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Organochlorine Residues in Adipose Tissue of Residents of the Texas Gulf Coast

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Humans are exposed to organochlorine compounds mainly through the food chain. Chronic exposure to these chemicals leads to accumulation of the parent compounds and/or their metabolites in the adipose tissue, apparently due to their lipophilic nature. Several investigators have analyzed various tissues to estimate the body burden of xenobiotic compounds (Hayes 1975, 1982) in exposed workers as well as in the general population. We analyzed fat tissues collected at autopsy from 109 persons for 2,2-bis(4-chlorophenyl)-1,1-dichloroethylene (DDE), hexachlorobenzene (HCB), and the hexachlorobiphenyls (HCBP) isomers (2,4,5,2',4',5'- and 2,3,4,2', 4',5'-).

MATERIALS AND METHODS

Human adipose tissues (from anterior abdominal wall, axillary fossae and omentum) were obtained during autopsy at the University of Texas Medical Branch, Galveston, TX, between 1979 and 1980 and stored in glass containers with teflon lined screw caps at -70°C until analyzed.

All solvents were pesticide grade. Standard HCB, o,p-DDE, and p,p-DDE were obtained from Aldrich Chemical Co. (Milwaukee, WI) while aldrin and the PCB's were supplied by Analabs, Inc. (North Haven, CT). Anhydrous sodium sulfate (Na_2SO_4) was purchased from Fisher Scientific Co. (Pittsburgh, PA). Diazomethane was generated according to the procedure of (Foles et al., 1973).

Fat samples (1.0 g) mixed with anhydrous Na_2SO_4 (0.5 g) were homogenized in hexane (5.0 ml) using a Polytron homogenizer (Brinkman Instruments, Westbury, NY). The homogenization was repeated four times and the combined extract (20 ml) was separated into two fractions: A (2 ml) and B (18.0 ml). To 200 µl of fraction A, aldrin (50 ng) was added and the volume was brought up to 1.0 ml by adding hexane. This fraction was used to analyze for p,p-DDE. Fifty ng of aldrin was added to the rest of part A (1.8 ml) and the volume was reduced to 1 ml on a Buchler vortex mixer-evaporator (Fisher Scientific) for the analysis of PCB's and o,p-DDE. To fraction B (18.0 ml) aldrin (50 ng) was added and the volume was reduced to 1.0 ml using a Buchler vortex mixer-

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evaporator. This fraction was applied to a BioBeads SX-2 column (30 cm x 20 mm i.d.) and eluted with cyclohexane at a flow rate of 4.0 ml/min. After discarding the first 60 ml, 150 ml of cyclohexane was collected and reduced to 2.0 ml by using the flash evaporator (Fisher Scientific). This was used for the analysis of HCB.

The fractions were chromatographed on a Varian 3700 series chromatograph (Varian Instrument Division, Palo Alto, CA) equipped with a ^{63}Ni electron capture detector, an automatic sample injector, a CDS 111 chromatography data system, and a 2 m x 2 mm i.d. glass column packed with 4% SE-30 + 6% OV-210 on 80/100 mesh chromosorb 750 (Johns Manville, Denver, CO). Nitrogen carrier flow rate was 30 ml/min. Under these conditions, a baseline separation was obtained and the relative retention times with respect to aldrin were o,p-DDE (1.6), p,p-DDE (2.1), 2,4,5,2',4',5'-HCBP (3.3), 2,3,4,2',4',5'-HCBP (3.8) and HCB (0.4).

Analytical recovery, linearity, and sensitivity were established by supplementing 1.0 g fat samples with the standard compounds over a range of 5 to 50 ng/g fat. These supplemented samples were analyzed as described above.

Table 1. Recovery, sensitivity, and linear range of analysis of organochlorines in human fat

Compound	Recovery From Fat	Limiting Sensitivity	Linear Range
	(%)	(ng/g Fat)	(ng/g Fat)
HCB	86	5	5-50
p,p-DDE	96	4	5-50
2,4,5,2',4',5'-HCBP	92	5	5-50
2,3,4,2',4',5'-HCBP	95	5	5-50

RESULTS AND DISCUSSION

Recovery, sensitivity and linear range for the analysis of organochlorine in human fat are given in Table 1.

In order to assess the variability of the distribution of organochlorine compounds in body fat, we examined the concentration of these compounds in the anterior abdominal, axillary and omental fat samples of seven patients (Table 2).

Table 2. Variability of organochlorine content based upon the source of body fat

Compound	Patient No.	Anterior Wall	Axillae	Omentum
		ng/gm adipose tissue		
p,p-DDE	1	5836	4208	n.d.
	2	4060	4493	3183
	3	3372	3018	3288
	4	1917	2026	1751
	5	843	n.d.	1036
	6	6527	6789	6297
	7	4386	3699	4058
2,4,5,2', 4',5'-HCBP	1	276	251	218
	2	124	120	109
	3	212	201	231
	4	188	177	201
	5	98	n.d.	109
	6	205	237	186
	7	186	181	197
2,3,4,2', 4',5'-HCBP	1	1625	1166	1161
	2	849	816	802
	3	534	588	535
	4	211	187	221
	5	322	n.d.	294
	6	541	574	592
	7	433	370	377
HCB	1	33	33	32
	2	20	20	19
	3	17	20	21
	4	43	46	38
	5	9	n.d.	12
	6	22	26	28
	7	n.d.	59	73

n.d. - not determined

The fat burden of the four halogenated aromatics under investigation showed a variation of 7.5 to 20% between different sites within the same individual patient. Therefore, in subsequent studies, only fat from anterior abdominal wall was analyzed. Table 3 summarizes the concentration of p,p-DDE, 4,5- and 3,4-HCBP, and HCB as a function of age.

Table 3. Organochlorine residues in human fat as a function of age[a]

Age Group	N	p,p-DDE	HCBP 2,4,5,2',4',5'	HCBP 2,3,4,2',4',5'	HCB
		ng/gm adipose tissue			
0-4	3	319±28	22±12	67±13	18±15
4-9	2	457±104	30±10	77±25	18±05
10-19	3	871±322	212±131	19±19	22±03
20-29	15	1358±164	82±17	146±29	24±04
30-39	12	2006±385	163±61	253±61	35±13
40-49	15	4185±1232	136±41	340±110	24±05
50-59	16	5850±1807	154±24	586±130	23±03
60-69	24	3804±750	153±28	296±56	27±04
70-79	14	4302±748	128±17	296±73	24±3
80-89	5	12826±9802	198±97	641±372	31±10

a - Values reported as mean ± standard error.

The fat burden of these chlorinated aromatic hydrocarbons was compared as a function of sex in the 60-69 yrs age group. The data is given in Table 4.

Table 4. Organochlorine residues in human fat as a function of sex[a]

Sex	N	pp,DDE	HCBP 2,4,5,2',4',5'-	HCBP 2,3,4,2',4',5'-	HCB
			ng/gm fatty tissue		
male	12	4866±1313	164±51	331±82	26±5
female	12	2734±637	142±28	260±79	29±6

a - Values reported as mean ± standard error.

The most persistent form of DDT in fat is DDE. In previous studies, the concentration of DDE ranged between 3100 ng/gm to 12500 ng/gm fat tissue in the general population of the USA (Hayes, 1975). In an occupationally exposed population it varied between 91000 ng/gm to 44000 ng/gm in the adipose tissues (Hayes, 1982). A recent study (Barquet et al., 1982) showed that DDE varied between 12300 ng/gm to 14100 ng/gm in the 10 adipose tissues analyzed. Table 4 indicates p,p-DDE is more retained in the males than the females. This is in accordance with the earlier observations (Matsumura and Madhukar, 1984).

The two isomers of HCBP analyzed constitute about 35% of 60 polychlorinated biphenyls identified in human fat (Jensen and Sundstrom, 1974). In our study 2,4,5,2',4',5'- was about 2 to 3-fold more abundant than the 2,3,4,2',4',5'-isomer, which is contrary to the observation of Jensen and Sundstrom (1974) in a Swedish population where the ratio was 1:1.5. This difference may result from exposure to different kinds of PCB's which vary in composition (Safe, 1984). Although tissue burden data is available on total PCB exposure, no attempt has been made to quantitate each isomer individually. The body burden of polychlorinated biphenyls in human fat was found to be in the range of 500-1500 ng/g (Safe, 1984). A recent study indicated that the level of PCB's in Canadian population were in the range of 307±277 to 944±902 ng/g fat (Mes et al., 1982).

HCB was found in all the fat samples analyzed in this study. The amount of HCB varied between 18 to 35 ng/gm fat and did not show either age-dependent accumulation or sex-dependence in humans between 60-69 years of age. The values we obtained for HCB are much lower than those reported by Barquet et al. (1981) in a Florida population and our values also differ from those reported from European and Asian countries (Hayes, 1982). Placental and mammary transfer may account for the presence of HCB in the 0-4 age group (Mendoza et al., 1977, 1978).

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