STUDY ON ORGANOCHLORINE PESTICIDES IN BODY TISSUE OF INVERTEBRATES COLLECTED USING ARTIFICIAL SUBSTRATUM FROM WATER SOURCES IN AND AROUND DELHI, INDIA

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Introduction

The Indian consumption of pesticides is approximately 85,000 metric tons, where 70% accounts for DDTs, HCHs & organophosphorus pesticides (OPPs)[1]. In the recent years the consumption of pesticides has shown a downward trend to around 3700 metric tons in 2006-2007[2].The production of DDT, lindane and endosulfan are going on in India, but restricted use is still continue for control of vector borne diseases[11]. Most of these compounds are identified as hormone disrupters, which can leads to alteration of normal functioning of endocrine and reproduction system in humans and wildlife[3]. The pesticides are transported to aquatic bodies by rain runoff, rivers and steams and associated with the biotic and abiotic macroparticles[4]. The liophilic nature, hydrophobicity and low chemical and biological degradation rates of organochlorine pesticides have led to their accumulation in biological tissues and subsequent magnification of concentrations in organisms progressing up the food chain[5,6]. Because of their persistency to decompose and their liophilic property, the global monitoring of these pesticides has become one of the world's most important priorities[7,8].

Although data on organochlorine pesticides in foods[9,10]and environmental samples[11,12,13,14] in Delhi and adjoining areas are available in literature, but such report on benthic invertebrates is limited [15]. Therefore bio-sensing studies on organochlorine pesticides have been undertaken using artificial substratum for benthic macro-invertebrate collection at different locations of Delhi, India.

Materials and Methods

Nine locations were selected for sampling at river Yamuna, a tributary of Ganges river system and a canal from Ganges (gang canal). The biotic samples of macro-invertebrates have been collected through artificial substratum. An artificial substratum was made of iron cage (11"x 11"x14") with galvanized iron mesh and filled up to 2/3rd with glass marbles[16]. The artificial substratum was lowered in water body with the help of iron chain and periodically retrieved for sample collection. The macro-invertebrates colonized on the marble substratum collected, segregated and preserved in wide mouth glass jars. The periodically collected samples stored to get sufficient mass of body tissue for further chemical analysis.

Air dried sample (approximately 5 gms) homogenized in a tissue homogenizer and extracted three times with dichloromethane in ultrasonic bath for 2-3 hours. A method blank was process along with the samples to check any contamination during the sample processing. The extracts were centrifuged, filtered and concentrated to 2 ml with vacuum rotavapor (Buchi, Switzerland) for further cleanup by column chromatography. Moisture contents were determined gravimetrically after oven drying the samples. Cleanup of the extracts were performed by Florisil column chromatography[17].

Certified reference standard (AccuStandards Inc.,USA) were used to calibrate the Gas Chromatograph. Spiking of standard into samples was carried out for recovery of pesticides to assess the loss/contamination of analyte during

processing of samples, the recoveries ranged from 86 to 107 percent and the results were not corrected for recoveries.

Identification and quantification of pesticide residues were done in gas chromatograph (Hewlett Packard, 5890 series II) equipped with electron capture detector (^{63}Ni). A 25 m x 0.2 mm ID Ultra-2 (0.33µm of 5% diphenylpolysiloxane and 95% dimethylpolysiloxane) column was used for all the separations. The oven temperature was 190^{0}C ramped to 220^{0}C at the rate 7^{0}C.min^{-1} and again programmed to 250^{0}C at 8^{0}C.min^{-1} and held for 6 min. Injector and detector temperatures were 250^{0}C and 300^{0}C respectively. Nitrogen at a flow rate of 1.0 ml.min^{-1} was used as carrier gas. The pesticide residues were quantified by comparing peak areas with the corresponding peak areas of the standards (Aqustandard, USA).

Result and Discussions

Average levels of organochlorine residues in microgram per kilogram dry weight (µg.kg^{-1} dry wt) in biota are presented in Table-1. The data revealed that in biota HCH, aldrin, dieldrin, endosulphan and DDT concentrations ranged from 30.17-3839.08 (mean 1031.79), 0.37-411.87 (mean 94.49), 15.26-812.71 (mean 247.60), 64.11-1353.22 (mean 623.08) and 628.22-3702.46 (mean 1650.40) respectively in the study area. Among OCPs DDT is maximum bioaccumulated followed by HCH, endosulphan, dieldrin, aldrin.

Table 1. Average values of pesticide residues in biota (µg.kg^1 dry wt) and water (ng/l) collected in and around Delhi, India

Water source	Sampling site	t-HCH	Aldrin	Dieldrin	t-endosulfan	t-DDT
River Yamuna	1	1905.26	102.92	135.95	479.66	1262.68
	2	112.71	ND	252.54	970.12	3702.46
	3	109.01	ND	15.26	363.51	1198.29
	4	1353.47	ND	171.20	64.11	628.22
	5	370.72	0.37	112.97	445.54	1772.99
	6	31.38	21.53	38.92	188.50	1430.47
	7	1396.95	ND	294.44	228.29	1747.36
	8	1690.68	3.62	812.71	1319.96	1853.53
	9	510.25	26.60	279.34	1353.22	1898.69
Gang Canal	1	30.17	ND	52.83	306.09	1586.13
	2	3839.08	411.87	557.40	1134.89	1073.57

ND-Not Detected, CV-Coefficient of Variation

The higher concentration of DDT in tissues of biota indicated slow degradation of DDT or fresh input of DDT[18] to river Yamuna in Delhi. DDT is still used in public health practices in tropical countries including India, therefore the observed levels of DDT in biota and water could be attributed to waste water flow to the river water systems. In such situations input of HCH, aldrin, dildrin and endosulphan in to the river water system can not be ruled out. A significant variation (51.33 to 192.32%) was observed in the levels of OCPs in biota at differentlocations.

The benthic macro-invertebrates are constantly exposed to pesticide residues and because of liophilic in nature these get accumulated in biotic tissues over a period of time. A comparative study of pesticide residues in different groups

of invertebrates was done and results tabulated in Table-2. The bioaccumulation potential of taxonomic groups varies with respect to the bioavailability of different pesticides. The results indicate that ephemerptera, tricoptera and mollusca accumulate maximum pesticides followed by placoptera, odenta, and crabs but oligocheta group of invertebrates accumulates least quantity of pesticides.

Table 2. Levels of organochlorine pesticide residues ($\mu g.kg^{-1}$ dry wt) in different groups of invertebrates

Pesticide residue	Ephemeroptera	Tricoptera	Placopetra	Odenta	Crabs	Mollusca	Oligocheta
t-HCH	661.95	43.14	41.53	378.60	227.39	1541.74	10.9
Aldrin	206.17	8.99	ND	ND	2.56	119.19	ND
Dieldrin	946.35	ND	69.53	ND	10.45	429.22	85.26
t-endosulphan	2283.83	1097.39	369.28	147.40	251.84	508.59	262.52
t-DDT	1690.75	3415.53	2671.05	1221.55	487.22	1927.37	ND
Total	**5789.05**	**4565.05**	**3151.39**	**1747.55**	**979.46**	**4526.11**	**358.68**

The observations of the study could not be compared well due to limited reports; however concentrations of pesticide residues in water and biota far below the findings of study during eighties[14].

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