Kavitha, 2026, 14:3
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology
An Open Access Journal

Pesticide Residue contamination and Health risk assessment in Channa sp. from Degganahalli, Mysore

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Abstract- Water pollution through pesticides residues and their accumulation in different tissue of aquatic animals and crops has become a real threat to human and other animals on earth. OCP's are found cause health risks including cancer. The current study focuses on assessing the Organochloride contamination in the fish tissue (Channa.sp.) from Cauvery River, near Degganahalli area of Mysore district. Fish samples were collected from the sample site and processed following FSSAI test method using GCMS/MS. Hazard Quotient was calculated for a sample size of 384 using EDI and ADI. Concentration levels of pesticides were in the order Dieldrin> Aldrin> γ-HCH>β HCH. Corresponding concentrations of pesticides are 7.73 ± 0.94 > 1.07 ± 0.15> 0.08 ± 0.03 > 0.06 ±0.03 respectively. Hazard quotient of dieldrin is significant with a Mean± SD value of 0.05 ± 0.03 followed by Aldrin,0.00662 ± 0.00441, γ-HCH, 0.00050 ± 0.00033 and β-HCH, 0.00037 ± 0.00025 respectively. Pesticide levels in the fish are found to be below permissible limits across all seasons od study period. Hazard quotient also falls under low risk level. Detection of Aldrin and dieldrin in the current study signifies the presences of POPs in the environment.

Keywords— Channa Sp., Pesticides, EDI, Health risk, Hazard quotient

I. INTRODUCTION

Fresh water ecosystems have played a major role in diversity distribution, civilizations, cultural, industrial developments etc. It comprises around 2.5% of world's water supply. Merely 0.77% of all water is available in lakes, rivers, wetlands, aquifers, soil pores, plant life and atmosphere. (Postel & Carpenter 1997). Ecosystems provide ecosystem services to human. (Apostolaki et.al.,2020). Ecosystem services provided by these freshwater bodies include house hold utilities, crop irrigation, supply of food like fish, clams, mussels. Their service also includes flood control, transportation, recreation, pollution dilution, hydroelectricity, providing bird and wildlife habitat etc, (Postel & Carpenter 1997). These freshwater ecosystems are also facing the threat of degradation through anthropogenic activities. Urbanisation, increased agricultural activities and pollution are major threats to these ecosystems. Rundown water carrying silt, industrial, agricultural wastes are reducing the freshwater catchment areas and cause pollution. One of the most common pollutions is through pesticide e pollution. Pesticides belong to a category of chemicals used worldwide as fungicides, insecticides, herbicides, growth inhibitors etc. These may fall under categories like Organochloride pesticides, Organophosphate pesticides, carbomates and pyrethroids. (Nag et al., 2023). The positive aspects of pesticides are that they have helped in controlling major pests, pathogens of crops and contributed to improve agricultural output. How ever their unregulated applications have led to serious environmental pollution including soil and water. They have also caused adverse effect on human and animal health. Despite their ban many organochloride residues have been reported by various across India and world.(Agrawal et al., 2010). Pesticides like cypermethrin, dichlorvos, chlordane, Atrazine and malathion were reported from various sampling sites of Ganga. (Shah & Parveen, 2023).

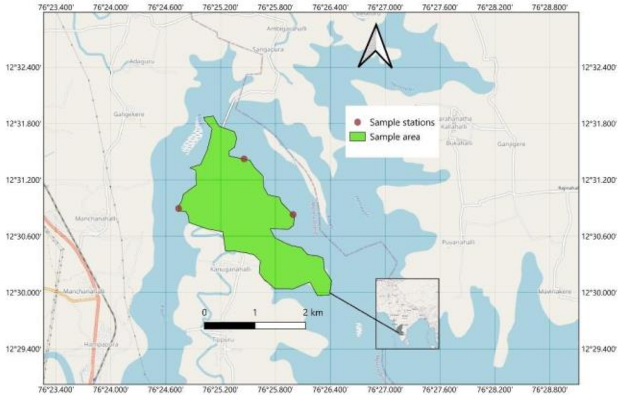
Endosulphan, DDT, Chloropyrifos, Methyl parathion residues have also been detected by (Hashmi et al., 2020) in Tapi river.(Samanta, n.d.) Identified HCH, DDT and endosulphan as major contaminant in river Ganga. Similar contaminants were reported from Gomti (Nag et al., 2023), Kaveri (Rajendran & Subramanian, 1999) and Tamiraparani river basin(Kumarasamy et al., 2012). These Pesticides are non-biodegradable and tend to bioaccumulate resulting in biomagnification. "Bioconcentration is the process where a pesticide is absorbed from water through gills or epithelial tissues. The impact of nutritional absorption through food consumption or ingestion of bottom sediments can be related to Bioaccumulation(Ray & Shaju, 2023) When the pesticides are concentrated in an organism due to its exposure to pesticides through few trophic levels. (Katagi, 2010). Fishes have high lipid content and also being higher at the trophic level makes it ideal organism for biomagnification. Residue retention is common in sediment feeders. Biomagnification potencies was affected by hydrophobicity of the compounds and biotransformation properties in the organisms at different trophic levels.(Wang et al., 2019) In fishes Liver, kidney, Muscle tissue and gills show bioaccumulation. (Ray & Shaju, 2023). Concentrations of OCP were found to be higher in fishes compared to molluscans. (Liu et al., 2010). Various pesticide residues ilike Aldrin, Dieldrin, Isomers of DDT, β-HCH, γ- HCH, Chloropyrifos etc have been identified in fish samples like Tilapia, Common Carp, Channa etc. (Singh et al., n.d.), (Rajendran & Subramanian, 1999), (Hussein et al., 2022). The liver damage, headache, nausea, dizziness, vomiting, muscle twitching and convulsions are symptoms of Aldrin toxicity observed in people. ("Health Risk Assessment and Toxicity Management of Organochlorine Pesticide," 2025). Mode of action of Dieldrin toxicity may be specific to individual tissues. Multiple modes of action have been identified for Dieldrin.(Stern, 2014) Isomers of HCH are found to cause central nervous system, reproductive, and endocrine damage.(Willett et al., 1998a). Cauvery river born in Brahmagiri hills flows through Karnataka, Tamil Nadu, and empties into Bey of Bengal at Cuddalore, Tamil Nadu. In Mysore district it passes through Kudige, KR Nagar and reaches KRS Dam. (Rajkamal, 2023)

In KR Sagara it is joined by two tributaries, Hemavathi and Lakshmana Teertha. (Cauvery, n.d.). Throughout its route Cauvery River is major source of water for Drinking and other domestic uses as well as agricultural source of water. Twin Districts Mysore and Mandya have been identified for their intensive agricultural activities. K R Nagar Taluk of Mysore is famously known as 'Battada Kanaja" (Grain storage) of Karnataka. Major crops include paddy, tomato, tobacco and ginger. Some of the common pesticides used by the farmers in these areas are Benevia, Star 20, Damal 505, Coragen, Monostar etc.. Aiding to the national average of 70% Non-vegetarians, District also has larger population of nonvegetarians. Meat being chief source a larger population also feeds on fishes. Fishes like Tilapia, Mrigal, Channa, Rohu, Catla Common Carp, etc are captured and marketed throughout the length of Cauvery. Channa feed on higher percentage of crustaceans, insects, molluscs, fishes and semi-digested materials, annelids etc. (Baghel et al., n.d.). Fish is rich source of lipids and protein Fish is used in traditional medicines in South East Asian Countries including India and Malaysia. Fish is used by post-operative patients to induce wound healing. They are used as anti-microbial, anti-inflammatory and for cell proliferation, induction of platelet aggregation and anti-nociceptive properties of the mucus. (Jais, n.d.) Thus the current study aims analyse the Organochloride pesticide residues in the tissue of Channa striatus and their dietary implications by calculating the hazard quotient.

II. MATERIALS AND METHOD

Sample site: The study area, Degganahalli village is located in the bank of Cauvery River, under Krishnarajanagar taluk of Mysore district. It is 12km away from Taluk head-quarters and 40 km from District centre. It is located at an altitude of 788 meters above sea level, with a geographical coordinate of 12.446^0 N 76.398^{0}E. The average rain fall of this area is 778mm to 830mm. Average temperature varies from 16^{0}C -19^{0}C in winter to 28^{0}C-34^{0}C in the summer. This village has a population density of 245 people/sq.km. Agriculture is the major occupation in the area followed of fishing in the water bodies around the village including Cauvery River. (Fig: 2.1)

Fig 2.1 STUDY AREA - DEGGANAHALLI



Sample collection
Fish samples were collected from the Study area between 2023 and 2024 for 4 seasons (pre-monsoon to post-monsoon) in duplicates. Fish samples were collected by random sampling. Fishermen of the village cooperated in sampling.

Collected fish was transferred to the polyethylene covers, then placed them in the icebox. They were transported to the laboratory and kept in at -20^{0}C freezer before further analysis.

Sample processing and analysis of pesticides:
Samples were processed and analysed by FSSAI Test method. The sample was homogenized to obtain a uniform matrix. A 10g homogenized sample was taken in a 50 mL polypropylene centrifuge tube.10 mL ethyl acetate was added and vortex for 1 min, 10gm anhydrous sodium sulphate was added and homogenized it at 15000 rpm for 2 minutes. Centrifuged at 5000 rpm for 5 minutes.1 mL supernatant was taken in the Eppendorf tube containing 25 mg PSA and shaken vigorously for 30 s. Centrifuged at 10000 rpm for 5 min. the supernatant extract was taken in a GC auto sampler vial. Injected the cleaned extract into the GC-MS/MS. Output was tabulated. (FSSAI Manual Test method)

Survey of fish consumption
Using google forms, personal interviews fish consumption rate of study group was conducted. Sample size was limited to 384. Through the forms we have collected details of fish consumption under different categories like daily, thrice in a week, twice in a week, weekly, fortnightly and once in a month with age and weight of the respondents.

Estimation of daily intake:
Following formula was used for calculating EDI EDI=(H×C) / B.W.

- *H is the concentration of pesticide residues [mg/kg],
- *C is the amount of the consumed food (kg/day),
- *B.W is the body weight (the average body weight in each cluster) (kg).

Hazard quotient:

- Hazard quotient is the ratio of estimated dietary intake
- ADI- (Acceptable daily intake) (Ar et al., 2006)
- Following equation is used for calculating Hazard Quotient
- HQ=EDI/ADI. (FAO, 2011)

Data analysis: Pesticide analysis: Descriptive statistics such as mean concentrations of pesticides across seasons and SD at confidence level of 95% was carried out to develop relationship among four different pesticides using Excel and GraphPad prism. Interpretation of concentration of various pesticide and hazard quotient was done by graphical representation using GraphPad Prism.

III. RESULT AND DISCUSSION

Seasonal variations in the Physico-chemical parameters during study period are tabulated in the Table 3.1. pH of 7.65 ± 0.31, in the water samples during sampling period showed comparatively stable, slightly alkaline environment. Alkalinity increased slightly during summer. The water pH is within permissible limit. (Bhawan & Marg, n.d.) Average temperature of the water body was found to be 21.49 ± 5.50 across seasons. Both temperature and pH falls in the range reported by (Kumar et al., 2024). Acceptable limit for hardness in drinking water is 200mg/l, (Bhawan & Marg, n.d.) the water samples from the sampling site were within acceptable limits 145.08 ± 12.81. Chloride levels in the water were 27.63 ± 1.19, within acceptable limits.

Table: 1 Physicochemical properties of Water at the sample site during study period.

Sample site	pH	Temp 0 C	Total hardness (mg/l)	Chloride (mg/l)
Mean ±SD	7.65 ± 0.31	21.49 ± 5.50	145.08 ± 12.81	27.63 ± 1.19

Organochloride pesticides like Aldrin, Dieldrin, β – HCH, γ – HCH were found in the muscle tissue of the fish when analyzed using GCMS-MS. As shown in the Table 3.2 Dieldrin concentration was comparatively higher in the muscle tissue. Concentration levels were in the order Dieldrin> Aldrin> γ-HCH>β HCH. Corresponding concentrations of pesticides are 7.73 ± 0.94 >1.07 ± 0.15> 0.08 ± 0.03 > 0.06 ± 0.03 respectively. Fig 3.1.

The mean concentration (µg/kg) of aldrin in tissue is 1.07 ± 0.15 across seasons. This is below acceptable limit. Most of the countries have set

ADI value to 0.0001mg/kg (International Programme on Chemical Safety, 1989). In nature aldrin breaks down into Dieldrin in nature. Thus, Dieldrin concentration is often found to be more than aldrin in water, sediment and fish tissues. Aldrin and Dieldrin are persistent organic pollutants. (Amininejad & Movassaghghazani, 2025). The level in the current study is less than the one reported in the previous report by various researchers. (Zargar & Singh Gill, 2018) in Market fish of Punjab, Gomti river (Malik et al., 2007), River Ganga (Kumari et al., 2001) (Bakre et al., 1990).

Table 2: OCP Level in the Muscle tissue of Channa sp.

Pesticides	Aldrin	Dieldrin	Beta HCH	Gamma HCH
Confidence Level (95.0%)	0.23327389	1.500397716	0.05196913	0.045006587
Mean ± SD	1.07 ± 0.15	7.73 ± 0.94	0.06 ± 0.03	0.08 ± 0.03

Mean γ-HCH, β HCH concentrations in the current study is 0.06 ± 0.03 and 0.08 ± 0.03. γ-HCH levels are slightly higher than β HCH. studies by (Zargar & Singh Gill, 2018) have shown higher levels of β HCH than γ-HCH. Various studies also reported detectable levels of HCH isomers in different species of fishes.(Kumari et al., 2001), (Kole et al., 2001), (Wu et al., 2013)etc. Studies on soil samples have shown considerable level of all four pesticides even in populated areas (Ulugov et al., 2018) A one-way ANOVA demonstrated a statistically significant difference among the group means, $F = 238.9$, $P < 0.0001$. with 98.35% of the variance ($R^2 = 0.9835$) for seasonal variations in the pesticide levels.

To understand the impact of these residues on human health, details of fish consumptions were collected from the sample site by questionnaire methods, by interview and google forms under different categories and hazard quotients were calculated as given in the Table 3.3. For an average adult body weight of 55 kg consumption of average 34gms of fish tissue shows low risk for tall the four pesticide residues in the fish. Hazard quotient of dieldrin is significant with a Mean± SD value of 0.05 ± 0.03 followed by Aldrin, 0.00662 ± 0.00441, γ-HCH, 0.00050 ± 0.00033 and β-HCH, 0.00037 ± 0.00025 respectively. (Table 3.4) Fig 3.2. Average consumption of 79.5gms per day under thrice a day consumers shows increased HQ compare to the other categories of fish eaters. (Table 3.3). All the HQ for four pesticide residues is under low risk. (The hazard quotient of below 1 is low risk, 1 and 10 refers to moderate risk, above 10 is linked to increased risk (Năstăsescu et al., 2020)) Hazard quotient might considerably increase higher consumption rates for a longer period of time. Bioaccumulation of these pesticides over period of time might lead to increased health risk.(Yohannes et al., 2014). Certain HCH cause reproductive and endocrine disruptions. Their residues are also found in human fat, blood and milk.(Willett et al., 1998b).

Table 3: Hazard quotient for pesticides residues under each category of consumption frequency

Pesticide	Frequency of Consumption	Average Consumption per day in grams	EDI=H*C/B. W	HQ=EDI/ADI
ALDRIN	ED	50	0.00000078	0.007754
	TD	79.5	0.00000129	0.012947
	TWD	57.4	0.00000096	0.009575
	WK	32.7	0.00000056	0.005571
	FN	17.7	0.0000003	0.003021
	MN	5.2	0.00000009	0.000875
DIELDRIN	ED	50	0.0000056	0.055978
	TD	79.5	0.00000935	0.093476
	TWD	57.4	0.00000691	0.069125
	WK	32.7	0.00000402	0.040224
	FN	17.7	0.00000218	0.021807
	MN	5.2	0.00000063	0.00632
β-HCH	ED	50	0.00000004	0.000435
	TD	79.5	0.00000007	0.000726
	TWD	57.4	0.00000005	0.000537
	WK	32.7	0.00000003	0.000312
	FN	17.7	0.00000002	0.000169
	MN	5.2	0	0.000049
γ – HCH	ED	50	0.00000006	0.00058
	TD	79.5	0.0000001	0.000968
	TWD	57.4	0.00000007	0.000716
	WK	32.7	0.00000004	0.000417
	FN	17.7	0.00000002	0.000226
	MN	5.2	0.00000001	0.000065

ED- Everyday, TD -thrice a week, TWD-two days a week, WK-Weekly, FN-Fortnightly, MN-monthly: EDI-Estimated Dietary Intake, H* =Concentration of the aldrin [mg/kg], HQ* =Hazard Quotient, ADI* =Acceptable Daily Intake WHO JMPR 1991*

Table 4: Mean Hazard Quotient for different pesticides

Pesticide	ALDRIN	DIELDRIN	β-HCH	γ- HCH
Confidence Level (95.0%)	0.00462	0.03339	0.00026	0.00035
Mean	0.00662	0.04782	0.00037	0.00050
SD	0.00441	0.03182	0.00025	0.00033

Fig 3.1 Pesticide Residue levels in *Channa sp.*

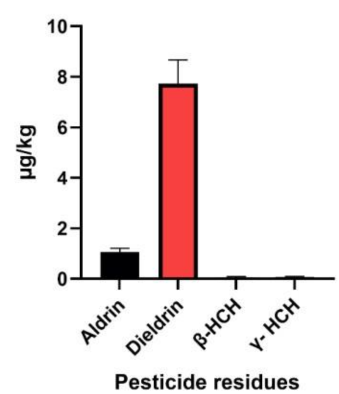
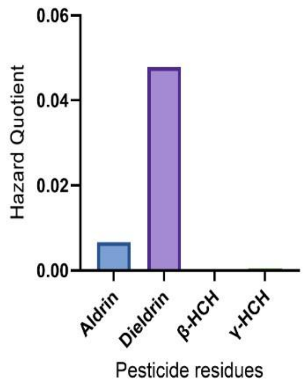


Fig 3.2 Comparison of HQ of different Pesticide Residues



IV. CONCLUSION

The current study helped in assessing the pesticide contamination in the study area. Detection of Organochloride pesticide residues like aldrin and dieldrin in the fish tissue indicates the persistent nature of these OCP's despite their ban since 2001 in India. Hazard quotient of less than 1 though falls in lower risk area, increased consumption rates might for a longer duration might lead to significant health risk. Future work can be focused on determining the histopathological conditions fishes and bioaccumulation status of these pesticides in various sample groups from this area.

Conflict of Interest

The Authors have no conflict of interest to declare. This submission is original work of authors. This research work doesn't include financial benefits. Authors are in agreement with contents of the paper.

Acknowledgement

We are in gratitude to the Department of Applied Zoology Mangalore University, Mangalagangothri, Field Marshal K M Cariappa

College Madikeri, Food Science and Agriculture Research & Development Centre, Rajajinagar, Bangalore and Mysuru District Water Quality Testing Laboratory, Mysuru,

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