Journal of Drug Discovery and Health Sciences, 2026;3(1):1-8 eISSN- 3048-8842

Journal of Drug Discovery and Health Sciences

journal home page : https://jddhs.com/index.php/jddhs/index

Research Article

Assessment of Acute Toxicity and Behavioral Disruptions in Indian Major Carp (Labeo Rohita) Under Pyrthrum Stress

Vipin Kumar Pandey[1], Praveen Kumar[2], Anjani Kumar Shukla[3], Rakesh Kumar Pandey[1*]

[1]*Department of Zoology, Kamla Nehru Institute of Physical and Social Sciences, Sultanpur, Uttar Pradesh, India.*
[2]*Lecturer, Bora Institute of Allied Health Sciences Lucknow, Uttar Pradesh, India.*
[3]*Assistant professor Department of Zoology Kisan PG College Bahraich, Uttar Pradesh, India.*

ARTICLE INFO

Article history:
Received: 02 January, 2024
Revised: 14 February, 2024
Accepted: 10 March, 2024
Published: 25 March, 2025

Keywords:
Pyrethrum, Lethal Concentrations, *Labeo rohita*, Acute Toxicity, Mortality, LC_{50}

DOI:
10.21590/jddhs.03.01.01

ABSTRACT

The extensive use of pesticides in agriculture has raised serious concerns regarding their inadvertent entry into aquatic ecosystems and subsequent toxicity to non-target organisms. Pyrethrum, a botanical insecticide derived from *Tanacetum cinerariifolium*, is often regarded as an eco-friendly alternative to synthetic pesticides; however, its toxic effects on aquatic fauna remain insufficiently explored. The present study evaluates the acute toxicity and associated behavioral alterations induced by pyrethrum in the Indian major carp *Labeo rohita*. Acute toxicity bioassays were conducted under laboratory conditions following APHA guidelines, and median lethal concentrations (LC_{50}) were determined for 24, 48, 72, and 96 hours of exposure. The LC_{50} values exhibited a time-dependent decline, indicating increased toxicity with prolonged exposure, with the lowest LC_{50} recorded at 96 hours (21.40 µg/L). Mortality increased with both concentration and exposure duration, reaching 100% at higher concentrations. In addition to lethality, pronounced behavioral and physiological disturbances were observed, including erratic swimming, surfacing and gulping, avoidance responses, excessive mucus secretion, reduced opercular movement, fin damage, and body discoloration. Dissolved oxygen levels declined significantly in exposure tanks, suggesting elevated metabolic stress and impaired respiration. These findings demonstrate that pyrethrum is highly toxic to *Labeo rohita* even at low concentrations and induces severe behavioral disruptions. The study underscores the ecological risks associated with botanical insecticides and highlights the need for cautious application and stringent regulation to protect aquatic ecosystems.

INTRODUCTION

Pesticides have become an evil necessity in agricultural practices due to their efficacy in pest control and enhancing crop production. The application of pesticides has increase sharply over the past few decades. From 1990 to 2022, the worldwide agricultural use of pesticides has increased gradually, reaching 3.69 million metric tons in 2022 (URL1).

However, the liberal and often unsystematic application of these chemicals has raised serious environmental concerns, particularly with respect to their entry into aquatic ecosystems. Surface runoff from agricultural fields is the major pathway through which pesticides are transported to aquatic environments, where they come into direct contact with water bodies and bio-accumulate in aquatic organisms, including fish (Pandey et al., 2009). Consequently, pesticides have emerged as a major threat to aquatic biodiversity; disorganize food webs and ecological balance (Aydinalp and Porca 2004; Antwi and Reddy 2015; Baweja et al. 2020; Saha and Dutta 2024).

***Corresponding Author:** Rakesh Kumar Pandey

Address: Department of Zoology, Kamla Nehru Institute of Physical and Social Sciences, Sultanpur, Uttar Pradesh, India.

Email ✉**:** rakeshzoology@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Chronic pesticide exposure has been associated with physiological disturbances, behavioral abnormalities, histopathological damage, hematological alterations, biochemical disruptions, endocrine interference, immunosuppression, reproductive disorders, and even carcinogenic outcomes (Pandey et al., 1995, 2014; Crisp et al., 1998; Brouwer et al., 1999; Mishra et al., 2006, 2008; Ullah et al., 2014; Ullah & Zorriehzahra, 2015).

Fishes are very sensitive to water quality alterations, so they are considered definitive bioindicators of aquatic contamination. Protecting fish health is fundamental to global food security and ecological stability, reflecting their critical role as both economic commodities and essential nutrient sources (Srivastava & Singh, 2013a).

In contemporary era, botanical insecticides have acquired increasing attention as environmental friendly substitute to synthetic pesticides. Among these, pyrethrum (*Tanacetum cinerariifolium*), a perennial plant of the family *Asteraceae*, has been extensively used for the extraction of pyrethrins (Moslemi et al., 2018).

Pyrethrins are natural neurotoxic compounds obtained from the flower heads of pyrethrum (fig-1,2), that represent one of the most important groups of natural insecticides because of their rapid assault effects against various insect pests (Yang et al., 2014). Historically, the insecticidal assets of pyrethrum were acknowledged in Central Asia nearly two centuries ago, and its use gained prestige during the Napoleonic wars when French soldiers employed it for the control of flea and lice infection. Its spread into Europe was facilitated through ancient trade routes (Mkawale, 2001).

Chemically, pyrethrins are grouped into two classes, i.e. pyrethrin I (comprising pyrethrin I, cinerin I, and jasmolin I) and pyrethrin II (including pyrethrin II, cinerin II, and jasmolin II)—which differ in their acid moieties (chrysanthemic acid and pyrethric acid respectively) (Chesang et al. 2017).

These esters exert their insecticidal effects by binding to sodium channels in the nerve membrane, causing repetitive nerve discharges, paralysis, and ultimately death. Although naturally derived, pyrethrins are not without environmental hazards. They are frequently formulated with synergists such as piperonyl butoxide to amplify potency, and their mode of action carries similarity to that of synthetic pyrethroids and organochlorines (Cox, 2002).

Critically, pyrethrins are classified as acutely toxic to fish, with described median lethal concentrations (LC50) in the range of 9–58 ppb, on the basis of species and water temperature. Their toxicity tends to increase in warm water, making tropical fish species particularly endangered (Johnson et al., 1980).

Deltamethrin, first marketed in 1977, and cypermethrin are among the most widely used pyrethroids due to their high strength and photostability (Bradbury & Coats, 1989). However, their ecotoxicological impacts are intense. Terrible fish kills, such as the massive eel mortality in Lake Balaton, Hungary, have been linked to deltamethrin applications for mosquito control (Bálint et al., 1995). Similarly, cypermethrin discloses high affinity for gill membranes, furnishing fish extremely susceptible even at trace concentrations (Shaluei et al., 2012). Different from mammals, fish lack efficient metabolic pathways to detoxify pyrethroids, making them highly endangered to bioaccumulation and neurotoxic consequences (Borges et al., 2007).

Behavioral changes are frequently the preliminary and most sensitive indicators of pesticide induced stress in fish. Pyrethroids and pyrethrins disrupt acetylcholinesterase activity, leading to hyperactivity, loss of equilibrium, erratic swimming, increased surfacing activity, and eventually lethargy prior to death. These behavioural inconsistencies are not only useful in ecotoxicological estimations but also provide understandings into sub-lethal impacts that could compromise feeding efficiency, predator avoidance, and reproductive success in natural populations. (Borges et al., 2007; Ullah et al., 2019; Tsai & Lein, 2021).

Within these circumstances, *Labeo rohita* (rohu), a freshwater major carp species of the family *Cyprinidae*, is of particular interest. As one of the most commercially predominant aquaculture species in South Asia, it contributes significantly to food supply and rural income. Its omnivorous feeding habits and sensitivity to waterborne pollutants mark it as an ideal representative organism for aquatic toxicology studies. Assessing the lethal concentration (LC50) of pyrethrum in *Labeo rohita* and analyzing associated behavioural alterations is therefore essential for griping the ecological indications of pyrethrin use and for establishing safe approaches that minimize threat to aquaculture and biodiversity.

Thus, the current study is designed to assess the acute toxicity of pyrethrum in *Labeo rohita* by finding out its LC50 value and reporting behavioural alterations under experimental conditions. consequently, the research aims to provide a scientific basis for environmental-toxicological risk assessment of plant based insecticides and contribute to sustainable pesticide management approaches that protect aquatic ecosystems.

MATERIALS AND METHODS

Fish (*Labeo rohita*) were collected from the local fish farms of Sultanpur, U. P. India and sensibly carried to the laboratory. Fishes were sanitized first in 0.05% $KMnO_4$ solutions for 2-3 minutes to avoid any cutaneous infection. The sanitized fishes were set aside in 300 litre plastic tank for 14 to 15 days for acclimatization in in-vitro condition. Fishes were fed with wheat flour and mustard cake in the ratio of 3:1 on alternate days. Water with food waste was replaced with freshwater in every 24hrs. Water tanks were covered with transparent nylon net. When toxicity test was performed the feeding were halted before 24 hours. Fish were exposed to natural photoperiods and were set aside at room temperature. The physicochemical parameters such as dissolved oxygen (DO), temperature, and pH of the test media were recorded. The experiments were carried out in glass aquaria of 15L capacity in stationary laboratory conditions.

The DO of water was determined by modified Winkler's method in ppm before and after the transfer of fish for 24hrs, 48hrs, 72hrs and 96hrs in glass jars. The fish approximately of uniform length (16.75±1.20 cm) and weight (71.9±4.5 gm) were designated for the bioassay (fig-3). Fish were not given any food through the experiment. Besides mortality, fish behaviour and other external changes in the body of fish during the bioassay were observed and recorded. The test was performed during the month of May at room temperature (37.78 ± 1.3°C). The physicochemical parameters were maintained as per the guidelines of APHA (2005). The physicochemical properties of the water used in the experiments were as follows; temperature (29.85 ± 0.61°C), pH (6.96 ± 0.14), DO (7.7 ± 0.5 mg/L).

Pyrethrum 2% v/v technical grade procured online from the manufacturer Sabari Crop Care Sciences Pvt. Ltd, Thiruvallur, Tamilnadu, India for use in bioassay. The Stock solution of pyrethrum was prepared by mixing in absolute alcohol. The range finding tests or exploratory tests as prescribed by APHA (2005) were used to determine pyrethrum dose and mortality in fish. The range finding tests showed no mortality at concentration up to 5µg/L, 70% mortality at 40µg/L and 100% mortality at 50µg/L. After determining the test range (5µg/L, 10µg/L, 15µg/L, 20µg/L, 25µg/L, 30µg/L, 35µg/L, 40µg/L, 45µg/L, 50µg/L), 30 acclimatized fishes in three replicates for each concentration, were released in 15L water tank for 24hrs, 48hrs, 72hrs and 96hrs acute toxicity test. A control set with equal number of fishes was also simultaneously run. Prior to the exposure, solution of desired concentrations of the pyrethrum were prepared and thoroughly mixed in tap water containing troughs. Pyrethrum induced fish mortality data were analyzed using IBM SPSS Student Version 21.

Behavioural responses, such as swimming pattern, opercular movement (OCM), surfacing and gulping, avoidance behaviour, mucus secretion, skin colour and fin posture were also observed.

RESULTS

LC_{50} Value of Pyrethrum and behaviour of fish:

The table (Table 1) provides estimated LC (lethal concentration) values and their corresponding 95% lower and upper confidence limits (C.L.) for Pyrethrum exposure at different time points (24hrs, 48hrs, 72hrs, and 96hrs) and Plot of adjusted Probits for LC_{50} of pyrethrum are represented in graphs (GRAPH-1, 2, 3, and 4) for these hours respectively.

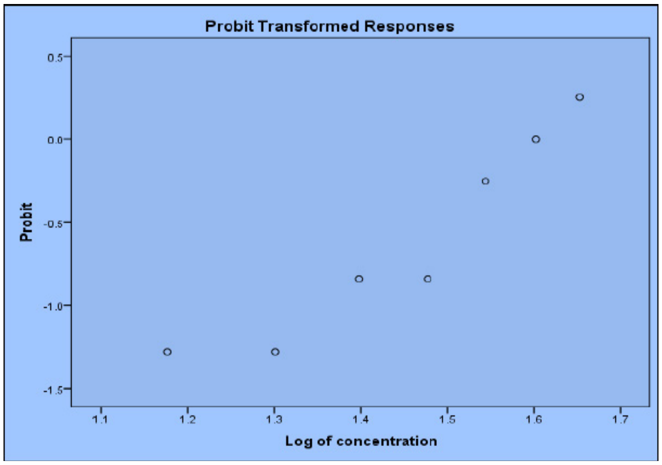
The LC values represent the concentration of Pyrethrum at which a certain percentage of the experimental system is expected to exhibit a lethal response. The 95% confidence limit (C.L.) reflects the range within which we can be 95% confident that the true LC value lies. At 24h, the estimated LC values ranged from 12.45 (LC 1.00) to 106.75 (LC 99.00) µg, with corresponding 95% confidence limit (C.L.), lower limits ranging from 5.89 to 73.59 µg, and upper limits ranging from 17.06 to 261.20 µg. This indicates variability in the estimated LC values, with higher concentrations having wider confidence intervals. At 48hrs, the estimated LC values continued to vary, ranging from 6.72 to 116.58 µg, with corresponding 95% confidence limit (C.L.), lower limits ranging from 2.57 to 75.88 µg, and upper limits ranging from 10.35 to 302.39 µg. The variability observed in the LC values and confidence intervals persisted, suggesting ongoing changes in the response to Pyrethrum exposure over time. Similarly, at 72hrs and 96hrs, the estimated LC values and confidence intervals continued to fluctuate, indicating a dynamic response to Pyrethrum exposure. This variability underscores the importance of considering both the concentration of the substance and the time of exposure when assessing its potential lethality in the experimental system. These data are essential in toxicology studies for understanding dose-response relationships and determining safe exposure levels.

Plot of adjusted Probits- (PYRETHRUM)

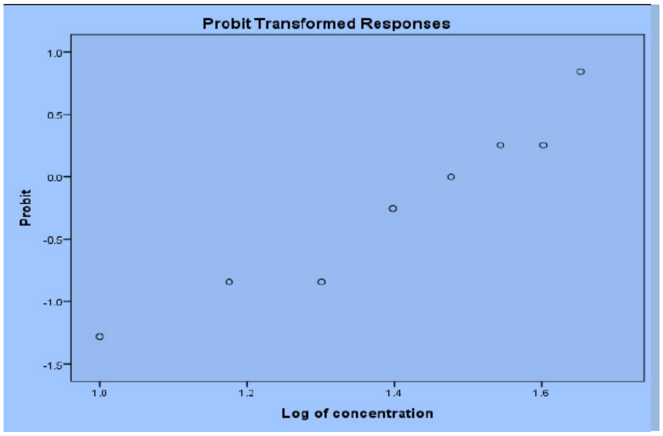
The Table (Table 2) presents data on the mortality of fish after short-term exposure to Pyrethrum at various concentrations (µg/L) over a 96h period. The "Control" group, without exposure to Pyrethrum, showed no mortality throughout the duration of the experiment. In contrast, the "Exposed" groups, which were exposed to increasing concentrations of Pyrethrum ranging from 5µg/L to 50µg/L, exhibited varying levels of mortality. At 24hrs, there were no observed mortalities in the exposed groups, indicating no immediate lethal effects of Pyrethrum at these concentrations within the first day of exposure. However, as the exposure duration increased to 48hrs, 72hrs, and 96hrs, mortality rates in the exposed groups started to rise. The number of responding fish, which signifies mortality, increased with higher concentrations of Pyrethrum and longer exposure times. At 48hrs, mortalities were reported in the groups exposed to 9µg/L and above, with the highest mortality rate in the 30 µg/l group. This trend continued at 72hrs and 96hrs, with increasing mortalities in the exposed groups compared to earlier time points. The highest mortality rates were consistently observed in the group exposed to 30µg/L, where all fish succumbed to the effects of Pyrethrum by the end of the 96hrs period.

Table 1: Estimated LC value and 95% lower and upper confidence limits (C.L.) for Pyrethrum exposure

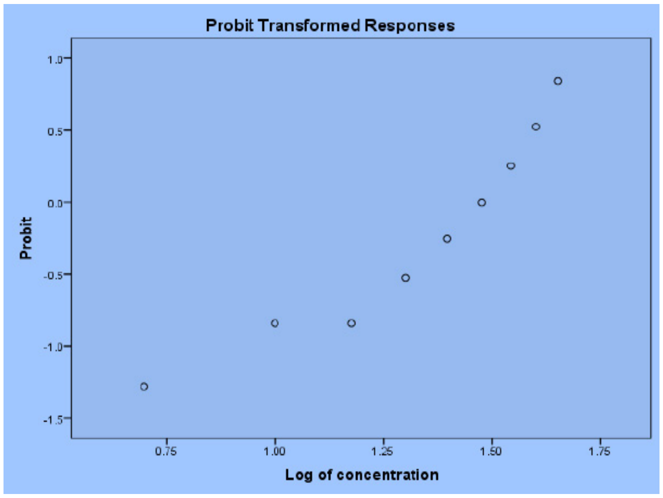
POINT	*24 HOURS*			*48 HOURS*			*72 HOURS*			*96 HOURS*		
	EXP. CON.	*95% C.L.*		*EXP. CON.*	*95% C.L.*		*EXP. CON.*	*95% C.L.*		*EXP. CON.*	*95% C.L.*	
		LOWER	*UPPER*		*LOWER*	*UPPER*		*LOWER*	*UPPER*		*LOWER*	*UPPER*
LC 1.00	12.45	5.89	17.06	6.72	2.57	10.35	3.31	0.78	6.17	3.75	1.20	6.40
LC 10.00	20.17	13.39	24.44	12.76	7.27	16.72	8.18	3.54	12.01	8.20	4.11	11.57
LC 50.00	36.46	31.54	44.10	28.00	23.08	33.90	24.85	19.16	32.10	21.40	16.64	26.49
LC 95.00	77.92	58.61	151.6	76.76	55.64	153.29	103.38	65.38	290.45	73.34	51.56	149.12
LC 99.00	106.75	73.59	261.20	116.58	75.88	302.39	186.60	100.67	781.18	122.18	75.93	330.98



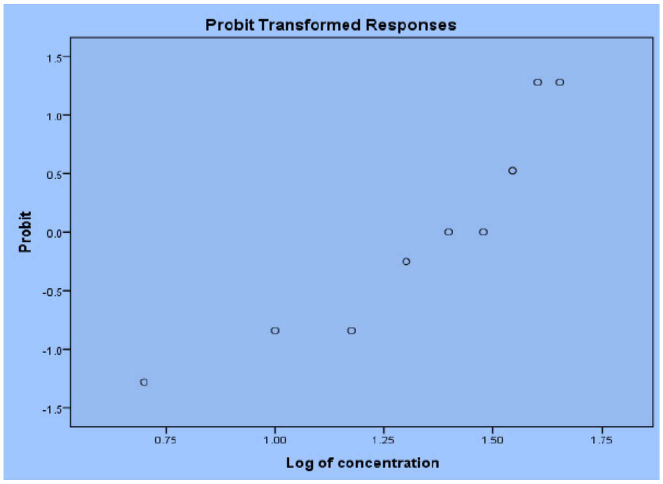
Graph 1: 24 hrs LC_{50} value of Pyrethrum



Graph 2: 48 hrs LC50 value of Pyrethrum



Graph 3: 72 hrs LC_{50} value of Pyrethrum



Graph 4: 96 hrs LC_{50} value of Pyrethrum

Fish exposed with different concentrations of pyrethrum induces adverse behavioural changes in fish, including restlessness, erratic swimming, and avoidance behaviour. Physiological manifestations include decreased opercular movement, increased mucus secretion, and discoloration with fin deterioration. The opercular movement (OCM) of the fish exhibits a decrease at all exposure concentrations (Table 3).

These symptoms signify heightened stress, respiratory distress, and physical damage, potentially culminating in death if exposure persists. Monitoring and regulating pesticide levels in aquatic habitats are vital to safeguarding fish and maintaining ecosystem health. Outcome of DO has been given in (Tables 4 and 5).

DISCUSSION

Toxicity experiments were conducted in accordance with APHA (2005) guidelines. The water used in the bioassays

Table 2: Mortality of fish after short term exposure to Pyrethrum

Conc. (µg/l)	*Exposed number*	*Responding numbers*			
		24 hours	*48 hours*	*72 hours*	*96 hours*
Control	30	0	0	0	0
5 µg/L	30	0	0	3	3
10 µg/L	30	0	3	6	6
15 µg/L	30	3	6	6	6
20 µg/L	30	3	6	9	12
25 µg/L	30	6	12	12	15
30 µg/L	30	6	15	15	15
35 µg/L	30	12	18	18	21
40 µg/L	30	15	18	21	27
45 µg/L	30	18	24	24	27
50 µg/L	30	30	30	30	30

had the following physicochemical properties: temperature 29.85 ± 0.61°C, pH 6.96 ± 0.14, and dissolved oxygen (DO) 7.7 ± 0.44 ppm. These conditions fell within the normal range for conducting bioassays. Acute toxicity tests are designed to establish the concentration of a toxicant that results in 50% mortality of the test organisms (LC50) over a defined period. Such assays generate reproducible dose–response curves, which are essential for evaluating the toxic effects of chemicals. The LC50 is widely accepted as a reliable measure to assess the potential ecological risks of contaminants on aquatic organisms.

The present study examined the effects of pyrethrum on *Labeo rohita*, revealing significant toxic impacts. Monitoring of water quality showed variations in dissolved oxygen and temperature both in the presence and absence of fish. Without fish, DO declined from an initial 7.7 ppm to 5.02 ppm over 96 hours, while the temperature increased from 28.03°C to 33.48°C. In contrast, when fish were introduced, DO dropped more sharply from 7.83 ppm to 3.37 ppm, while temperature rose from 29.36°C to 33.98°C. These findings suggest that the stressed fish, under pyrethrum exposure, accelerated DO depletion through heightened metabolic activity. Consequently, the chemical not only directly affected fish health but also altered the aquatic environment, amplifying stress conditions and toxic effects.

The LC50 values indicated that higher concentrations were required to produce lethal effects at shorter exposures, while lower concentrations became lethal with prolonged exposure. At 24 hours, LC values ranged from 12.45 µg (LC1.00) to 36.46 µg (LC50) and 106.75 µg (LC99.00). By 48 hours, these shifted to 6.72 µg, 28 µg, and 116.58 µg, respectively. At 72 hours, LC values were 3.31 µg, 24.85 µg, and 186.60 µg, while at 96 hours they were 3.75 µg, 21.40 µg, and 122.18 µg. The progressive reduction in LC50 values indicates increased sensitivity of fish to pyrethrum over time. Mortality analysis supported these observations, with higher death rates occurring at elevated concentrations and longer exposures, culminating in 100% mortality at 50 µg/L after 96 hours.

Compared with other studies, these LC50 values were relatively higher. For example, Sapna et. al., (2023) reported a 96-hour LC50 of 30 µg/L for cyphenothrin in *Cirrhinus mrigala*, and Saha and Kaviraj (2003) recorded a 96-hour LC50 of 1.27 µg/L for cypermethrin in *Heteropneustes fossilis*. Such variability in LC50 values may stem from environmental factors, particularly temperature (Pandey et al., 2008). Pandey et al. (2008) demonstrated that temperature significantly influences the physiological and chemical responses of *Heteropneustes fossilis* to dimethoate. Using a 96-hour static bioassay, they reported LC50 values of 14.39 mg/L at lower temperatures (17.16 ± 0.78°C) and 2.98 mg/L at higher temperatures (27.50 ± 1.50°C). In addition, behavioural changes including altered schooling, frequent surfacing, mucus secretion, and abnormal opercular activity were noted. Their results highlighted that increased temperatures intensified mortality, emphasizing the importance of considering seasonal temperature variations when assessing toxicant impacts.

Table 3: Movement of operculum in Labeo rohita after exposure with pyrethrum at different concentration levels and different time intervals

Concentration (µg/l)	*0 hrs*	*24 hrs*	*48hrs*	*72hrs*	*96 hrs*
Control	139.80 ± 2.85	145.00 ± 1.58	136.80 ± 1.31	146.40 ± 2.07	147.00 ± 1.41
5 µg	118.40 ± 2.72	133.40 ± 2.30	114.00 ± 1.58	92.80 ± 6.14	84.80 ± 2.78
10 µg	125.40 ± 5.23	131.40 ± 2.31	107.40 ± 4.34	92.20 ± 1.30	83.6 ± 1.63
15 µg	121.20 ± 2.56	125.00 ± 3.08	109.20 ± 2.38	90.00 ± 1.58	76.00 ± 2.28
20 µg	131.80 ± 2.78	130.40 ± 1.67	105.00 ± 1.58	84.80 ± 1.92	72.40 ± 1.85
25 µg	122.40 ± 3.93	135.00 ± 1.58	102.00 ± 1.58	82.20 ± 1.78	71.00 ± 1.41
30 µg	126.00 ± 5.29	130.80 ± 1.64	98.60 ± 1.67	80.60 ± 3.13	67.80 ± 1.72
35 µg	123.40 ± 4.22	134.40 ± 2.70	96.00 ± 1.58	75.80 ± 1.30	64.20 ± 1.72
40 µg	129.20 ± 3.70	128.00 ± 2.64	91.20 ± 4.55	69.40 ± 2.07	61.4 ± 1.85
45 µg	134.00 ± 1.67	140.00 ± 2.86	82.00 ± 1.58	64.80 ± 3.13	57.00 ± 2.00
50 µg	115.6±3.77	Mortality	Mortality	Mortality	Mortality

Table 4: Estimation of DO at different time intervals of tap water used for fish experiment in PPM (Without fish)

	Initial		*24 hrs*		*48 hrs*		*72 hrs*		*96 hrs*	
Tests	*DO (ppm)*	*Temp. (°C)*	*DO (ppm)*	*Temp. (°C)*	*DO (ppm)*	*Temp. (°C)*	*DO (ppm)*	*Temp. (°C)*	*DO (ppm)*	*Temp. (°C)*
Mean	7.7	28.03	6.99	29.89	6.35	31.77	5.69	32.62	5.02	33.48
SD	0.44	0.48	0.43	0.45	0.32	0.58	0.31	0.46	0.27	0.44

Table 5: Estimation of DO at different time intervals of tap water used for fish experiment in PPM (With 5 fish in each tank).

Tests	*Initial*		*24 hrs*		*48 hrs*		*72 hrs*		*96 hrs*	
	DO (ppm)	*Temp. (°C)*	*DO (ppm)*	*Temp. (°C)*	*DO (ppm)*	*Temp. (°C)*	*DO (ppm)*	*Temp. (°C)*	*DO (ppm)*	*Temp. (°C)*
Mean	7.83	29.36	6.22	30.38	5.53	31.31	4.46	33.30	3.37	33.98
SD	0.73	0.39	0.71	0.54	0.59	0.41	0.43	0.68	0.42	0.31

Pandey et al. (2022) further reported pyrethrum LC50 values of 0.75 µg/L (24h), 0.70 µg/L (48h), 0.62 µg/L (72h), and 0.55 µg/L (96h) for *Labeo rohita*. Soderlund et al. (2002) investigated oral LC50 values of pyrethroids in rats, finding 710 mg/kg (males) and 320 mg/kg (females) for pyrethrins, while permethrin had values of 1200 mg/kg for both sexes. Similarly, Cox (2002) reported high toxicity of pyrethrins to fish, with LC50 values ranging from 9 to 58 ppb. Bradbury and Coats (1989) also noted median lethal concentrations of pyrethroids typically below 10 µg/L. Toxicity of pyrethroids tends to increase at lower temperatures and is influenced by factors such as fish species, body size, and environmental conditions like sediment presence (Haya, 1989).

Several studies corroborate the acute toxicity of pyrethroids in freshwater fish. Sahoo et al. (2017) studied deltamethrin toxicity in *Labeo rohita* fingerlings, reporting 50% mortality at 0.38 µg/L after 72 hours, 0.39 µg/L after 60 hours, and 0.40 µg/L after 36 hours. Similarly, Sarkar et al. (2018) assessed cypermethrin toxicity in *Cyprinus carpio* fry, reporting LC50 values of 1.04 mg/L (24h), 0.92 mg/L (48h), 0.89 mg/L (72h), and 0.79 mg/L (96h), alongside noticeable behavioural changes.

The low LC50 values recorded in this study authenticate that pyrethrum is extremely toxic to *Labeo rohita*. Exposed fish exhibit several behavioural disorders, including avoidance reactions, erratic swimming, decreased opercular activity, excessive mucus secretion, fin damage, and periodic surfacing. These traits indicate drastic stress and reduced respiration, highlighting the strong toxicological impact of pyrethrum. Comparable detection were reported in *Anabas sp.* exposed to monocrotophos (Santhakumar and Balaji, 2000). Increased surfacing has also been linked to hypoxic conditions (Radhaia et al.), while the observed reduction in opercular movement may serve to limit toxin absorption through the gills, leading to reduced oxygen uptake. Similar reductions in oxygen utilization have been registered in *Cyprinus carpio* exposed to sub-lethal copper concentrations (Boeck et al., 1995). In contrast, Ganeshwade et al., 2006 reported elevated opercular activity and coughing in common carp subjected to industrial effluents. Disorganized swimming patterns likely result from impaired neuromuscular coordination caused by acetylcholine accumulation at synaptic and neuromuscular junctions (Rao et al., 2005). Changes in body coloration have also been reported in *Cyprinus carpio* following exposure to $HgCl_2$ (Masud et al., 2005).

CONCLUSION

The present investigation clearly demonstrates that pyrethrum, despite its botanical origin, exerts strong acute toxic effects on the freshwater fish *Labeo rohita*. The progressive decrease in LC_{50} values with increasing exposure duration confirms the cumulative and time-dependent nature of pyrethrum toxicity. High mortality rates at relatively low concentrations, coupled with marked behavioral and physiological disturbances, indicate that *L. rohita* is extremely sensitive to pyrethrum stress.

Behavioral responses such as erratic swimming, frequent surfacing, reduced opercular movement, mucus hypersecretion, fin deterioration, and discoloration served as early and sensitive indicators of pyrethrum-induced stress. These alterations reflect severe neurotoxic and respiratory impairment, which may compromise feeding efficiency, predator avoidance, growth, and reproductive fitness in natural populations. Additionally, the observed depletion of dissolved oxygen in exposure tanks further intensified physiological stress, exacerbating toxic outcomes. Overall, the findings challenge the assumption that botanical insecticides are inherently safe for aquatic organisms and emphasize that pyrethrum poses a significant ecological threat to freshwater fish. The study highlights the necessity for comprehensive ecotoxicological evaluation of plant-based pesticides before their widespread use. Further research involving chronic exposure, combined pesticide effects, and field-based assessments is strongly recommended to develop sustainable pest-management strategies that safeguard aquatic biodiversity and aquaculture productivity.

References

1. (URL)1:https://www.statista.com/statistics/1263077/global-pesticide-agricultural-use/?srsltid=AfmBOoonWt8_m4KrMkgCnQ0pPYLqhFxcbAYnNgAVC-lvVnLHvz10HHSQ).
2. Abedi Z, Hasantabar F, Khalesi M K and Babaei S (2013) Enzymatic activities in common carp, *Cyprinus carpio* influenced by sublethal concentrations of cadmium, lead and chromium. *World J. Fish. Mar. Sci.* 5, 144-151.
3. Aktar W, Sengupta D and Chowdhury A (2009) Impact of pesticides use in agriculture: their benefits and hazards. *Interdiscip. Toxicol*. 2, 1-12.
4. Anigol, S. S., Neglur, S. B., & David, M. U. N. I. S. W. A. M. Y. (2023). Studies on the toxic effects of synthetic prethyroid insecticide, Cyphenothrin on protein metabolic profiles of Indian major carp, Cirrihinus mrigala. *International Journal of Ecology and Environmental Sciences*, *49*(4), 353-361.
5. APHA : Standard Methods for the Examination of Water and Wastewater, (21st Edn.). APHA, AWWA, WPCF: Washington DC, USA, 2005.
6. Balint, T.; Szegletes, T.; Szegletes, Z.; Halasy, K. & Nemcsok, J. (1995). Biochemical and subcellular changes in carp exposed to the organophosphorus methidathion and the pyrethroid deltamethrin. *Aquatic Toxicology*, Vol.33, No. 3-4, (October 1995) , pp. 279-295, ISSN 0166-445X
7. Baweja, P., Kumar, S., Kumar, G. (2020). Fertilizers and Pesticides: Their Impact on Soil Health and Environment. In: Giri, B., Varma, A. (eds) Soil Health. Soil Biology, vol 59. Springer, Cham. https://doi.org/10.1007/978-3-030-44364-1_15]
8. Borges, A., Scotti, L.V., Siqueira, D.R., Zanini, R., et al. (2007). Changes in hematological and serum biochemical values in jundiá *Rhamdia quelen* due to sub-lethal toxicity of cypermethrin. *Chemosphere, 69*(6), 920–926.
9. Bradbury SP, Coats JR. Comparative toxicology of the pyrethroid insecticides. Reviews of environmental contamination and toxicology. 1:133-177, 1989.
10. Bradbury, S.P. & Coats, J.R. (1989). Toxicokinetics and toxicodynamics of pyrethroid insecticides in fish*. Environmental Toxicology and Chemistry*, Vol. 8, No. 5, (May 1989), pp. 373–380, ISSN 0730-7268.
11. Brouwer A, Longnecker M P, Birnbaum L S and Moore J (1999) Characterization of potential endocrine related health effects at low-dose levels of exposure to PBCs. *Environ. Heath. Perspect*. 107, 639-649.
12. C. AYDINALP, M.M. PORCA. (2004). The effects of pesticides in water resources J. Cent. Eur. Agric., 5 (1), 5-12.
13. Chesang, P. K., Simiyu, G. M., Were, P. (2017). Assessment of efficacy of unstabilized *pyrethrins* and diatomaceous earth admisture on sitophilus zeamais in maize grains. International Journal of Entomology Research. 2(1):51-54.
14. Cox, C. (2002). Pyrethrins/pyrethrum insecticide factsheet. *Journal of pesticide reform*, *22*(1), 14-20.
15. Crisp T M, Clegg E D, Cooper R L and Wood W P (1998) Environmental endocrine disruption: an effects assessment and analysis. *Environ. Hlth. Perspect*. 106 (Suppl. 1), 11-56.
16. F.B. Antwi, G.V. Reddy 2015. Toxicological effects of pyrethroids on non-target aquatic insects. Environ. Toxicol. Pharmacol., 40 (3) (2015), pp. 915-923, 10.1016/j.etap.2015.09.023.
17. Forget G (1993) Balancing the need for pesticides with the risk to human health. In: *Impact of Pesticide Use on Health in Developing Countries* (eds. Forget G, Goodman T and De Villiers A.), 2-16. IDRC, Ottawa.
18. G Boeck, De., Smeth, De. and R. Blust, 1995. The effect of sublethal levels of copper on oxygen consumption and ammonia excretion in the common carp, *Cyprinus carpio*. Aquatic toxicol, 32: 127-141.
19. Ganeshwade, R.M., P.B. Bokade and S.R. Sonwane, 2006. Behavioral responses of Cyprinus carpio hypothalamoexposed to industrial effluents. J. Environ. Biol., 27(1): 159-160.
20. Haya K. Toxicity of pyrethroid insecticides to fish. Environmental Toxicology and Chemistry: An International Journal. 8(5):381-91, 1989.
21. Igbedioh S O (1991) Effects of agricultural pesticides on humans, animals and higher plants in developing countries. *Arch. Environ. Hlth.* 46, 218-224.
22. Johnson, W.W. and M.T. FInley. 1980. Handbook of acute toxicity of chemicals to fish and aquatic invertebrates. Washington, D.C.: U.S. Dept. of the Interior. Fish and Wildlife Service. p. 70.
23. Masud, S., I.J. Singh and R.N. Ram, 2005. Behavioral and haematological responses of *Cyprinus carpio* exposed to mercuric chloride. J. Environ. Biol., 26(2 Suppl): 133-136.
24. Mishra D K, Bohidar K and Pandey A K (2006) Responses of interregnal cells of freshwater teleost, *Channa punctatus* (Bloch), exposed to sublethal concentrations of carbaryl and cartap. *J. Ecophysiol. Occup. Hlth.* 6, 137-141.
25. Mishra D K, Bohidar K and Pandey A K (2008) Effect of sublethal exposure of cartap on hypothalamo-neurosecretory system of the freshwater teleost, *Channa punctatus* (Bloch). *J. Environ. Biol.* 29, 917-922.
26. Mkawale, S. (2001). Pyrethrum output up by 1500 tonnes. In. (The Financial Standard: Nairobi).
27. Morel F M M, Kraepiel A M L and Amyot M (1998) The chemical cycle and bioaccumulation of mercury. *Ann. Rev. Ecol. Systa*. 29, 543-566.
28. Moslemi, A., Ades, P. K., Crous, P. W., Groom, T., Scott, J. B., Nicolas, M. E., and Taylor, P. W. J. (2018). *Paraphoma chlamydocopiosa sp. nov*. and *Paraphoma pye sp. nov*., two new species associated with leaf and crown infection of pyrethrum. Plant Pathology. 67:24-135.
29. Pandey A K, George K C and Mohamed M P (1995) Effect of DDT on thyroid gland of the mullet, *Liza parsia* (Hamilton-Buchanan). *J. Mar. Biol. Assoc. India* 37, 287-290.
30. Pandey A K, Mishra D K and Bohidar K (2014) Histopathological changes in gonadotrophs of *Channa punctatus* (Bloch) exposed to sublethal concentration of carbaryl and cartap. *J. Exp. Zool. India* 17, 451-455.
31. Pandey RK, Singh RN, Das VK (2008). Effect of temperature on mortality and behavioural responses in freshwater catfish *Heteropneustes fossilis* (Bloch) exposed to dimethoate. Global Journal of Environmental Research. 2(3):126-32..
32. Pandey VK, Pandey RK (2022). Determination of lethality in a freshwater Indian major carp *Labeo rohita*, exposed to Pyrethrum and atrazine. Thanuj International Publishers, Tamil Nadu, India. 2:205.
33. Radhaiah, V. and K. Jayantha Rao, 1998. Behavioral Zool. Pol., 47(3-4): 49-64. responses of fish *Tilapia mossambica* exposed to fenvalerate. Environ. Ecol., 6(2): 2-23.
34. Raja Saha, Sangita Maiti Dutta, (2024). Pesticides' mode of action on aquatic life, *Toxicology Reports,* 13, 101780. https://doi.org/10.1016/j.toxrep.2024.101780.
35. *Ram Nayan Singh, Rakesh Kumar Pandey, Narendra Nath Singh and Vijai Krishna Das (2009),* Acute Toxicity and Behavioral Responses of Common Carp *Cyprinus carpio* (Linn.) To an Organophosphate (Dimethoate). World Journal of Zoology 4 (2): 70-75.
36. Rao, J.V., G. Begum, G. Pallela, P.K. Usman and R.N. Rao, 2005. Changes in behavior and brain acetylcholinesterase activity in mosquito fish *Gambusia affinis* in relation to sublethal exposure of chlorpyrifos. Intl. J. Environ. Res. Public Health, 2(3-4): 478-483.
37. Saha, S. and A. Kaviraj (2003) : Acute toxicity of synthetic pyrethroid Cypermethrin to freshwater catfish *Heteropneustes fossilis* (Bloch). International journal of toxicology. 22(4):325-328.
38. Sahoo J, Nanda S, Mahapatra CR, Panda D, Kund GC. Lethal toxicity of deltamethrin and histological changes in the vital organs of fingerlings of *Labeo rohita*. International Journal of Fisheries and Aquatic Studies. 5(3):506-13, 2017.
39. Santhakumar, M. and M. Balaji, 2000. Acute toxicity of organophosphorus insecticide monocrotophos and its effect on behavior of an airbreathing fish *Anabas testudineus* (Bloch). J. Environ. Biol., 21(2): 121-123.
40. Sarba F S and Mehana S D (2015) Pesticides toxicity in fish with particular reference to insecticides. *Asian J. Agri. Food. Sci*. 3,
41. Sarkar C, Saha NC. Evaluation of acute toxicity levels and behavioral

changes to the fry of common carp, *Cyprinus carpio* (Linnaeus, 1758) under exposure of a pyrethroid insecticide cypermethrin. Research & Reviews: A Journal of Life Sciences. 8(3):102-7, 2018.

42. Shaluei, F., Hedayati, A., Kolangi, H., Jahanbakhshi, A., & Baghfalaki, M. (2012). Evaluation of the acute toxicity of cypermethrin and its effect on behavioral responses of Caspian Roach (*Rutilus rutilus caspicus*) and silver carp (*Hypophthalmicthys molitrix*). *Global Veterinaria, 9*(2), 215–219.
43. Soderlund DM, Clark JM, Sheets LP, Mullin LS, Piccirillo VJ, Sargent D, Stevens JT, Weiner ML. Mechanisms of pyrethroid neurotoxicity: implications for cumulative risk assessment. Toxicology. 171(1):3-59, 2002.
44. Srivastava P and Singh A (2013a) *In vivo* study of effects of dithiocarbamates fungicide (Mancozeb) and its metabolite ethylenethiourea (ETU) on freshwater fish, *Clarius batrachus. J. Biol. Earth Sci.* 3, 228-235.
45. Srivastava P and Singh A (2014) Fate of fungicides on fish, *Clarias batrachus*- a complete study. LAP LAMBERT Academic Publishing, Germany. 134P.
46. Tsai, Y.H., & Lein, P. J. (2021). Mechanisms of organophosphate neurotoxicity. *Current Opinion in Toxicology*, *26*, 49–60.
47. Ullah R, Zuberi A, Ullah S, Ullah I and Dawar F U (2014) Cypermethrin induced behavioural and biochemical changes in mahseer, *Tor putitora*. *J. Toxicol. Sci*. 39, 829-836.
48. Ullah S and Zorriehzahra M J (2015) Ecotoxicology: a review of pesticides induced toxicity in fish. *Adv. Anim. Vet. Sci.* 3, 40-57.
49. Ullah, S., Li, Z., Zuberi, A., Arifeen, M.Z.U., & Baig, M.M.F.A. (2019). Biomarkers of pyrethroid toxicity in fish. *Environmental Chemistry Letters*, *17*(2), 945–973.
50. Xie P, Zhuge Y and Dai M (1996) Impacts of eutrophication on biodiversity of plankton community. *Acta Hydrobiol. Sinica* 20 (Suppl.), 30-37.
51. Yang, T., Gao, L., Hu, H., Stoopen, G., Wang, C., and Jongsma, M. A. (2014). Chrysanthemyl diphosphate synthase operates in plants as a bifunctional enzyme with chrysanthemol synthase activity. J. Biol. Chem. Published on November 5as Manuscript M114.623348.

HOW TO CITE THIS ARTICLE: Pandey, V.K., Kumar, P., Shukla, A.K., Pandey, R.K. Assessment of Acute Toxicity and Behavioral Disruptions in Indian Major Carp (Labeo Rohita) Under Pyrthrum Stress. J. of Drug Disc. and Health Sci. 2026;3(1):1-8. **DOI:** 10.21590/jddhs.03.01.01