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DDT Residues in Blood of Residents of Areas Surrounding a DDT Manufacturing Factory in Delhi

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The large scale use of persistent organochlorine pesticides in developing countries has caused serious concern due to demonstrated long term toxic effects of these chemicals in humans and in experimental animals. It is possible that continued exposure to these toxic chemicals may result in biologically significant accumulation of their residues in the general population. Previous studies on human fat (Dale et al. 1965; Ramachandran et al. 1973) and blood (Agarwal et al. 1976) have established the presence of higher levels of DDT residues in general population of Delhi area, as compared to people from other parts of the world. In recent years uncontrolled use of DDT in malaria control programme and volatilization of DDT from DDT manufacturing plant have resulted in build up of very high levels of DDT residues in the environment of Delhi. Since 1975, no report is available on DDT residues in the tissues of general population of Delhi. It was therefore considered of interest to monitor the levels of DDT in the blood of occupationally unexposed population of Delhi area.

MATERIALS AND METHODS

Analytical standards of chlorinated pesticides were gifts from United States Environmental Protection Agency, Research Triangle Park, NC. All solvents were glass distilled prior to use and checked for purity by a fifty-fold concentration using gas liquid chromatograph.

Blood samples (5 ml) were collected by venipuncture from 50 volunteers and stored in residue free 20 ml glass vials containing 200 USP units of heparin in 0.2 ml solution. For each case a detailed questionnaire incorporating the history of exposure and

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factors relevant to pesticide residue accumulation such as social status, dietary habits, age etc. was completed. Only healthy subjects with no history of any accidental or occupational exposure to DDT, were included in the present study.

The analytical procedures included extraction,cleanup, and quantification by gas liquid chromatography as described in the literature (Agarwal et al. 1976). Gas chromatographic analysis of DDT residues was performed on a Packard 7300-A Series Gas Chromatograph equipped with a ^{63}Ni-electron capture detector. The column used was 1.5% OV_{17} and 1.95% QF_1 on Gas Chrom Q (100-120 mesh) packed in 2m x 2mm (i.d.) glass column. The column operating conditions were:injector temperature, 210°C;column temperature, 190°C;detector temperature, 210°C;Nitrogen carrier gas flow rate at 60 ml/min.

Peaks were identified by comparing relative retention times with those of known pesticide standards. The standards were run before and after all analyses to keep track of the correct retention time and detector response. Results were confirmed by reinjecting the samples into a 5% DEGS on Gas Chrom Q (100-120 mesh) glass column. Further confirmation was carried out by thin layer chromatography using silica gel and rhodamine spray for detection. Recovery of DDT and its metabolites from spiked samples was always more than 88 %.

RESULTS AND DISCUSSION

The results presented in Table 1 are indicative of presence of very high levels of DDT and its metabolites in whole blood of occupationally unexposed population of Delhi area. Total DDT ranged from 0.053 to 0.663 ppm with a mean value of 0.301 ppm. In a similar survey conducted in 1975 (Agarwal et al. 1976), 174 out of 182 blood samples were reported to contain DDT and its metabolites and total DDT ranged from 0.166 to 0.683 mg/litre. It is clear from these two surveys that levels of DDT in blood of general population of Delhi are several times higher than that of people from other countries (Griffith and Blanke 1975; Kreiss et al. 1981).

Table 1 shows that the mean total DDT in male (0.344 ppm) was higher than that of female (0.229 ppm;$p<0.05$). A similar trend was observed in other surveys (Griffith and Blanke 1975;Agarwal et al.1976). This sexual difference in residue levels may be due to excretion of these chemicals in mother's milk and during menses in females. Moreover, females have more fat than males.

In this survey,the age of the donors had no influence

on the accumulation of DDT residues in blood. In contrast to these findings, Agarwal et al.(1976) and Kreiss et al.(1981) reported that total DDT increase with the age of the donor.

Table 1. Levels of DDT and its metabolites in whole blood of occupationally unexposed population of Delhi (ppm)

Metabolites	Range of concentrations and means ± S.D.		
	Male N=31	Female N=19	Total N=50
p,p'-DDE	0.026-0.239 0.147±0.059 (31)	0.042-0.269 0.102±0.053 (19)	0.026-0.269 0.129±0.061 (50)
o,p'-DDT	0.000-0.180 0.000±0.048 (30)	0.010-0.117 0.051±0.032 (19)	0.000-0.180 0.066±0.044 (49)
p,p'-DDD	0.000-0.006 0.0008±0.001 (7)	0.000-0.002 0.0005±0.0007 (8)	0.000-0.006 0.0005±0.0007 (15)
p,p'-DDT	0.000-0.295 0.119±0.088 (28)	0.000-0.194 0.075±0.055 (17)	0.000-0.295 0.102±0.079 (45)
Total DDT	0.112-0.663 0.344^{a}±0.175 (31)	0.053-0.560 0.229^{b}±0.133 (19)	0.053-0.663 0.301±0.169 (50)

N=Number of samples
Figures in parentheses indicate the number of positive samples
'a' Vs 'b' $p<0.05$

The dietetic habits have been found to influence the accumulation of DDT residues in blood. The mean total DDT in non-vegetarians (0.345 ppm) was higher than that of vegetarians (0.221 ppm;$p<0.05$). This difference may be due to the high DDT levels in meat products(Kaphalia and Seth 1981), which are common in non-vegetarian meals.

In this survey,it was also observed that the blood of residents of areas close to DDT manufacturing factory had significantly higher levels ($p<0.001$)of DDT,as compared to those living in areas away from the factory. Kreiss et al.(1981) reported that geometric mean level of total DDT in 499 persons living downstream from a DDT manufacturing plant was several times the national geometric mean level.

The presence of high levels of DDT and its metabolites in the blood of occupationally unexposed population of Delhi area may be due to ingestion of DDT through food

contaminated as a result of general environmental contamination; food is responsible for more than 80% of intake of the pesticides by the general population (Kraybill 1969). Apart from this, direct exposure to contaminated air, water and dust might have resulted in higher body burden of DDT residues in population living close to DDT factory.

The human pesticide residue is a biological index of pesticide exposure (Davies 1973) and studies on blood can be used for assessing the total body burden of DDT in the general population (Brown and Chow 1975). The present data will provide information of diagnostic value for future epidemiological work in this area.

REFERENCES

Agarwal HC, Pillai MKK, Yadav DV, Menon KB, Gupta RK (1976) Residues of DDT and its metabolites in human blood samples in Delhi,India. Bull WHO 54:349-351

Brown JR, Chow LY (1975) Comparative study of DDT and its derivatives in human blood samples in Norfolk county and Holland Marsh, Ontario. Bull Environ Contam Toxicol 13:483-488

Dale WE, Copeland MF, Hayes Jr WJ (1965) Chlorinated insecticides in the body fat of people of India. Bull WHO 33:471-477

Davies JE (1973) Pesticide residues in man. In: Edwards CA (ed) Environmental Pollution by Pesticides. Plenum Press, London p 315

Griffith Jr FD, Blanke RV (1975) Pesticides in people-Blood organochlorine pesticide levels in Virginia residents. Pestic Monit J 8:219-224

Kaphalia BS and Seth TD (1981) DDT and BHC residues in some body tissues of goat, buffalo and chickens, Lucknow, India. Pestic Monit J 15:103-106

Kraybill HF (1969) Significance of pesticide residues in foods in relation to total environmental stress. Can Med Assoc J 100:204-215

Kreiss K, Zack MW, Kimbrough RD, Needham LL, Smerk,AL, Jones BT (1981) Cross-sectional study of a community with exceptional exposure to DDT. J Am Med Assoc 245:1926-1930

Ramachandran M, Sharma MID, Sharma SC, Mathur PS, Arvindakshan A, Edwards GJ (1973) DDT and its metabolites in human body fat in India. Bull WHO 49:637-638

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