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Monitoring of Hexachlorobenzene Residues in Delhi and Faridabad, India

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Hexachlorobenzene (HCB), a persistent and highly mobile organochlorine chemical is known to occur in the environment and accumulates in the food chains. Though HCB is not currently used very much as a fungicide, its main source in the environment is demonstrated to be from chemical industries as impurity present in nearly 135 pesticide ingredients (Tobin 1986) and as a waste by-product from chlorinated solvents (Mumma and Lawless 1975). Besides, there are reports of biological conversion of lindane to HCB in plants (Engst et al. 1977; Steinwandter and Schluter 1978). Studies in many developed countries have shown low to high levels of HCB residues in the various components of the environment (Greve 1986, Carey 1986). The outbreak of cutaneous porphyria in Turkey in 1956, due to consumption of wheat treated with HCB has highlighted the importance and global concern of the residues of HCB. This warrants a world wide monitoring programme to assess the HCB burden in the total environment. Data from developing countries are lacking in this respect and it is uncertain whether it poses a problem or not in developing countries. With this objective, monitoring studies were undertaken in Delhi and a neighbouring industrial area, Faridabad to assess the current status of HCB residues in the environment.

MATERIALS AND METHODS

Samples used for HCB residue analyses were collected during 1987. Soil samples from different parts of Delhi were taken from the upper 10 cm using a soil auger. Earthworms were also dug out from the same soil sites. Water, fresh water clam and fish from river Jamuna in Delhi, water from lake Badkal in Faridabad, buffalo milk from dairy farms in Delhi and human milk and human fat samples from the hospitals in Delhi and Faridabad were used in this study. All human milk samples were 2 to 4 weeks post partum from mothers who had given birth for the first time. In addition a few samples of breast muscles of pigeon were also collected from Delhi area.

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In general, EPA protocol with certain modifications was used for HCB residue analysis (EPA Manual 1980; Beall Jr 1976; Snow 1985; Anonymous 1979). Samples were soxhlet extracted with a mixture of hexane, acetone and methanol (8:1:1) for 12 hours. Milk samples were lyophilized weighed prior to extraction with hexane (Bush 1985). Human fat samples were macerated in acetone and hexane, separated with 2% aqueous sodium sulphate and was extracted in hexane (Anonymous 1979). Water samples were extracted by partioning it with dichloromethane (EPA Manual 1980). The extracted samples of soil, earthworm, clam, fish, pigeon and milk were cleaned up in a florosil column, while that of water sample was cleaned up with silica gel (EPA Manual 1980) and of human fat in neutral alumina (Anonymous 1979). A Packard g.l.c. model 438 equipped with ECD and coupled with an Integrator (Chromatopac Shimadzu C-R2A) was used for HCB analysis. The glass column (2 m long, 0.2 mm i.d.) contained a mixture of 1.5% OV-17 and 1.95% QF-1 on gas chrom Q-100 to 120 mesh. The operating conditions were as follows:- Column = 200°C, Inlet = 220°C and the detector at 260°C with nitrogen gas flow rate at 30 ml/min. The analytical standard, HCB used for g.l.c. was obtained from EPA.

The presence of HCB in samples were confirmed by subjecting them to derivatization procedure as given in EPA Manual (1980). Recovery studies were performed separately for various samples and the results showed recoveries ranging from 79 to 102% with an average greater than 90%.

RESULTS AND DISCUSSION

The levels of HCB residues in various samples analysed are given in Table-1; all the results are expressed in ng/g. HCB residues were detected in 60 out of the 78 samples analysed and it ranged from 0.0 to 2102 ng/g in the various samples. Out of the 21 soil samples analysed, only 15 contained HCB with a mean value of 24 ng/g (Table-1) which was considerably lower to the levels reported from USA (Carey 1986). Similarly, the levels of HCB in earthworms were slightly lower to those reported from Germany (Gebefugi 1986). It is apparent from the results that there was no bioaccumulation of HCB residues in earthworm collected from Delhi. Out of the 4 samples of water from Delhi, only 2 showed presence of HCB and one among them collected from an industrial area in Delhi registered highest level of HCB residues. Also all the samples from Faridabad, an industrial town adjoining Delhi were positive for HCB residues. The levels of HCB residues detected from waters of Delhi and Faridabad were comparatively higher than those reported from river Rhine, Germany (Greve 1986) but considerably lower than the levels detected in waste waters from an industrial area in Germany (Vogelgesang 1986). The 3 samples of clams were positive for HCB residues, with a mean of 40 ng/g. Similarly, all fish samples were positive for HCB with an average of 122 ng/g. However fish from Delhi had lower levels of HCB as compared to fish from the Netherlands (Greve and Jansen 1981).

Table 1. Hexachlorobenzene residues (ng/g)[1] in various samples collected from Delhi and Faridabad

	Type of Sample	No. of Samples analysed	No. of Samples positive	Range	Mean ± SE
Delhi	Soil	21	15	0-165	24 ± 9
	Earthworm	3	3	5-18	13 ± 4
	Water	4	2	0-5.97	1.92 ± 1.41
	Clam	3	3	13-82	40 ± 20
	Fish	5	5	47-267	122 ± 40
	Pigeon	4	4	6-13	10 ± 4
	Buffalo milk	4	ND	-	-
	Human milk	16	14	0-2102	449 ± 183
	Human fat	7	3	0-64	12.19 ± 8
Faridabad	Water	2	2	0.324-1.592	0.958 ± 0.634
	Human milk	5	5	29-43	35 ± 3
	Human fat	4	4	59-830	280 ± 180

1 ng/g weight wet basis except milk samples which are in dry weight basis.

The higher levels of HCB in clams and fish seem to be due to bioaccumulation of HCB. Muscles of pigeon registered only a very low level of HCB as compared to fish eating birds from Gdnask, Poland (Dubrawski 1980). The buffalo milk samples were free of HCB residues. However, out of the 16 human milk samples from Delhi, 14 samples had a mean of 449 ng/g of HCB residues, whereas in Faridabad the mean levels for 5 samples were very low. The levels of HCB in human milk in Delhi were high but were lower as reported from West Germany (Andersen 1984). Human fat samples from Delhi contained much lower levels of HCB residues as compared to human milk. Out of the 7 samples, only 3 contained HCB residues with a mean value of 12.19 ng/g which were very much lower than the levels in Poland (Falandysz 1982) and Italy (Focardi 1986). The present data clearly indicate that HCB residue levels in India are low as compared to many developed countries. This probably may be due to the fact that HCB has never been used as a fungicide in India. However, the main source of HCB could be from the industrial chemicals, as is evident from higher levels of HCB from samples collected from industrial areas.

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