of individual food items, it can be seen that an average inhabitant of the Slovak Republic intakes PCBs according to the supply of food of animal origin (retail network versus domestic production, eventually game and fish hunting). Dietary habits of consumers play also an important role. The above results assume the fact that the exposure to PCBs of inhabitants located in the Michalovce district can be higher than in other areas of the Slovak Republic.

The actual exposure levels were estimated for contamination of foodstuffs coming from:

a) primary production, food industry and households of the risk locality of Michalovce,
b) primary production, food industry and house-

holds of other localities in the Slovak Republic,
c) retail network of the risk locality of Michalovce,
d) retail network of the other localities in the Slovak Republic.

As the results show, the actual exposure of average Slovak consumers to PCBs was fairly low, 8.6% of TDI, when considering food from the primary production, industry and households. PCBs exposure from retail food only was estimated even lower, i.e. 3.8% of TDI (Tab. 5).

Long-term mean exposure of the risky area could be fairly low as well (only 7.5% of TDI) in case of consuming exclusively retail food. However, situation is considerably worse if food coming from outside the retail network is consumed. In that case, the mean PCBs intake of 0.828 μg.kg^{-1} of body weight represents about 207% of TDI that represents about 24 times higher exposure than in other localities of the Slovak Republic. Statistical data indicate that the exposure of 5% of the inhabitants to PCBs might be even up to 453% of TDI.

A higher exposure to PCBs was confirmed also a study of the Slovak Health University (Bratislava, Slovakia). The PCBs concentration in mother milk fat of the Michalovce district in 1996 reached levels of 621 ng.g^{-1} to 1 015 ng.g^{-1}, while 331 ng.g^{-1} to 490 ng.g^{-1} were found in other regions of the country [6].

Let us mention the most vulnerable group, fishermen in the Michalovce district. Unofficial information of the Slovak Fishery Association says that the amount of locally hunted fresh-water fish consumed in a week by a fisherman is 1 kg in summer and/or autumn and 0.3 kg in winter and/or spring. Thus, consumption of fish may lead to an enormous exposure to PCBs and endanger the health.

Statistics confirm the fact that high PCBs levels in the human serum can be caused by dietary intake of contaminated fish and other animal food (mainly eggs and poultry). In 2001, mean PCBs levels in the fat component of the serum of inhabitants from the Michalovce district reached 2 414 ng.g^{-1} (378 samples) while a value of 692 ng.g^{-1} (1 038 samples) was found for inhabitants from other regions of the Slovak Republic [17].

An extensive study of the Slovak Health University run in 2001–2002 definitely confirmed increased levels of PCBs in the human serum in the Michalovce district, 3 007 ng.g^{-1} in the fat portion on average. Among others, 14 fishermen were included with the PCBs levels in the fat portion of the serum of up to 25 833 ng.g^{-1}, which represents a 26 multiple of the mean levels of other districts of the Slovak Republic [18].

A direct relation is evident between the pollution by PCBs and the intermediate lifetime, which was in the Michalovce district in 1993–1996 by 3.69 years less than in the Trenčín district. Mortality due to cancer and cardiovascular diseases exceeded adjacent regions by 18.29% and 26.31%, respectively [19].

Tab. 5. Long-term exposure of average inhabitants of the Slovak Republic to PCBs.

			Mean value	Median value	95th percentile
Actual nutrition habits	Michalovce district	PCB intake*	0.828	0.180	1.810
		% TDI**	207.0	44.9	452.5
	Michalovce district (retail network)	PCB intake	0.030	0.021	0.074
		% TDI	7.5	5.3	18.5
	Slovak Republic	PCB intake	0.034	0.008	0.143
		% TDI	8.6	2.1	35.8
	Slovak Republic (retail network)	PCB intake	0.015	0.004	0.064
		% TDI	3.8	1.0	16.0
Model nutrition habits	Michalovce district	PCB intake	4.605	0.775	9.205
		% TDI	1151.4	193.8	2301.2
	Michalovce district (retail network)	PCB intake	0.055	0.034	0.150
		% TDI	13.9	8.5	37.5
	Slovak Republic	PCB intake	0.064	0.014	0.235
		% TDI	16.0	3.6	58.7
	Slovak Republic (retail network)	PCB intake	0.028	0.009	0.114
		% TDI	7.0	2.2	28.5

* - intake of PCBs in μg.kg^{-1} body weight a day, ** - percentage of Tolerable Daily Intake (TDI = 0,4 μg.kg^{-1} body weight a day).

Assumed model dietary exposure to PCB

Considering data on PCB levels in individual foods, we estimated the mean consumer exposure at an assumption that consumers respect scientific nutrition recommendations. The model intake of individual foodstuffs of local origin would lead to a slightly higher exposure than discussed above. This fact could be caused by raised fish consumption, which is currently in the Slovak Republic about 6.3 times lower than recommended. Nevertheless, the total exposure from retail foods and non-retail foods was kept low, on average at 7.0% of TDI and 16.0% of TDI, respectively. Also the exposure of an average inhabitant of the Michalovce district by PCBs from retail foods was fairly low (13.9% of TDI).

It is known that a short-term change in dietary PCBs intake affects human body less than in case of other contaminants. Similarly, at persistent PCBs levels in food, the long-term exposure does not change considerably with variation in dietary habits [13]. On the other hand, it can be assumed that increased intake of local animal foods in the Michalovce district would result in an extreme exposure of the consumers that could exceed the TDI value about 10 times. In addition, statistical data show that 5% of the inhabitants would suffer due to an exposure about 23 times higher than TDI.

It is obvious that scientific recommendations on rational nutrition should not regard only natural compounds but also regional availability and contamination of foodstuffs.

CONCLUSIONS

Intake of animal food contaminated with polychlorinated biphenyls in Slovakia within 1994–2005 resulted in a satisfactory low exposure. Its mean value represented about 3.8% of TDI for retail food. A slightly higher exposure was observed in a risky locality of the Michalovce region, nevertheless, it did not exceed 10% of TDI.

The actual food sources and dietary habits of the inhabitants of the risky locality lead to an increased exposure to PCBs that can highly exceed TDI (about 207% of TDI) on average. This value represents an about 24 times higher exposure than in other regions of the country, and epidemiological studies assume that it may participate in the aggravated health status of local inhabitants.

Considering scientifically recommended rules of the rational nutrition, the actually available dietary sources of consumers in the risky locality should be taken into account, since respecting of the rules without the prevention of local contaminated foodstuffs could result even in a higher dietary exposure to PCBs (about 10 times TDI). Health protection of consumers should be aimed at both food service and adult education as important tools to reduce domestic production of animal products and preferring the retail products.

Liable food authorities carry on the PCBs monitoring and inspection continuously. It is evident that measures oriented to decontamination of the affected locality as well as prevention of the further dissemination of the contamination are inevitable.

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