Bull. Environ. Contam. Toxicol. (1996) 56:58-64

Bulletin of Environmental Contamination and Toxicology

DDT and HCH Load in Mothers and Their Infants in Delhi, India

A. Nair,[1] R. Mandapati,[2] P. Dureja,[3] M. K. K. Pillai[1]

[1]Department of Zoology, University of Delhi, Delhi-110007, India
[2]Irwin Hospital, Delhi-110001, India
[3]Division of Agrochemicals, Indian Agriculture Research Institute. New Delhi-110012, India

Received: 12 October 1994/Accepted: 12 June 1995

Among the organochlorine pesticides, DDT and HCH excel in their broad spectrum toxicity and residual activity. However, developed countries have banned the usage of DDT since 1975, due to its inherent chemical stability, persistence, high liposolubility and bioaccumulation. Despite these undesirable properties, developing countries still use these insecticides primarly due to cost-benefit efficacy and broad spectrum toxicity. Also, it has been shown that both DDT and HCH have significantly shorter half lives in tropical environments than in temperate zones (Sleicher and Hoperaft, 1984, Samuel et al., 1988, Nair et al., 1992).

In India, DDT and HCH contribute more than 70 percent of the total pesticide consumption. Hence, it becomes imperative to ascertain the extent of contamination in man. The aim of the present study was to assess the levels of DDT and HCH in breast milk, maternal serum and cord serum from mothers and their infants; to examine a possible correlation between them and finally to compare the extent of transfer of these chemicals by primigravidae and multigravidae donors to the newborn. Comparative data concerning all these parameters is lacking from the developing countries.

MATERIALS AND METHODS

Samples of maternal blood, breast milk and cord blood from 25 mothers (23.4 ± 1.085 years of age with range of 18-40 years) and their newborn from Irwin Hospital, Delhi constituted the study group. Donors were unemployed, non-smokers, on a vegetarian diet, belonging to a lower socio-economic class but healthy with no major illness in the recent past. Twelve donors were primigravidae while the remaining were multigravide.

Correspondence to: A. Nair

Breast milk samples (5 ml) were manually expressed, from lactating mothers only after the infant was nursed (hind milk). Maternal blood samples (5 ml) were drawn from the median cubital vein of the left arm, immediately after parturation, while cord blood samples (5 ml) were collected by declamping the placental side of the umbilical cord. The milk samples were lyophilized, weighed and Soxhlet extracted (Bush et al., 1985), and the extract eluted with hexane (60 ml) on a basic alumina column (Holden and Marsden, 1969). Blood samples were centrifuged (2500 rpm for 10 min) and the serum (2 ml) obtained were extracted with hexane for 2 hrs in a slow speed rotating mixer (EPA Manual, 1980).

A Hewlett-Packard model, 5890A series Gas Chromatograph equipped with Ni^{63} ECD coupled with an integrator was used for the analysis with megabore capillary column, 0.53 mm i.d. and 10 m long containing 3 percent OV-17. The operating conditions were as follows : the column temperature was initially programmed at 200°C for 3 min and then increased at the rate of 10°C min^{-1} up to a final temperature of 250°C; the detector and injector were maintained at 300°C. Nitrogen with a flow rate of 45 ml min^{-1} was used as the carrier gas. The analytical standards of DDT and its metabolites and HCH isomers were obtained from EPA. In samples the pesticide residue analysed were further confirmed by a JOEL Model JMS-DX-300, GC-MS.

Recovery studies were performed separately for the three original sample types and the results showed average recoveries exceeding 90 percent. However, the data presented in the Tables have not been corrected for the recovery.

RESULTS AND DISCUSSION

The levels of DDT and HCH residues present in breast milk, maternal serum and cord serum are shown in Table 1. The average level of DDT in breast milk, maternal serum and cord serum were found to be 1.27, 0.27 and 0.14 mgL^{-1}, respectively. Breast milk contained four and a half times more DDT than the maternal serum. The metabolite, p,p'DDE was the predominant contaminant in milk, comprising 53 percent of the total DDT, while serum samples contained 8 to 10 percent p,p'-DDE of the total DDT. A similar trend was observed in breast milk and blood sample from Yugoslavia (Kruthacker et al., 1980). The levels of different DDT metabolites in maternal serum were more than those present in the cord serum. An altered hormonal status, a different grade of metabolic activity and an increased deposition of fat in the breast during pregnancy perhaps favoured degradation and selective partitioning of a few metabolites from the blood serum to the breast. The accumulation of DDT in breast milk and maternal serum showed a positive correlation (r=0.395, P < 0.05) while no correlation could be established either between breast milk and cord serum or maternal serum and cord serum. Skaare et al. (1988) reported a significant correlation between content of DDE in breast milk and maternal blood in samples from Norway.

HCH isomers were found to be present in smaller amounts than those of DDT residues (Table 1). The levels of different HCH isomers in breast milk were several fold higher than those in either of the serum samples. The β-HCH isomer was the predominant contaminant in the sample and in both breast milk and maternal serum it comprised more than 60 percent of the various HCH isomers. However, breast milk contained 6.5 times more β-HCH when compared to the maternal serum. The β-isomer is the most persistent HCH isomer (Steinwandter and Schluter, 1978 and Jensen, 1983) and is eliminated more slowly from the body than the γ-isomer (Pfeilsticker, 1973). In addition, it accumulates 10 to 30 times more in fatty tissues than lindane (Heeschen, 1980). Also the α- and γ-isomers are known to isomerise into β-isomer in living organisms (Jensen, 1983). Thus, the ratio between different HCH isomers changes from the start of the food chain till excretion in human milk, resulting in the more persistent β-HCH being the predominant isomer in human milk (Szokolay et al., 1977). Interestingly, the δ-isomer which was found in both types of serum samples, remained undetected in milk samples. Although the mean total HCH residues in maternal serum were more than those in the cord serum, there was only a slight difference in the amounts of each isomer among the samples. A highly significant correlation was observed between the HCH concentrations in the maternal serum and cord serum (r=0.712; P<0.00). However, no correlation was found either between the levels of HCH in breast milk and maternal serum or between those in breast milk and cord serum.

Breast milk samples (hind milk), sampled after the first feeding, showed 80 percent more residues of DDT and HCH when compared to maternal serum. Consumption of such a feed involved a direct entry of almost 88 percent additional residues in the new born to its pre-existing levels. Although, the residues of HCH were significantly lower as compared to those of DDT, the relative amounts of the pesticides in the cord serum and breast milk were similar. In the present study, the mean total DDT level in the breast milk was 1.27 mgL^{-1} (Table 1). Hence a 3 kg infant consuming 500 ml of milk daily will ingest 0.21 DDT/kg/day which is 42 times greater than the recommended 0.005 mg kg^{-1} ADI for DDT (WHO 1973).

The primigravidae donors showed 1.15 and 2.3 times more DDT and HCH residue in the breast milk, respectively when compared to

Table 1. Residues of DDT and HCH (mean ± S.E. in mgL^{-1}) in breast milk, maternal serum and cord serum.

Pesticides Detected	Breast Milk N=25	Maternal Serum N=25	Cord Serum N=25
o,p'-DDE	0.152 ± 0.056 (23) 12	0.010 ± 0.003 (24) 4	0.013 ± 0.005 (21) 10
p,p'-DDE	0.672 ± 0.153 (24) 53	0.028 ± 0.009 (24) 10	0.011 ± 0.002 (22) 8
o,p'-DDT	0.078 ± 0.049 (20) 6	0.016 ± 0.006 (14) 6	0.002 ± 0.001 (6) 1
p,p'-DDT	0.158 ± 0.066 (23) 12	0.083 ± 0.029 (19) 31	0.026 ± 0.010 (11) 19
p,p'-DDD	0.210 ± 0.114 (25) 16	0.134 ± 0.043 (25) 49	0.083 ± 0.032 (23) 61
Σ-DDT mean	1.270 ± 0.219	0.271 ± 0.063	0.135 ± 0.036
Σ-DDT range	0.33 - 4.11	0.01 - 1.54	ND - 0.69
α-HCH	0.045 ± 0.012 (25) 14	0.011 ± 0.003 (19) 22	0.016 ± 0.006 (18) 48
ß-HCH	0.198 ± 0.130 (7) 61	0.031 ± 0.003 (23) 62	0.012 ± 0.003 (18) 36
γ-HCH	0.084 ± 0.022 (25) 25	0.004 ± 0.001 (23) 8	0.004 ± 0.001 (14) 12
δ-HCH	N.D.	0.003 ± 0.002 (3) 6	0.001 ± 0.001 (2) 3
Σ-HCH mean	0.327 ± 0.160	0.050 ± 0.005	0.033 ± 0.008
Σ-HCH range	0.02 - 4.16	0.01 - 0.12	ND - 0.16

N = Number of samples
Figures in parentheses indicate number of positive samples
Figures below parentheses indicate percentage

Table 2. Residues of Σ-DDT and Σ-HCH (mean ± S.E. in mg/L^{-1}) in breast milk, maternal serum and cord serum of primigravidae and multigravidae mothers (expressed in mgL^{-1}).

Sample	**Σ -DDT Mean ± S.E.**	**Σ -HCH Mean ± S.E.**
BREAST MILK		
Primigravidae N=12	1.302 ± 0.367 (12)*	0.486 ± 0.320 (12)
Multigravidae N=12	1.120 ± 0.306 (12)	0.206 ± 0.061 (12)
MATERNAL SERUM		
Primigravidae N=12	0.112 ± 0.019 (12)	0.042 ± 0.005 (12)
Multigravidae N=12	0.431 ± 0.116 (12)	0.054 ± 0.008 (12)
CORD SERUM		
Primigravidae N=12	0.103 ± 0.022 (12)	0.021 ± 0.006 (10)
Multigravidae N=12	0.178 ± 0.069 (10)	0.047 ± 0.015 (12)

N = Number of samples

*Figures in parentheses indicate number of positive samples

multigravidae mothers (Table 2), suggesting bioconcentration and storage of the pesticides in breasts of primigravidae mothers from their birth until the first lactation. Pesticide contamination is more by a primigravidae than a multigravidae donor. Further, the level of pesticide in the maternal serum in both donor types did not show any significant impact in the transfer of pesticide to the newborn, since the levels in maternal and cord serum were almost similar and many fold lower than the breast milk. Hence breast milk was the main source of pesticide contamination to the newborn. However, the placenta was no barrier for the movement of chlorinated hydrocarbon pesticide to the foetus since the levels of pesticides in the maternal serum were almost identical to those of the cord serum.

The present data clearly indicate a significant bioconcentration of DDT and HCH residues in the breast milk and the newborn is a recipient of this bioconcentrated form of pesticides. The results also demonstrate that considerable amounts of DDT and HCH are transferred from the mother through breast feeding rather than the placental circulations. In addition breast milk could be used as a suitable indicator substance in monitoring the burden of persistent lipophillic chlorinated hydrocarbon pesticides in the human body.

Acknowledgments. The authors thank Dr. Arunima Sahgal and Ms Nandini Iyer, Department of Zoology, University of Delhi. The award of Research Associateship to one of us (AN) from University Grants Commission is acknowledged.

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