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A Case Study on the Bioaccumulated Organochlorines in Fish Relative to Their Inhabitant

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ABSTRACT

The extensive and rough use of pesticides, heavy metals in agriculture, different industries are resulting in deteriorating effects of these toxicants in aquatic organisms. Their effects have been seen at both levels i.e. cellular and molecular. In the present study we tried to assess that which pesticides are mostly found in fish relative to their inhabitant. The findings prove that benthic fish inhabiting marine or brackish water bio accumulates more pesticides as compared to pelagic fish. The observations may be helpful in classifying bioaccumulation in fish on the basis of their inhabitant. Though, it needs much more study to frame a proper taxonomy on the bioaccumulation of different types of pesticides in fish based on their inhabitants.

INTRODUCTION

All living organisms need water and air to survive. Fresh water is the purest form of water which has all the minerals in optimum range, has high concentration of oxygen which makes it fit for drinking as well as survival for aquatic organisms. The direct discharge of pollutants (pesticides, heavy metals, fertilizers etc.) from different factories or runoff from agricultural lands or burning of domestic wastes or illegal use and weak monitoring of the level of pollutants[1] contributes to pollute the water, rendering it harmful for aquatic biota and loss of biodiversity[2,3]. They disturb the predator-prey relationship and also aquatic biodiversity. These toxicants harm all the three domains of aquatic ecosystems esp sediment, ground water, surface water, aquatic organisms. Due to their lipophilic and highly persistence nature these organochlorines get settled on the particulate matter and stay there for a very long time period. The sources of pollutants are of two types: residential and non-residential pollutants. The residential contaminants include sewage which constitutes suspended solids (organic particles), biodegradable dissolved organic compounds (biomolecules like protein, fat, carbohydrates), nutrients (nitrogen, phosphorus), inorganic solids (sediments, salts, and metals), and pathogenic microorganisms. Non-residential pollutants include discharges from agriculture, factories, and commercial uses[4].

Another factor of aquatic pollution is rainfall. High levels of rainfall increase the risk of pesticides and fertilizers leaching from agricultural fields due to soil erosion and contaminating the water[5]. The quality of a river generally refers to water's component to be present at the threshold level for the proper growth of plants and animals. Both colligative and non-colligative properties of water play an essential role in the growth of plants and animals.The water which has high concentration of salts are generally referred as brackish and marine waer is mostly of oceans and seas. In the present study we tried to assess that which pesticides are mostly found water, which in fish relative to their inhabitant.

MATERIALS AND METHODS

We have reviewed number of articles related to organochlorine pesticide bioaccumulation in aquatic organisms, and from them we selected 10 years paper for analysing the data. The fish taken for analysis i.e their feeding behaviour and habitat is shown in **Table 1**. The data was analysed on the basis of these mentioned points:

- Bioaccumulation in fresh water *vs* marine water in benthopelagic fish.
- Bioaccumulation in fresh water+brackish water *vs* marine+brackish water in benthopelagic fish.

- Bioaccumulation in benthic *vs* pelagic in freshwater fish.
- Bioaccumulation in benthic *vs* pelagic in marine+fresh water+brackish water fish.
- Bioaccumulation in benthopelagic *vs* pelagic in marine+fresh water+brackish water fish.
- Which pesticide is mostly present in aquatic organisms throughout the world?

Table 1. Fish name, feeding and habitat of fish used for analysis.

S.No	Fish Name	Feeding	Habitat
1	*Chrysichthus nigrodigitatus*	Benthopelagic	Freshwater
	Oreochromis niloticus	Benthopelagic	Freshwater
	Claries gariepinus	Benthopelagic	Freshwater
	Pseudotolithus senegalensis	Benthopelagic	Marine
	Diaphus watasei	Benthopelagic	Marine
	Diaphus luetkeni	Benthopelagic	Marine
	Myctophum obtusirostre	Benthopelagic	Marine
2	*Tillapi Zilli*	Benthopelagic	Freshwater/Brackish
	Hypophthalmichthys molitrix	Benthopelagic	Fresh water/Brackish
	Drapane africana	Benthopelagic	Marine/Brackish
	Vomer septapinis	Benthopelagic	Marine/Brackish
3	*Mochokus niloticus*	Benthic	Fresh water
	Heterotis niloticus	Pelagic	Freshwater
4	*Bostrychus sinensis*	Benthic	Marine/Fresh water/Brackish
	Pseudolithus elongates	Benthic	Marine/Fresh water/Brackish
	Litjanus gorensis	Benthic	Marine/Fresh water/Brackish
	Pristipoma jubelini	Pelagic	Marine/Fresh water/Brackish
5	*Mugil cephalus*	Benthopelagic	Marine/Fresh water/Brackish
	Pristipoma jubelini	Pelagic	Marine/Fresh/ water/Brackish

Results and Discussion

The result used for analysing the data from research articles is shown in **Table 2**.

- Bioaccumulation in fresh water and marine fishes: The order of bioaccumulation in marine fish *Pseudolithus selegalensis* was DDT>Endosulphan>HCH>Heptachlor>Aldrin>Endrin>Dieldrin where as in fresh water fish *Claries gariepinus* was Endosulphan>HCH>Heptachlor>DDT>Endrin>Diendrin>Aldrin. The total OCP was found more in marine fishes as compared to freshwater fish.
- Bio accumulation in fresh water +brackish water Vs marine +brackish water in benthopelagic fish: The order of bio accumulation in fish *Tillapia zilli* for brackish+fresh water was Endosulphan>HCH>Heptachlor>DDT>Dieldrin>Endrin>Aldrin where as for *Drapane africana* in marine+brackish water was DDT>Endosulphan>Heptachlor>HCH>Aldrin>Endrin>Dieldrin. The total OCP concentration was higher in marine+brackish water as compared to fresh+brackish water.
- Bio accumulation in benthic Vs pelagic in freshwater fish: The order of bioaccumulation for fresh water benthic fish *Mochokus niloticus* was DDT>Endosulphan>heptachlor>HCH>Aldrin>Endrin>Dieldrin whereas for pelagic fish *Heterotic niloticus* was HCH>Endosulphan>heptachlor>DDT>Endrin>Dieldrin>Aldrin. However total OCP was more in benthic fish.
- Bio accumulation in benthic Vs pelagic in marine+fresh water+brackish water fish: The order of bioaccumulation in benthic fish *Pseudolithus elongates* was DDT>Endosulphan>Heptachlor>HCH>Aldrin>Endrin>Diendrin where as in pelagic fish *pristipoma jubelini* was DDT>Heptachlor>HCH>Endosulphan>Aldrin>Endrin>Dieldrin. The total OCP was maximum in benthic fish.
- Bioaccumulation in benthopelagic Vs pelagic in marine+fresh water+brackish water fish: The order of bioaccumulation benthopelagic fish *Mugil cephalus* was DDT>Heptachlor>HCH>Endosulphan>Aldrin>endrin>Dieldrin whereas for pelagic fish *pristipoma jubelini* was DDT>Heptachlor>HCH>Endosulphan>Aldrin>Endrin>Dieldrin. The total OCP was found more in benthopelagic fish.
- The pesticides mostly found predominant in all the fish irrespective of their inhabitant and feeding habitat were HCH, DDT, Endosulphan and Heptachlor.

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The results prove that higher accumulation of pesticides was found in benthic/benthopelagic fish and in marine/brackish water as compared to fresh water. The brackish water has less concentration of saline (salt) relative to marine water but more in comparison to fresh water. Changes in chemical balances due to presence of these toxicants in the aquatic eco system, disturbs the living conditions of the aquatic organisms, phytoplanktons[6]. Different organisms show different tolerance level against the toxicants. The competitions within their community to survive and predation, itself decrease the tolerance levels[7] which alleviates the proneness of the aquatic organisms for toxicants. The extensive use of agricultural products in form of salts acts as co stressors to aquatic organisms along with pesticides[8]. These co-stressors can be more lethal to aquatic biota if they act in a synergistic way[9] or as antagonist can lead to decline in algal blooms, zooplanktons. Millenium Ecosyystem assessment (MEA) stated that pesticides, heavy metals and high salt concentrations act as major toxicants for aquatic organisms[10]. The studies done by[11, 12] showed synergistic deleterious effects of pesticides and salinity where as in some of the studies, it showed both antagonistic as well as synergistic effects on the zooplanktons and phytoplanktons related to salt concentration[13]. The increased salinity may lead to decreased biomass in the aquatic eco system and also deteriorate the quality of fish for human's consumption[14]. Salts like sodium chloride are used in the construction of roads[15] and Emerging when it rains these are carried directly into the river streams along with several other pollutants. Cations like aluminium, iron, magnesium, sodium when combines with the negatively charge of the pesticides they decrease its interaction with the target pests and hence it settles[16]. The property of the pesticide is also changed when it combines with different types of salts. As most of the pesticides work in acidic conditions, the increased salinity in water can give a conducive environment for pesticides to act and this is the main reason that brackish or marine water has higher concentration of pesticides[17]. The surface water is less polluted as compared to ground water as surface water has higher concentration of oxygen and it is always in motion which dilutes the toxicants. Microorganisms which live on the sediments inside the water are also not much effective in mitigating the effects of pesticides[18]. Their slow nature of breakdown increases the persistivity of pesticides[19]. The high concentration of pesticides seen in fishes all over the world, itself shows that despite the ban on the use of pesticides, they are still more or less in use, either in their crude form or in any formulations[20].

Table 2. Analysed data from research articles.

Year	Org.	Mean concentration of OCP in Fish (ng/g)																		
		α-HCH	β -HCH	γ -HCH	δ - HCH	**Σ – HCH**	HEPTA EPOXIDE	HEPTA CHLOR	**Σ – HEPTA**	End. 1	End. 2	End. Sulpahte	**Σ- ENDO SULPHAN**	P,p. DDD	P.P DDE	P,p, DDT	**Σ – DDT**	Ald Rin	Dieldr in	End rin
Ize-Iyamu[21]; Adeyemi	CG	5.33	12.7	21	-	**39**	14.96	22.5	**37.46**	35.6	16.9	16.6	**69.1**	12.4	-	5.46	**17.9**	11.5	22.1	26.4
	CN	1.5	4.96	7	-	**13.5**	4.93	7.46	**12.42**	12.9	6.73	7.3	**26.9**	4.13	-	2.79	**6.92**	4.86	7.66	10.7
	TN	0.82	3.43	4.7	-	**8.95**	3.12	4.9	**8.02**	8.16	4.36	3.2	**15.7**	2.49	-	0.87	**3.36**	2.93	4.73	6.7
	ON	0.31	1.73	2.64	-	**4.68**	1.69	2.57	**4.26**	3.86	2.77	2.4	**9.03**	1.22	-	0.89	**2.11**	9.43	3.19	8.66
	HN	0.99	4.73	2.83	-	**8.55**	1.41	3.36	**4.77**	4.36	1.97	1.6	**7.93**	1.02	-	0.5	**1.52**	1.99	2.5	2.81
Faroon[22]; Hu G[23]	AN	0.14	0.06	0.18	0.14	**0.53**	-	0.18	**0.18**	-	-	-	**-**	0.16	0.17	ND	**0.34**	0.13	-	-
	HM	0.18	0.1	0.25	0.17	**0.71**	-	0.25	**0.25**	-	-	-	**-**	0.26	0.67	ND	**0.93**	0.18	-	-
Sankar[24]; Sarkar[25]	DW	BDL	BDL	4.38	-	**4.38**	1.63	5.56	**7.19**	-	-	-	**-**	BDL	BDL	BDL	**-**	BDL	BDL	15.3
	DL	1.47	2.53	1.07	-	**5.07**	0.51	1.17	**1.68**	-	-	-	**-**	8.76	BDL	0.67	**9.43**	BDL	BDL	12.4
	MO	BDL	BDL	6.38	-	**6.38**	12.6	6.65	**19.32**	-	-	-	**-**	BDL	BDL	BDL	**-**	BDL	BDL	16.4
Commen[26]	BS	0.12	0.28	0.06	0.15	**0.61**	-	0.12	**0.12**	0.21	0.02	0.9	**1.2**	0.53	0.26	1.29	**2.08**	0.15	0.21	0.07

F[27]; J[28]	DA	6.12	23.66	14.89	14.9	59.6	11.85	66.66	**78.51**	11.5	82.2	38.8	**132.4**	205	15.7	39	**260**	43	4.28	18
	MN	2.19	10.82	5.15	8.97	27.1	16.46	18.68	**35.14**	5.41	56.2	8.18	**69.75**	109	13.6	31.8	**154**	23.8	4.41	7.6
	CN	5.84	15.61	4.92	19.83	46.2	37.66	24.16	**61.82**	5.71	42.3	7.86	**55.9**	40.6	16.6	22.1	**79.3**	27.5	4.61	12.9
	PJ	3.98	5.29	1.51	12.3	23.1	3.18	20	**23.18**	4.23	16	0.38	**20.56**	15.9	10.5	15	**41.4**	6.15	4.6	6.36
	VS	6.07	12.62	4.18	16.01	38.9	11.73	29.83	**41.56**	7.08	64.3	38.3	**109.7**	79.3	10.8	16.2	**106**	31.8	4.41	7.76
	PS	5.67	10.74	6.57	14.78	37.8	8.04	22.83	**30.87**	8.06	88.2	19.9	**116.1**	143	8.2	28	**179**	14.8	6.26	6.39
	MC	9.21	24.66	8.21	19	61.1	25.66	43.66	**69.32**	4.25	37	13.9	**55.16**	78.8	14	22.1	**115**	53.5	4.05	9.15
	PE	5.75	25.16	5.44	15.62	52	17.83	42.33	**60.16**	4.55	84.7	1.04	**90.25**	150	8.7	40.8	**200**	38.8	4.03	12.4
	LG	6.41	21.23	13.16	13.75	54.6	20.61	84.98	**105.59**	7.58	32.8	28.9	**69.26**	23.5	7.05	5.28	**35.8**	67.3	4.68	11.3
	SP	5.68	20.33	12.46	13.06	51.5	19.75	68.33	**88.08**	6.68	31.1	27.5	**65.22**	21.8	6.38	4.71	**32.9**	66	4.46	10.7

Clarias gariepinus (CG), *Chysichthys nigrodigitatus* (CN), *Tilipia zilli* (TZ), *Oreochromis niloticus* (ON), *Heterotis niloticus* (HN), *Aristichthys nobilis* (AN), *Hypophthalmichthys molitrix* (HM), *Diaphus watasei* (DW), Diaphus_luetkeni (DL), *Myctophum obtusirostre* (MO), *Margaritifera auricularia* (MA), *Tegillarca granosa* (TG), *Meretrix lyeata* (ML), *Bostrychus sinensis* (BS), Bostrychus sinensis (BS), *Drapane africana* (DA), *Mochokus niloticus* (MN), *Chrysichthys nirgrodigitatus* (CN), *Pristipoma jubelini* (PJ), *Vomer Septapinis* (VS), *Pseudotolithus senegalensis* (PS), *Mugil cephalus* (MG), *Pseudotolithus elongates* (PE), *Lutjanus Goreensis* (LG),*Sphyraena piscatorum* (SP)

CONCLUSION

The results of this study combined with several other studies for different classes of pesticides can be used to frame taxonomy on bioaccumulation based on the fish inhabitant.

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