Levels of PCBs and Some Organochlorine Pesticides in the Human Population from Selected Areas of the Slovak Republic. Part II. Adipose Tissue

Anton Kočan, Ján Petrík, Beata Drobná, Jana Chovancová
GC/MS Laboratory, Department of Xenobiotics in the Environment, Institute of Preventive and Clinical Medicine, Limbová 14, SK-833 01 Bratislava, Slovak Republic

1. Introduction

Polychlorinated biphenyls under the name Delor were produced in Slovakia for 25 years (1959-1984). During this period PCBs entered the air, soil and especially water as a consequence of contaminated effluents from a production plant situated in the Michalovce district. Moreover, the environment of Slovakia has also been contaminated due to leaks in transformers, capacitors and heat exchangers and due to improper use (e.g. as paint additives applied on fodder silage walls) and storage of rejected or damaged devices or drums containing PCBs. Organochlorine pesticides such as DDT and Lindan had been extensively used in Slovakia until their use was banned (DDT) or restricted (Lindan) in 1973. There is conjecture, that their superfluous stocks have been liquidated partly in unsuitable ways. As to hexachlorobenzene (HCB) entering the environment as an agricultural fungicide, and as an industrial by-product formed in the production of chlorinated compounds, unexpected levels of hexachlorobenzene (HCB) up to a hundred times higher when compared to other countries, were found in human blood specimens collected from the Slovak and Czech general population[1),2),3)].

While, in Slovakia, PCB and pesticide levels in drinking water and foodstuffs are regularly checked by governmental and contract laboratories because maximal acceptable levels are limited by law, there is currently lack of information on PCB occurrence in air, soil, sediment and human samples, including mother's milk.

Therefore our research group has started with a pilot project aimed at understanding the state of exposure of the Slovak general human population to PCBs, PCDDs/Fs and some organochlorine pesticides through the analysis of blood, adipose tissue and milk. Five areas have been selected for the study:

The *Michalovce* District (PCB production at the Chemko Company), the *Veľký Krtíš* District (increased contamination of dairy products), the town of *Bratislava* (chemical industry, dense automobile traffic, municipal, industrial and hospital waste incineration[4),5),6)]), the *Nitra* District (an agricultural region), the *Myjava* region (a highland region characterized by home-made food, including cow's milk, butter, eggs, pork, etc.). A map of Slovakia on a district level with the blackened selected areas is shown in Fig. 1.

At the DIOXIN '93 Symposium in Vienna as a part I of this study[1),7)], levels of polychlorinated biphenyl (PCB) congeners, hexachlorobenzene (HCB), p,p'-DDE, p,p'-DDT, γ-HCH were reported in blood samples from the human population living in the above-mentioned selected areas .

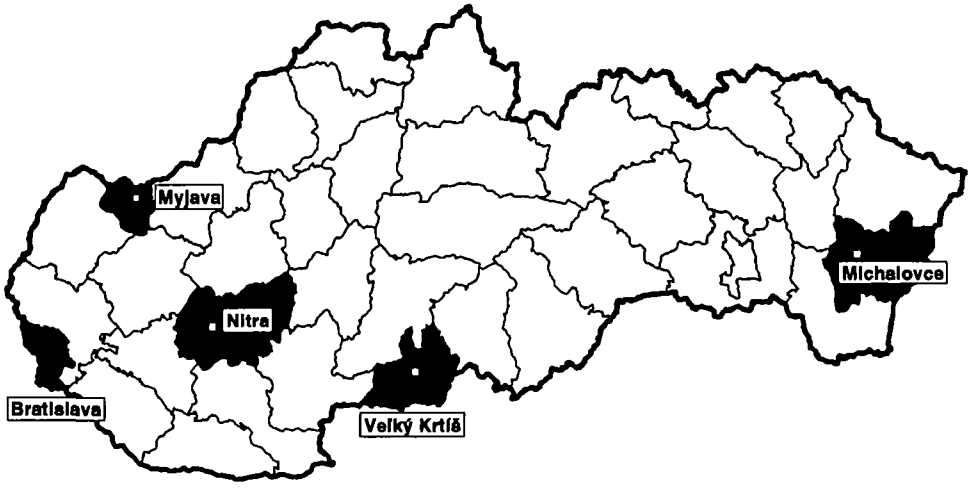

Fig. 1. A map of the Slovak Republic with studied areas

2. Experimental

About 1 to 5 g of subcutaneous adipose tissue from the abdominal area was taken from adult patients undergoing uncomplicated surgery (e.g. removing an appendix) and not suffering from carcinogenic or metabolic diseases. The tissue samples were stored in glass vials with PTFE caps at -18°C minimally until analysis. There was an effort to obtain the adipose tissue from an equal number of adult male and female donors for each selected area with representation of all age categories.
Individual questionnaires were completed by operating surgeons to obtain information on sex, age, body height and weight, dietary habits, previous and current occupation, smoking habits, and domicile. Selected data from the questionnaires summarized for the individual areas are given in Table 1.

Table 1. Characteristics of the Population Studied

Locality	Sex	No. of Samples	Age [yr.] mean / range	BMI[A] mean / range	Domicile	
					Urban[B]	Rural
Michalovce	M[C]	6	47.7 / 21-70	24.2 / 19.7-30.2	1	5
	F[D]	6	51.2 / 25-83	26.8 / 18.6-33.1	2	4
Veľký Krtíš	M	6	48.0 / 19-71	27.0 / 22.7-30.3	1	5
	F	6	49.2 / 27-71	30.9 / 22.7-40.8	2	4
Bratislava	M	3	49.0 / 35-60	24.8 / 20.7-26.9	3	0
	F	6	52.5 / 18-79	27.7 / 19.2-40.4	6	0
Nitra	M	5	54.8 / 34-77	27.1 / 22.0-30.3	5	0
	F	5	48.4 / 34-70	30.3 / 26.0-33.7	3	3
Myjava	M	5	55.4 / 25-77	24.8 / 20.5-29.8	0	5
	F	4	38.3 / 19-64	27.0 / 24.5-30.1	0	4

[A] Body Mass Index = [Weight in kg]/[Height in m]^2
[B] "Urban" in this case means that the donors live in the district towns
[C] Male [D] Female

Adipose tissue samples taken into analysis were weighed and ground with a sufficient amount of anhydrous Na_2SO_4. Lipids were extracted from the homogenized mixture packed in a glass column with n-hexane. After evaporating, lipids were weighed and cleaned-up using a florisil-H_2SO_4/silica-florisil column[7]. Eleven PCB congeners (28, 52, 101, 138, 153, 180, 105, 118, 156, 157 and 189) and four organochlorine pesticides (HCB, γ-HCH, p,p'-DDE and p,p'-DDT) were determined. A DB-5 column for separation and an EC detector for detection and quantification were used. Together with the lipid samples, blank and recovery samples (plant oil spiked with PCBs and organochlorine pesticides) were analyzed. HRGC/ECD chromatograms were evaluated by calibration curves of standard mixtures: PCB-28, 52, 101, 138, 153, 180, 105, 114, 118, 123, 156, 157, 189, 77, 126, 169, HCB, γ-HCH, p,p'-DDE and p,p'-DDT at four different concentration levels. A typical GC/ECD chromatogram of a cleaned-up adipose lipid sample is shown in Fig. 2. The QA/QC approach was based on the analysis of blank and recovery samples and certified reference materials.

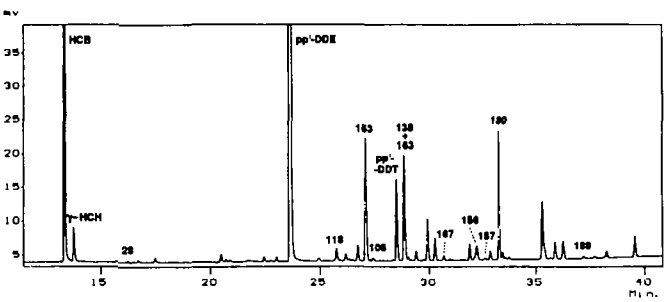

Fig. 2.
HRGC/ECD chromatogram of a human adipose tissue sample (the Veľký Krtíš District) aimed at the analysis of selected PCB congeners, HCB, γ-HCH, p,p'-DDE and p,p'-DDT

DB-5, 60m × .25mm, 220 kPa He, 120 °C(1.5min)/30 °C.min^{-1}/200 °C/ 2.5 °C.min^{-1}/305 °C

3. Conclusions

- Congeners Nos. 153, 180 and 138 were the most abundant from all the PCB congeners analyzed.
- HCB and p,p'-DDE were present at higher concentrations than individual PCB congeners and p,p'-DDT (see Figure 3 and 4). While the p,p'-DDE levels were comparable to published data from other countries the HCB levels were much higher[8),9),10)]. The average ratio of p,p'-DDE to p,p'-DDT was 18.5, which is in agreement with data obtained by analysis of human adipose tissue samples collected in the countries which banned the use of DDT about 15-20 years before the sample collection[10),11),12),13)]. The DDE/DDT ratio has considerably increased in the course of time because of a drop of DDT human lipid levels[10),14),15)].
- The results from all the areas correspond with the data obtained previously from autopsy adipose tissue[4)] and blood serum samples[1),7)] (see Fig. 4). The highest PCB levels were observed in the human population of the Michalovce District (PCBs were produced for 24 years in this district) and lowest ones in the Myjava area (a hilly area with home-breed cattle, etc.). While PCB concentrations in the blood lipids from the Michalovce District were 2-3 times higher in comparison with the other studied areas, in the case of the adipose lipids those concentrations were 4-6 times higher.
- There was no significant difference in HCB, p,p'-DDE and p,p'-DDT adipose lipid content between men and women. Concerning PCBs their levels were higher both in male adipose lipids (male 3.5 versus female 2.2 ng.g^{-1}) and male blood serum lipids (male 2.1 versus female 1.5 ng.g^{-1})[7].

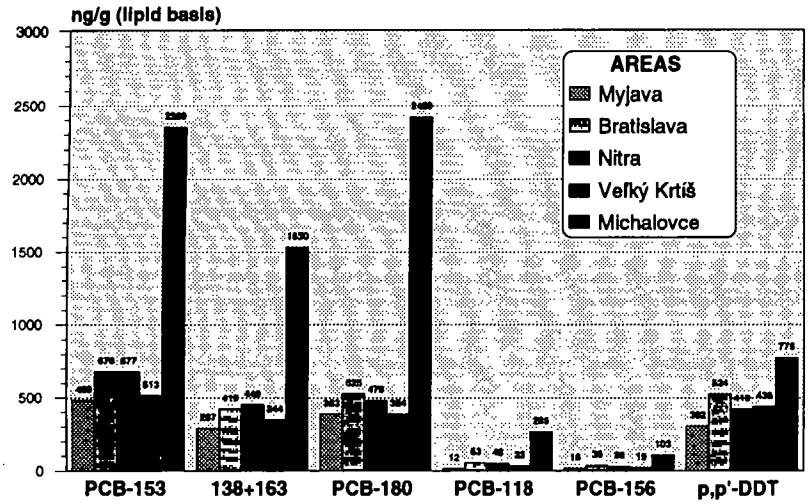

Fig. 3. Average levels of some PCB congeners and p,p'-DDT in adipose tissue lipids from the general human population of the five model areas of Slovakia

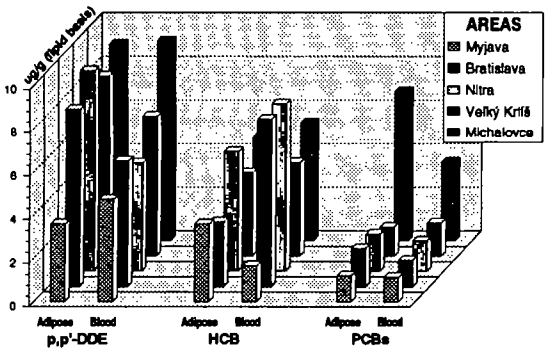

Fig. 5. Comparison of p,p'-DDE, HCB and summed PCB congener levels in human adipose tissue) and blood serum[7] samples from the general population of the five model areas of Slovakia*
) this study

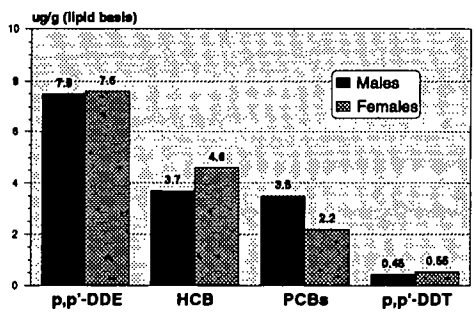

Fig. 6. Comparison of p,p'-DDE, HCB, PCB and p,p'-DDT average levels (arithmetic mean of all the values from the five selected areas) in the male and female adipose tissue samples

4. References

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