IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Pesticide Toxicity In Fish Of Gomti River At Various Locations With Particular Reference To Organochlorine Pesticides (Ocps)

Kumar Sangam* & Singh Shailendra Kumar**

*Research Scholar, Fish Biology Lab, Department of Zoology

Tilak Dhari College, Jaunpur 222002

** Assistant Professor, Fish Biology Lab, Department of Zoology

Tilak Dhari College, Jaunpur 222002

ABSTRACT

The levels and distribution patterns of certain organochlorine pesticides (OCPs) in fish samples obtained from three locations in the Gomti river, India, are reported in this study. POCPs in fish muscles varied from 2.58 to 22.56 ng g–1 (mean value: 9.66 5.60 ng g–1). There were no regional or chronological patterns in the distribution of the OCPs. Aldrin was the most abundant OCP, whereas HCB and methoxychlor were undetectable. The most often found OCPs were a-HCH and b-HCH among HCH isomers and ppDDE among DDT metabolites. According to the findings, the fish in the Gomti River are polluted with a variety of OCPs.

KEYWORDS: Organochlorine pesticides (OCPs), Channa punctatus, Gomti river, cardiovascular disease, enzyme.

INTRODUCTION:

Pesticides are widely used across the world to manage a variety of pests in crops. Pesticide residues tend to linger after application and infiltrate aquatic environment species, where they accumulate. Pesticide exposure has been linked to allergies, cancer, neuro abnormalities, endocrine dys-functioning, aberrant physiology, developmental consequences, headaches, stomach pains, vomiting, skin rash, coma, and other health problems. Regular intake of pesticide-contaminated food produces both short-term (acute) and long-term (chronic) consequences. Acute pesticide poisoning is relatively uncommon; but, long-term chronic toxicity induced by long-term exposure to low-dose pesticides is prevalent. The Gomti River, a major source of drinking water and irrigation in India, also provides basic nourishment to the people who live along its banks. India's population growth has resulted in fast industrialisation and economic development. Pesticide use in agriculture has expanded hundreds of times to support the country's growing population. Pesticides in massive amounts are being administered to agricultural areas throughout the Gomti river basin. Their waste eventually makes its way into the river via flash floods, leaching, drainage, and surface runoff. There are several reports indicating that the river Gomti is severely contaminated. Many reports are also available at the international level that demonstrate pesticide residues in water resources. The presence of pesticide residues in fish tissues indicates that these chemicals bio-accumulated along the food chain's trophic levels.

Pesticides are utilised at a rate of 60,000 MT per year in India, with the highest usage occurring around the river Gomti basin. Aside from the typical agricultural operations carried out along the Gomti basin, the river's dry beds are utilised to produce vegetables and fruits, and pesticides are added to the river during the monsoon season.

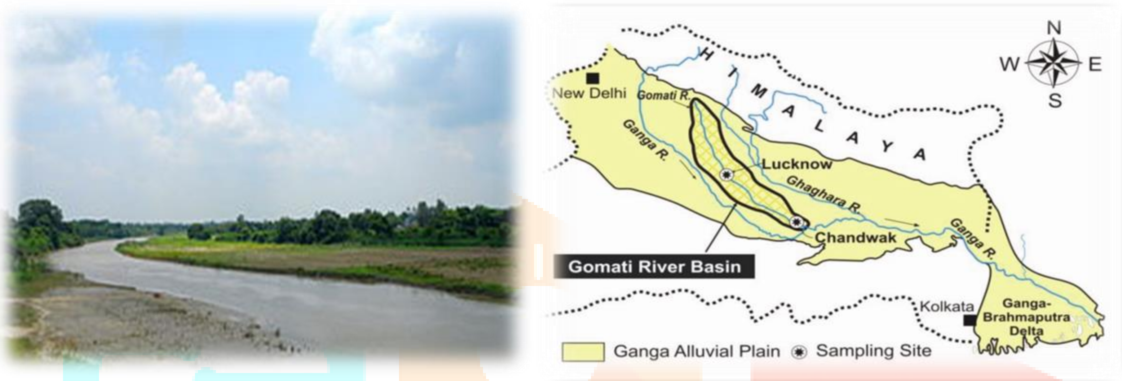
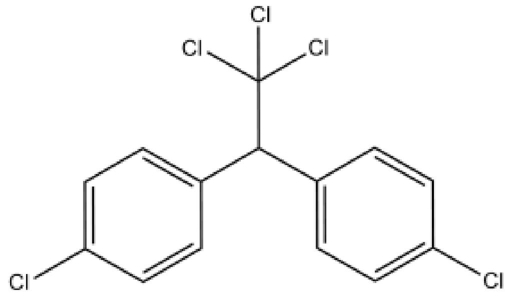


Fig 1. Location map of the Gomati River Basin

Among all aquatic creatures, fish is thought to be an appropriate bio-indicator animal for detecting environmental pollution. Because of their decreased mono-oxygenase (detoxifying enzyme) activity, fish ingest contaminants directly via the water via gills, integuments, and food intake, and have an enhanced propensity to bio-accumulate. Pollutants found in fish suggest not just their persistence in the environment, but also their transmission to other creatures via the food chain. Fish is a good source of not just proteins, but also omega-3-polyunsaturated fatty acids, which are suggested for those with cardiovascular disease. Fish fatty acids are also employed in pharmacological and cosmetic formulations. Consumption of contaminated fish, on the other hand, may result in the buildup of contaminants in the human body.

Pesticide risk assessment is based on toxicological effects, which are often stated as the ratio of projected ambient concentration and average daily ingestion to average body weight. Various research have been undertaken across the world to examine the health risk associated with the intake of pesticide contaminated fish, including a number of studies from the nation.

Organochlorine pesticides (OCPs) are among the most dangerous worldwide environmental pollutants. OCPs have remained substantial pollutants because to their resilience to environmental degradation, with multiple studies indicating the continuing and increasing levels of pollution.



Structure of DDT, An organochlorine pesticide

The occurrence of OCPs in the global atmosphere is pervasive (Hung et al. 2002). OCPs are mostly employed in agricultural areas to manage soil and crop pests, and they enter aquatic systems by discharges of home sewage and industrial wastewater, runoff from agricultural fields, and direct trash dumping into river systems. Pesticides may then be distributed throughout river ecosystem components such as water and sediment and accumulate in aquatic biota. Because pesticides are lipophilic in nature, their cumulative accumulation at low quantities in mammalian body fat may pose long-term risks (Metcaff 1997). Human breast and liver malignancies, testicular tumours, and reduced sperm counts have all been associated to OCPs (Davies and Barlow 1995). Because of its extensive usage in the past, chlorinated pesticide residues have been discovered in practically all segments of the environment in India, with the ability to biomagnify/accumulate in animal tissue, human blood, adipose tissue, and breast milk (Beg et al. 1989). The water and bed sediments of the Gomti River, one of the principal tributaries of the Gomti River in northern India, are polluted by polycyclic aromatic hydrocarbons (PAHs) and organic chlorinated paraffins (OCPs) (Malik et al. 2004; Singh et al. 2005a). However, there is no published data on the amounts of these dangerous chemicals in the river's biota. Throughout its course, the river's water is extracted for residential and drinking purposes, irrigation, recreation, and fishing. The presence of pollutants in river fish that are often carcinogenic in nature may cause major health risks to the surrounding people. As a result, this study was conducted to investigate the levels and distribution patterns of several persistent OCPs in fish samples from the Gomti river system in India.

SAMPLING:

The samples of fish (Channa punctatus) were taken from the Gomti River (India). The Gomti River drains a catchment area of around 25,000 km2 and travels a total distance of approximately 730 km before merging with the Gomti River. Several tiny tributaries (Kathna, Sarayan, Reth, Luni, Kalyani, Sai) originate within short distances and convey wastewater and industrial effluents from several towns and industrial facilities in the basin. Lucknow, Sultanpur, and Jaunpur are the three largest urban towns on the river's banks. The river is a key supply of drinking water for Lucknow City, the state capital of Uttar Pradesh, which has a population of over 3.5 million people. Following that, the river immediately collects untreated wastewater and effluents from Lucknow, Jagdishpur, Sultanpur, and Jaunpur via more than 40 wastewater drains. The fish samples were taken from three different locations throughout the pre- and post-monsoon seasons in 2004–2005. (Fig. 1). The river sample locations are positioned upstream (Site-1) of Lucknow City, in the middle of town (Site-2) and downstream (Site-3) of the city, indicating low (Site-1) and high (Sites 2 and

3) pollution sections, respectively. As much as feasible, similar sized fish samples were chosen. Each fish was measured (in centimetres), tagged, and placed on ice before being frozen until processed and tested. Each fish was weighed (g) in the laboratory, and the skin was peeled from the muscle in the centre of the fish with a steel knife and steel tweezers. Then a sub-sample (10 g) of the muscle was taken. This sub sample was crushed with activated sodium sulphate until it formed a homogenous mixture. The mixture was transferred to a paper thimble and extracted for 6 hours in a soxhlet device with 100 mL of solvent (n-hexane:dichloromethane, 1:1, v/v). The extract was concentrated to roughly 1–2 mL in a water bath using a rotary evaporator, and then purified using a glass column filled with glass wool, 6 g of activated florisil, and 2 g of sodium sulphate. 70 mL of n-hexane:dichloromethane (1:1, v/v) was used to pre-rinse the packed column. The elution was performed in 50 mL of n-hexane containing 25% (v/v) dichloromethane. The effluent was concentrated to a volume of 2–3 mL before being decreased to a level of 1 mL.

METHODOLOGY:

The OCPs in the extracts were evaluated using a Gas Chromatograph (Varion CP-3800) fitted with a Ni63 ECD (electron capture detector) and capillary column (30 m • 0.32 mm i.d. • 0.25 lm film thickness). The instrumental analyses were performed with nitrogen as the carrier gas (2 mL min–1) at the following operating temperatures: 300°C for the injector port and detector and 210°C for the column. The injected volume for both the sample and the standard (mixture) was 1 lL. The split ratio was set at 1:2. The chosen OCPs were discovered by comparing retention times to the relevant benchmark. The detection limit for all OCPs was 0.1 ng g–1 wet weight. Contamination control (strict washing/cleaning processes), monitoring of blank levels of solvents, equipment, and other materials, analysis of procedural blanks, recovery of spiked standards, and monitoring of detector response and linearity were among the quality assurance measures. Sigma-Aldrich, USA, provided the pesticide standards (99.9% purity). All analyses were performed in duplicate, and the recoveries of specific pesticides were measured using the spiking sample technique, which yielded results ranging from 79 to 108 percent. The final findings were subjected to recovery correction adjustments. The results are shown as lowest, maximum, and mean values with standard deviation. Means were calculated by setting non-detected analyte concentrations as zero. BDL denotes values that are less than the detection limits.

RESULTS AND DISCUSSION

POCPs (total of all OCPs) in fish muscles varied from 2.58 to 22.56 ng g–1, with a mean value of 9.66 5.60 ng g–1. Table 1 summarises the OCP residues found in the fish muscles. POCP values were lowest and highest in samples taken from Sites 1 and 3, respectively.

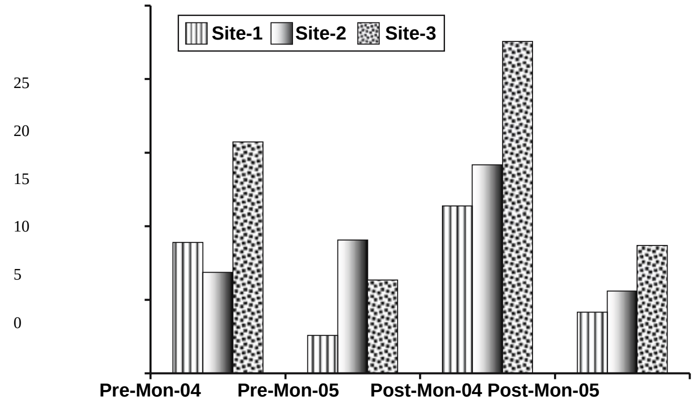


Fig. 2 Spatial variation of seasonal means of ROCPs in fish samples

The regional fluctuation of seasonal means of POCPs residues is depicted in Fig. 2. Although no apparent geographical or temporal pattern could be detected, substantially larger concentrations were reported at Site-3 over the research period, with the exception of the pre-monsoon season of 2005, and significantly lower amounts were found at Site-1. The increased residues at Sites 2 and 3 compared to Site 1 may be attributable to waste water intake from river drains and tributaries. The Site-2 is located in the centre of Lucknow, and it is preceded by six drains that convey partially treated/untreated sewage and industrial effluent from various sections of the city and discharge straight into the river. Just before Site-3, two tributaries, Reth and Luni, join the river, transporting urban waste water as well as mixed industrial effluents from Barabanki town and Gosaiganj township, respectively. Figure 3a shows the detection frequencies (DF) of individual OCPs in fish muscles. Aldrin (DF = 100 percent) was the most prevalent chemical, followed by dieldrin (DF = 75 percent), with neither HCB or Methoxychlor found in any of the samples. Among the HCH isomers, a- and b-HCH were the most common, followed by cand d-isomers. The pp-DDE was found in the majority of the fish samples as a DDT metabolite. The total average residue concentration of individual OCPs is depicted in Figure 3b. Aldrin, dieldrin, and endrin levels in fish muscles ranged from 0.30 to 7.84 ng g–1, BDL3.75 and BDL-0.75 ng g–1, respectively.

Table 1 OCPs residues (ng g^{-1} wet wt) in fish muscles of the Gomti River

Pesticides	Site-1 Range (mean ± SD)	Site-2 Range (mean ± SD)	Site-3 Range (mean ± SD)
Aldrin	0.30–3.27	0.70–4.34	0.46–7.84
	1.48 ± 1.36	2.55 ± 1.49	2.53 ± 3.56
α-HCH	BDL-0.57	BDL-1.33	BDL-0.35
	0.21 ± 0.27	0.65 ± 0.54	0.18 ± 0.15
β-HCH	BDL-0.31	BDL-0.57	BDL-0.68
	0.13 ± 0.16	0.30 ± 0.26	0.32 ± 0.28
γ-HCH	BDL-0.65	BDL-1.05	BDL-1.93
	0.28 ± 0.33	0.46 ± 0.54	0.84 ± 0.93
δ-HCH	BDL-2.13	BDL-1.43	BDL-0.90
	0.53 ± 1.07	0.36 ± 0.72	0.23 ± 0.45
α-Endosulfan	BDL-1.41	BDL-3.58	BDL-6.00
	0.35 ± 0.71	1.51 ± 1.80	2.76 ± 2.95
β-Endosulfan	BDL-0.23	BDL-0.14	BDL-0.41
	0.06 ± 0.12	0.04 ± 0.07	0.16 ± 0.20
Endosulfan	BDL-0.42	BDL-0.63	BDL-0.40
α-Chlordane	BDL-1.31	BDL-0.24	BDL-0.65
	0.55 ± 0.55	0.06 ± 0.12	0.29 ± 0.34
γ-Chlordane	BDL-0.49	BDL-0.89	BDL-1.05
	0.12 ± 0.25	0.30 ± 0.42	0.34 ± 0.50
Dieldrin	BDL-1.98	BDL-1.20	0.60–3.75
	0.79 ± 0.97	0.74 ± 0.58	1.85 ± 1.48
Endrin	BDL-0.56	BDL-0.46	BDL-0.75
	0.14 ± 0.28	0.11 ± 0.23	0.19 ± 0.38
Methoxychlor	BDL	BDL	BDL
ΣOCPs	2.58–11.38	2.59–14.18	6.33–22.56
	6.75 ± 4.09	8.92 ± 3.79	13.33 ± 7.34
op-DDT	BDL-0.35	BDL-0.38	BDL-0.25
	0.12 ± 0.17	0.12 ± 0.18	0.08 ± 0.12
pp-DDT	BDL-0.52	BDL-0.45	BDL-0.27
	0.20 ± 0.25	0.21 ± 0.24	0.10 ± 0.13
pp-DDE	BDL-0.45	BDL-0.83	BDL-7.61
	0.16 ± 0.21	0.44 ± 0.40	2.54 ± 3.56
pp-DDD	BDL-0.47	BDL-0.52	BDL-0.47
	0.20 ± 0.23	0.25 ± 0.29	0.17 ± 0.22
HCB	BDL	BDL	BDL
Heptachlor	BDL-0.52	BDL-0.47	BDL-0.41
	0.18 ± 0.25	0.20 ± 0.24	0.22 ± 0.19
Heptachlor epoxide A	BDL-0.21	BDL-0.51	BDL-0.14
	0.08 ± 0.10	0.19 ± 0.24	0.06 ± 0.07
Heptachlor epoxide B	BDL-3.50	BDL-0.31	BDL-0.85
	1.02 ± 1.66	0.12 ± 0.15	0.34 ± 0.42
α-Chlordane	BDL-1.31	BDL-0.24	BDL-0.65
	0.55 ± 0.55	0.06 ± 0.12	0.29 ± 0.34
γ-Chlordane	BDL-0.49	BDL-0.89	BDL-1.05
	0.12 ± 0.25	0.30 ± 0.42	0.34 ± 0.50

The detection and concentrations of aldrin. These findings are consistent with the findings of Ayas et al. (1997) and Barlas (1997), who found that aldrin outperformed dieldrin in fish samples. Normally, animals, microorganisms, plants, and insects convert aldrin to its epoxide counterpart (Matsumura 1985). Similar distribution patterns for aldrin and dieldrin have been documented in the Gomti river's water and bed sediments (Malik 2006), as well as in the soil, surface water, and groundwater of the surrounding areas (Singh et al. 2005b, 2007). These findings point to the continuous and recent usage of aldrin in the research region. Aldrin's dominance in the studied area has also been attributed by Ayas et al. (1997) and Erkmen and Kolankaya (2006). On average, achlordane outperformed c-chlordane in terms of detection frequency and residual levels among the chlordane isomers. The a-chlordane concentration varied between BDL-1.31 ng g–1 and BDL-1.05 ng g–1, with mean values of 0.30 0.40 and 0.25 1.13 ng g–1, respectively. Among the endosulfan isomers/metabolites, aendosulfan (range: BDL-6.00 ng g–1, mean SD: 1.54 2.11 ng g–1) had greater residue levels than b-Endosulfan (range: BDL-0.41 ng g–1, mean SD: 0.08 0.14 ng g–1) and endosulfan sulphate (range: BDL0.63 ng g–1, mean The residual levels and detection frequency of heptachlor epoxide-A were lower than those of heptachlor and heptachlor epoxide-B. For heptachlor, heptachlor epoxide-A, and heptachlor epoxide-B, the residue levels were BDL-0.52 ng g–1 (mean: 0.20 0.20 ng g–1), BDL-0.51 ng g–1 (mean: 0.11 0.15 ng g–1), and BDL3.5 ng g–1 (mean: 0.49 0.98 ng g– In general, heptachlor epoxide residue levels were greater than heptachlor residues. This is a common occurrence because heptachlor is metabolised in soils, plants, and animals to heptachlor epoxides, which are more stable in biological systems. In the fish samples, Barlas (1999) found larger amounts of heptachlor epoxides than heptachlor. Among the HCH isomers, a and b-isomers were the most common, with a detection frequency of 66.67 percent, followed by c-HCH (DF = 58.33 percent) and d-HCH (DF = 58.33 percent) (25.00 percent). Erkmen and Kolankaya (2006) discovered the prevalence of a and b-isomers of HCH in Meric delta fish samples (Turkey). The extensive distribution of aHCH isomer in fish samples may be explained by the fact that cHCH is quickly destroyed by microorganisms in soil and bottom sediments and photochemically isomerized to the a-isomer (Malaiyandi and Shah 1984), but the b-isomer is extremely durable in the environment. There was no discernible pattern in the distribution of HCH isomers in terms of residual concentrations (Fig. 4a). However, c-HCH levels were generally increased (range: BDL-1.93 ng g–1, mean SD: 0.53 0.64 ng g–1). These residue levels are lower than those reported by Bakre et al. (1990) for the identical samples obtained from a Jaipur reservoir (India). Bakre et al. (1990) found increased levels of b-HCH, followed by aHCH. Considering the persistence order of HCH isomers (a c b), our findings imply a historical intake of HCH and a recent application of lindane (c-HCH) in the catchments (Kauras et al. 1998). pp-DDE was the most detectable DDT metabolite (DF = 66.67 percent) and with considerably higher concentrations ranging from BDL-7.61 ng g–1 with a mean value of 1.04 2.18 ng g–1 (Figs. 3, 4b). The concentrations of the other metabolites, op-DDT, pp-DDT, and pp-DDD, were BDL-0.38 ng g–1 (0.11 0.14 ng g–1), BDL0.52 ng g–1 (0.17 0.20 ng g–1), and BDL-0.52 ng g–1 (0.21 0.23 ng g–1), respectively. These findings are consistent with those of Bakre et al (1990). In all of the fish samples, pp-DDE outperformed the other metabolites. The dominance of pp-DDE among DDT metabolites implies earlier DDT use in the catchments. Sethajintanin et al. (2004) and Yang et al. (2007) likewise found pp-DDE dominance in fish samples. pp-DDE is a long-lasting metabolite in the environment and in organisms. DDT and its metabolites are biomagnified significantly during trophic transfer. DDT metabolism in fish is mainly achieved by dechlorination to DDE but not to DDD (Schmitt et al. 1999). As a result, the existence of pp-DDD in fish tissue might be due to direct pp-DDD intake from the environment.

CONCLUSION:

According to the findings of this investigation, fish in the Gomti River are polluted with a variety of persistent OCPs. In fish, low levels of OCPs can result in an increase in mixed function oxidase activity (Fossi et al. 1986). Because there has been so little previous research, the current findings might serve as a starting point. More extensive research, in terms of sample network and sampling frequencies, are necessary in light of growing worldwide concern about persistent organic pollutants and their detrimental influence on the environment and human health.

REFERENCES:

- Ayas Z, Barlas N, Kolankaya D (1997) Determination of organochlorine pesticide residues in various environments and organisms in Giiksu Delta, Turkey. Aquat Toxicol 39:171–181
- Bakre PP, Mishra P. Bhatnagar P (1990) Residues of organochlorine insecticides in fish from Mahala water reservoir, Jaipur, India. Bull Environ Contam Toxicol 45:394–398
- Barlas NE (1999) Determination of organochlorine pesticide residues in aquatic systems and organisms in Upper Sakarya Basin, Tu¨rkiye. Bull Environ Contam Toxicol 62:278–285
- Beg MU, Saxena RP, Kidwai RM, Agarwal SN, Siddiqui F, Sinha R, Bhattachar-Jee BD, Ray PK (1989) Toxicology Map of India, vol 1 pesticides. ITRC, Lucknow, p 351
- Benezet HJ, Matsumura F (1973) Isomerization of c-BHC to a-BHC in the environment. Nature 243:480–481 Davies DL, Barlow HL (1995) Can environmental estrogen cause breast cancer? Sci Am October, pp 144–147
- Erkmen B, Kolankaya D (2006) Determination of organochlorine pesticide residues in water, sediemnt, and fish samples from the Meric Delta, Turkey. Int J Environ Anal Chem 86:161–169
- Fossi C, Leonzio C, Focardi S (1986) Increase of organochlorines and MFO activity in water birds wintering in an Italian lagoon. Bull Environ Contam Toxicol 37:538–545
- Hung H, Halsall CJ, Blanchard P, Li HH, Fellin P, Stern G (2002) Temporal trends of organochlorine pesticides in the Canadian Arctic atmosphere. Environ Sci Technol 36:862–868
- Kauras A, Zouboulis, Samara C, Kouimtzis T (1998) Removal of pesticides from aqueous solutions by combined physicochemical processes – the behavior of lindane. Environ Pollut 103:193–202
- Malaiyandi M, Shah SM (1984) Evidence of photo-isomerization of hexachlorocyclohexane isomers in the ecosphere. J Environ Sci Health A 19:887–910