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Residues of Organochlorine Insecticides in Fish from Mahala Water Reservoir, Jaipur, India

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Organochlorine insecticide (OC) residues have become an intrinsic part of the biological, geological and chemical cycles of the earth and are measurable in water (Pillai and Agarwal, 1979; Yamato et al. 1980; Polemio and Provenzano, 1983), bottom sediment (El-dib and Badawy 1985; Agarwal et al. 1986) and in fish (Aly and Badawy 1984; Devault et al. 1986; Agarwal et al. 1986).

When fish are exposed to pesticides, these are taken up through food or by gills which are extremely efficient in removing pesticides from water. The main uptake of pesticides by fish from water is direct but passive, and the entry through food is less important. Residues in tissues vary greatly from organ to organ, at least in part as a result of relative concentration of fats.

The purpose of the present work, which represents an essential part of a project is to find out OC residue levels in different fish species collected from Mahala water reservoir, a freshwater lake situated 40 Kms from Jaipur, on Jaipur-Ajmer highway. Pesticides used in the catchment area (220 sq. miles) are carried in the agricultural run-off from land to water (Bakre et al. 1990) where they adsorb on to bottom sediments (Misra et al. communicated) and move to other components of the aquatic system.

MATERIALS AND METHODS

Sixty four adult fish of 4 different species were collected during November 1986 to September 1987 from Mahala water reservoir. Number of fish caught for each species were as follows *Puntius sarana* 12, *Channa punctatus* 24, *Wallago attu* 12, *Labeo bata* 16.

The samples of muscle, liver, kidney, brain, alimentary canal and gill were analysed separately from each fish. The content of organochlorine insecticides was determined by a modified method of Mills et al. (1963). The pure

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pesticides references used in this study were: α-, β-, and γ-isomers of HCH, aldrin, p,p'-DDE, p,p'-DDD and p,p'-DDT, obtained from US. EPA.

Samples of 2 gm were weighed out, extracted with acetonitrile which were then diluted with 7.5 ml of 2% Sodium sulphate (anhyd), pesticide residues were extracted into hexane and purified by Florisil(R) column chromatography, eluting with hexane. Aliquots of 5 µl extracts were injected using Hamilton microsyringe into a Packard-438 gas chromatograph equipped with electron-capture detector with a glass column (2m x 4 mm; L x i.d.) packed with 1.5% OV-17 + 1.95% OV-210 on 80/100 chromosorb WHP. Operating temperatures were 200°, 220° and 280°C for column, injector and detector respectively. Nitrogen was used as a carrier gas at a flow rate of 40 ml/min. Determination of OC residues was based on peak area given by C-R2A Shimadzu integrator coupled to the GLC.

The data are reported as µg/g wet weight and are not corrected for extraction efficiency.

RESULTS AND DISCUSSION

Table 1 summarizes residues of α-, β-, γ-HCH, aldrin, p,p'-DDT and its metabolites (DDE and DDD) in various tissues of the fishes examined. Individual fishes studied contained residues of insecticides in quantities dependent on the species of fish, type of tissue and size of the individuals subjected to analysis.

The smallest quantities were detected in Channa punctatus, the highest were found in Labeo bata. The results can to some extent be justified by the way of nutrition and the fat content of the particular species of fish. Labeo bata which is a column and bottom feeder, as it mostly feeds on plankton (especially zooplanktons) from the bottom of water where in sediments more contamination may be found is exposed to more concentration of chlorinated hydrocarbons than other species analyzed. Puntius sarana which has a differentiated diet with a big share of plankton, especially phytoplankton, followed next, as it is dangered to lower concentration of chlorinated hydrocarbons. Wallago attu though carnivorous and a scavenger contained lesser residues, probably because of its low fat content (2.7%). But, this is contrary to the fact that Labeo bata with same fat content (2.5%) had more residues. Similarly, low concentration of residues in Channa punctatus, a scavenger too, could be attributed to its low fat content (0.6%). By the way of nutrition the latter two fish species should have concentrated more residues, but, besides, that Channa punctatus has a low fat content, results can not be justified on the basis of nutrition. Since the results in W. attu and C. punctatus could not be entirely justified by the way of nutrition, TABLE-1 : Mean OC residue levels (μg/g) in fish species collected from Mahala Water Reservoir

Fish	α-HCH	γ-HCH	β-HCH	Aldrin	p,p-DDE	p,p'-DDD	p,p-DDT
			KIDNEY				
Labeo bata	0.86	1.27	0.76	0.97	3.28	1.99	ND
Wallago attu	2.69	1.81	0.71	1.01	0.21	1.11	0.04
Channa punctatus	1.56	1.42	0.58	0.88	0.25	1.49	0.01
Puntius sarana	3.19	2.57	5.78	0.47	0.93	0.76	0.36
			MUSCLE				
Labeo bata	1.33	1.30	2.46	1.78	1.43	0.14	0.22
Wallago attu	0.76	0.28	1.06	0.46	0.17	0.19	0.02
Channa punctatus	0.26	0.17	1.28	0.30	0.06	1.14	0.32
Puntius sarana	0.49	0.73	ND	0.07	0.16	0.52	ND
			BRAIN				
Labeo bata	3.83	5.90	6.83	1.62	10.18	2.66	ND
Wallago attu	3.07	2.66	1.93	1.01	ND	0.28	0.54
Channa punctatus	2.01	1.68	1.75	1.56	2.41	2.38	ND
Puntius sarana	2.36	3.11	4.49	1.12	0.96	0.55	0.11
			GILL				
Labeo bata	0.71	0.90	0.78	0.23	0.22	0.34	0.03
Wallago attu	1.30	1.53	ND	0.29	0.45	0.17	ND
Channa punctatus	0.61	0.48	1.20	0.55	1.29	0.53	0.22
Puntius sarana	0.53	0.46	0.64	0.81	0.21	2.57	0.22
			LIVER				
Labeo bata	1.77	1.54	1.32	0.87	2.09	1.33	0.07
Wallago attu	2.89	2.11	1.04	1.44	0.28	1.38	0.89
Channa punctatus	1.13	1.47	2.73	2.16	1.40	1.12	0.33
Puntius sarana	0.83	1.14	1.22	0.48	0.24	1.12	0.07
			ALIMENTARY CANAL				
Labeo bata	1.76	3.25	2.45	1.80	1.28	1.64	0.29
Wallago attu	2.59	2.27	0.80	ND	0.14	0.24	ND
Channa punctatus	1.93	1.24	2.15	1.20	1.35	1.28	0.16
Puntius sarana	0.67	0.60	0.71	0.45	0.09	0.31	ND

the build up of residues could most likely be due to the direct absorption from water and sediments, rather than by the bioaccumulation through food chains. Henderson et al. (1971) were unable to correlate OC residues with different species of fish. According to Youngs et al. (1972) older fish could build up higher residues.

On comparison of organochlorine insecticide levels in muscle tissue and in other tissues of the fish, it results that the degree of cumulation of these compounds in muscles is considerably low. Residues of α-, γ- and β-HCH were found at higher levels in Labeo bata where average values of 3.83 µg/g, 5.90 µg/g and 6.83 µg/g respectively, reached in brain, against, 1.33 µg/g, 1.30 µg/g and 2.46 µg/g respectively in muscle tissue. p,p'-DDE amounted to 10.18 µg/g in the brain from Labeo bata while it touched only 1.43 in muscle. The reason is attributed to the higher fat content in other tissues than in muscle tissue alongwith the fact that the parenchymatous organs take part in metabolism of chlorinated hydrocarbons, as a result they are more dangered to cumulation of these compounds.

Major gaps obviously exist in the mode of pesticide uptake by fishes and fish tissues. Some investigators feel that swallowing is the primary route of pesticide intake (Mount 1962) while others credit the gills with being the primary pathway of pesticide entry (Holdon 1962, Ferguson et al. 1966). Previous study of Hansen (1980) showed that at higher concentrations (in the medium) the amount of pesticide taken up by the fish increased due to their sensitiveness and higher rate of metabolic activity, however, this increase varies greatly from fish to fish.

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