Bull. Environ. Contam. Toxicol. (1995) 55:43–49


Environmental Contamination and Toxicology

# Determination of Organochlorine Pesticide Residues in Human Adipose Tissue: 1992 Study in Mexico

S. M. Waliszewski,[1] V. T. Pardio Sedas,[2] R. M. Infanzon,[1] J. Rivera[1]

[1]Instituto de Medicina Forense, Universidad Veracruzana Framboyanes, esq. Reyes Heroles, 91950 Veracruz, Ver., Mexico
[2]Laboratorio de Analisis de Agua y Alimentos, Secretaria de Salud, 20 de Noviembre 1074, 91700 Veracruz, Ver., Mexico

Received: 23 June 1994/Accepted: 14 December 1994

Since organochlorine pesticides are offered for plant protection and sanitation, there has been improvement in the control of pest populations and spread of infectious born diseases vectors. Public health programms in many developing countries including also Mexico, utilize these measures as the pesticides of choice to control disease transmitting organisms (Gutierrez Samperio et al. 1992).

Unfortunately, due to lipophilic properties, residues accumulate in the food chain, exposing humans to high levels. Their dangerous vapors when breathed affect mainly central nervous system causing chronic ill health effects (Eto M 1990). The concentrations determined in adipose tissue of human populations are the best indices in estimating the extent of exposure and risk evaluation.
The purpose of this study was to determine the extent of DDT and HCH's residues in the human adipose tissue. In total 90 human adipose tissue samples were collected during the autopsies at the Institute of Forensic Medicine in Veracruz during 1992.

## MATERIAL AND METHODS

The following reagents- petroleum ether fresh distilled; sulfuric acid of analytical grade and anhydrous sodium sulfate heated overnight at 650°C - were purchased from J. T. Baker. Analytical standards of pp'-DDT, op'-DDT, pp'-DDE, γ-HCH, and β-HCH were purchased from Supelco, Inc. Before analysis all reagents were tested for impurities by gas chromatography.

The glassware was washed with chromic mixture, rinsed with distilled water and petroleum ether, to make it suitable for pesticide residues analysis.

The analyses were carried out on a gas liquid chromatograph, Varian model 3300 equipped with a $^{63}Ni$ electron capture detector and Varian model 4400 Integrator. For pesticide separation a glass boro-silicate column 200cm x 2mm id. packed with 1.5% SP-2250 + 1.95% SP-2401 on 100/120 mesh Supelcoport was employed. Operating condition were as

*Correspondence to:* S. M. Waliszewski

follows ; nitrogen carrier gas at 20 mL/min; temperatures column 200 °C, injector 250 °C,detector 300 °C and 1 µL injection volume.

Extraction and clean-up procedures were in accordance to our previously described method (Waliszewski S M et al. 1982). The human adipose tissue sample was ground with sufficient anhydrous sodium sulphate to obtain a coarse powder which was placed into a chromatographic column of 1 cm id. and 50 cm length and the organochlorine pesticides residues were extracted with 150 mL of petroleum ether. The eluate was concentrated in a rotary evaporator to aproximatelly 30 mL. The fat content was determined gravimetrically. Concentrated extract which contained maximum 500 mg of fat was transferred into a 10 mL tube with a glass stopper , 1 mL of concentrated sulphuric acid was added and the tube was tightly stopped and vigorously shaken for 30 seconds. The contents were left to phase separation and then the supernatant was dried by passing it through a 3 to 5 gram layer of sodium sulphate which was then washed with petroleum ether. The ether extract was rotary evaporated to a small volume and the concentrated extract was transferred to a 1 mL volumetric tube. The volume was adjusted with petroleum ether to 1 mL. Finally 1 µL was used for gas chromatographic analysis.

A total of 90 samples of adipose human tissue were taken randomly from abdominal cavity at necropsy. The samples were kept glass jars, sealed and immediately frozen and kept at -25°C until analysis.

## RESULTS AND DISCUSSION

The resulting percentage of positive samples (mean values of 90 analysed samples), their standard deviation (sd) and the ranges (minimal and maximal levels) are presented in Table 1.

Table 1.Percentage of positive samples, mean and standard deviations and ranges of human adipose tissue contamination

| compound | % positive | mean + sd | range |
|---|---|---|---|
| α- HCH | 5.5 | 0.30 ± 0.18 | 0.11 - 0.53 |
| β- HCH | 10.0 | 0.25 ± 0.26 | 0.07 - 0.83 |
| pp'-DDE | 100.0 | 18.91 ± 23.29 | 0.51 - 157.77 |
| op'-DDT | 54.4 | 1.19 ± 2.37 | 0.20 - 14.57 |
| pp'-DDT | 100.0 | 4.72 ± 9.39 | 0.20 - 55.17 |
| total DDT | | 24.14 ± 27.88 | 0.51 - 161.92 |

The concentration and frequency of α-HCH and β-HCH was very low. The dominant determined compound found in the tissue samples was pp'-DDE which constituted 78 % of pesticide The range of pp'-DDE concentrations oscilated from 0.51 to 157.77 mg/kg. Comparing the DDT analogs, pp'-DDT was the predominant with concentrations were three times higher than op'-DDT.

Table 2.DDT's concentration (mg/kg) found in human adipose tissue according to sample origin.

| ORIGIN | pp'-DDE | op'-DDT | pp'-DDT | total DDT |
|---|---|---|---|---|
| Veracruz city | | | | |
| nsp/nsa* | 27/27 | 10/27 | 27/27 | |
| min-max | 1.39 - 38.78 | 0.20 - 3.14 | 0.20 - 55.17 | 1.99 - 93.95 |
| x ± SD | 13.69±11.31 | 0.58 ± 0.91 | 4.91 ± 11.96 | 18.77±21.29 |
| Veracruz suburban | | | | |
| nsp/nsa* | 28/28 | 19/28 | 28/28 | |
| min-max | 1.47 -157.77 | 0.20 -14.57 | 0.20 - 33.93 | 1.67-161.92 |
| x ± SD | 28.89±36.50 | 2.34 ± 3.45 | 8.07 ± 10.02 | 38.55±39.59 |
| Veracruz state | | | | |
| nsp/nsa* | 20/20 | 12/20 | 20/20 | |
| min-max | 0.99 - 44.89 | 0.20 -1.89 | 0.20 -15.16 | 1.19 - 45.93 |
| x ± SD | 14.10±10.97 | 0.34 ± 0.49 | 1.34 ± 3.27 | 15.65±12.15 |
| Foreign | | | | |
| nsp/nsa* | 15/15 | 8/15 | 15/15 | |
| min-max | 0.51 - 40.64 | 0.20 - 0.84 | 0.20 - 21.72 | 0.71 - 52.40 |
| x ± SD | 16.07±13.52 | 0.28 ± 0.23 | 2.03 ± 5.55 | 18.24±16.19 |

*nsp/nsa is the number of positive samples versus number of samples analyzed.

The results were grouped depending on origin and are presented in Table 2. They show high DDT's concentration in *Veracruz suburban* population where DDT has been used for a long time for control of malarial disease. This population presented a very high pp'-DDE concentration ,the origin is assumed to be from contaminated food consumption.The contamination levels of the *Veracruz city* population is comparable with the foreign group from other mexican cities .

The results grouped according to sex are presented in Table 3. The total DDT's concentrations were not significantly different ( $p < 0.05$ ) in relation to sex but differences were observed relating to pp'-DDE concentrations. It could be probably caused by the differences in alimentary habituations between women and men.

The results grouped according to age are presented in Table 4. The highest concentration of DDT's where found in the oldest over 50 years (mean of 31.98 mg/kg) of the total DDT's where pp'-DDE constituted the principal compound (86%). This population grouping followed by a young group (2 -18 years old ) characterized by slightly lower DDT concentrations compared to the oldest grouping. Moreover, this youngest group presented the highest pp'-DDT concentrations indicating a greater direct exposure of

youngest to the different sources of DDT. Alarming results were found in the infant group (0 - 2 years ) which also included a new born baby with 102.21 mg/kg of the total DDT.

Table 3. Relation between sex and DDT's concentrations (mg/kg ).

| SEX | pp'-DDE | op'-DDT | pp'-DDT | total DDT |
|---|---|---|---|---|
| females | | | | |
| nsp/nsa* | 25/25 | 14/25 | 25/25 | |
| min-max | 0.51- 95.01 | 0.20 - 3.14 | 0.20 - 33.31 | 0.71 -102.21 |
| x ± SD | 18.56±24.07 | 0.67 ± 0.85 | 4.02 ± 7.03 | 22.87±28.15 |
| males | | | | |
| nsp/nsa* | 65/65 | 35/65 | 65/65 | |
| min-max | 0.70 -157.77 | 0.20 -14.56 | 0.20 - 55.2 | 0.90 -161.9 |
| x ± SD | 22.99±23.17 | 2.59 ± 7.70 | 4.88 ± 10.01 | 24.63±27.97 |

*nsp/nsa is the number of positive samples versus number of samples analyzed.

Table 4. DDT's concentration ( mg/kg ) in adipose tissue according to age.

| ORIGIN | pp'-DDE | op'-DDT | pp'-DDT | total DDT |
|---|---|---|---|---|
| 0 - 2 years | | | | |
| nsp/nsa* | 15/15 | 7/15 | 15/15 | |
| min-max | 0.51 - 85.8 | 0.20 -1.65 | 0.20 -16.45 | 0.71 -102.21 |
| x ± SD | 12.35±21.95 | 0.44 ± 0.53 | 2.64 ± 4.26 | 15.20±25.76 |
| 2-18 years | | | | |
| nsp/nsa* | 13/13 | 7/13 | 13/13 | |
| min-max | 0.70 - 84.42 | 0.20 - 5.66 | 0.20 - 55.17 | 0.90 - 96.67 |
| x ± SD | 20.29±23.25 | 1.71 ± 2.94 | 8.69±15.27 | 29.88±33.57 |
| 18-50 years | | | | |
| nsp/nsa* | 40/40 | 25/40 | 40/40 | |
| min-max | 0.99 - 95.01 | 0.20 - 4.77 | 0.20 - 33.3 | 1.19 -100.6 |
| x ± SD | 16.12±16.72 | 1.33 ± 3.05 | 4.38 ± 8.97 | 21.3 ± 21.9 |
| over 50 years | | | | |
| nsp/nsa* | 22/22 | 10/22 | 22/22 | |
| min-max | 6.62 -157.77 | 0.20 -1.89 | 0.20 - 33.93 | 5.76 -161.92 |
| x ± SD | 27.62±31.98 | 0.81 ± 0.92 | 4.00 ± 7.69 | 31.98±33.99 |

*nsp/nsa is the number of positive samples versus number of samples analyzed.

Table 6. Comparison of human body burden (mg/kg ) with organochlorine pesticides form different countries.

| COUNTRY | γ - HCH | β - HCH | pp'-DDE | op'-DDT | pp'-DDT | ΣDDT |
|---|---|---|---|---|---|---|
| Germany 1990[a] | 0.038 | 0.042 | 0.436 | 0.013 | 0.093 | 0.556 |
| Poland 1990[b] | 0.004 | 0.002 | 15.00 | 0.009 | 0.67 | 15.00 |
| Finland 1991[c] | n.d. | - | 2.60 | - | - | 2.80 |
| Japan 1991[d] | n.d. | 0.84 | 2.40 | - | - | - |
| USA 1991[e] | - | 0.163 | 0.679 | 0.014 | 0.294 | 0.987 |
| Canada 1992[f] | - | 0.028 | 0.585 | 0.006 | 0.032 | 0.623 |
| India 1992[g] | 0.09 | 0.18 | 0.71 | 0.20 | 0.88 | 3.03 |
| Kenya 1992[h] | - | 0.034 | 3.26 | 0.15 | 2.49 | 5.91 |
| USA 1992[i] | - | - | 0.308 | - | 0.042 | - |
| Spain 1993[j] | 0.06 | 1.97 | 6.00 | - | 1.18 | 7.18 |
| Mexico 1992[k] | 0.30 | 0.25 | 18.91 | 1.19 | 4.72 | 24.82 |

Sources: a. Teufel et al.; b. Tanabe el al.; c. Mussalo-Rauhamaa; d. Sasaki et al.;e. Adeshina et al.; f. Mes ; g.Nair et al.;h Kanja et al.; i. Falck et al.; j. Gomez-Catalan et al.; k. present study.

Table 5. Relation between the cause of death and total DDT content (mg / kg).

| CAUSE OF DEATH | TOTAL DDT |
|---|---|
| alcoholism | 9.53 |
| traumatism | 15.54 |
| suicide | 18.24 |
| pathologic | 21.74 |
| homicide | 32.58 |
| cardiovascular | 50.62 |

The results grouped according to the cause of death are shown in Table 5. These indicate that the highest total DDT concentration was found in the adipose tissue of cadavers with the cause of death being cardiovascular disorders.These results are in agreement with other studies (Szymczynski et al. 1986) .

Presented in Table 6 is a summary of available human body burden with organochlorine pesticide residues in the 1990's. As can be observed, high levels of organochlorine pesticides in Mexican population were mainly of DDT and its metabolite DDE. The source of this contamination is by DDT employed in the sanitary actions where inhaled DDT can be accumulated, but also by its metabolite DDE consumed with food of animal origin .

## REFERENCES


Adeshina F, Todd EL (1991) Exposure assessment of chlorinated pesticides in the environment. J Eviron Sci Hlth A26:139-153.

Eto M (1990) Biochemical mechanisms of insecticidal activities.Chemistry of Plant Protection 6. p. 65-107.

Falck F, Ricci A, Wolff MS, Godbold J, Deckers P (1992) Pesticides and polichlorinated biphenyl residues in human breast lipids and their relation to breast cancer. Arch Environ Hlth 47:143-146.

Gomez-Catalan J, Planas J, To-Figueras, Campos M, Corbella J (1993) Organochlorine pesticide residues in the population of Catalonia (Spain). Bull Envrion Contam Toxicol 51:160-164.

Gutierrez Samperio J, Trujillo Arriaga J, Ramirez y Ramirez F, Velez Mendez A. (1992) Catalogo Oficial de Plaguicidas. CICOPLAFEST Mexico, D.F.

Kanja LW, Skaare JU, Ojwang SBO, Maitai CK (1992) A comparison of organochlorine pesticide residues in maternal tissue, maternal blood , cord blood and human milk from mother/infant pairs. Arch Environ Contam Toxicol 22:21-24.

Mes J (1992) Organochlorine residues in human blood and biopsy fat and their relationship. Bull Environ Contam Toxicol 48:815-820.

Mussalo-Rauhamaa H (1991) Partitioning and level of natural compounds in human serum, blood cells, and adipose and liver tissue. Sci Tot Environ 103:159-175.

Nair A, Pillai MKK (1992) Trends in ambient levels of DDT and HCH residues in humans and the environment of Delhi, India. Sci Tot Environ 121:145-157.

Sasaki k, Ishizada T, Suzuki T, Takeda M, Uchiyama M (1991) Accumulation levels of organochlorine pesticides in human adipose tissue and blood. Bull Environ Contam Toxicol 46:662-669.

Szymczynski GA,Waliszewski SM (1986) High levels of chlorinated pesticide residues in adipose tissue of patients with cardiovascular disorders. The Sixth International Congress of Pesticide Chemistry. Ottawa,Ontario,Canada August 10-17, 8A/7E-01.

Tanabe S, Falandysz J, Higaki T, Kannan K, Tatsukawa R (1993) Polychlorinated biphenyl and organochlorine insecticide residues in human adipose tissue in Poland. Envrion Poll 79:45-49.

Teufel M, Niessen KH, Sartoris J, Brands W, Lochbühler H, Waag K, Schweizer P, Oelsnitz G (1990) Chlorinated hydrocarbons in fat tissue: Analyses of residues in healthy children, tumor patients and malformed children. Arch Envrion Contam Toxicol 19:646-652.

Waliszewski SM,Szymczynski GA (1982).Simple, low cost method for determination of selected chlorinated pesticides in fat samples.J Assoc Off Anal Chem 65: 677-679.