The Bioscan AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES 20(3): S.I (3), 728-731, 2025 www.thebioscan.com

Effect of Synthetic Pyrethroid-Lambda-Cyhalothrin on Haematological Parameters of Freshwater Catfish

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DOI: 10.63001/tbs.2025.v20.i03.S.I(3).pp728-731

KEYWORDS
Synthetic pyrethroid, red blood cells, white blood cells, haemoglobin

Received on:

06-07-2025

Accepted on:

05-08-2025

Published on:

04-09-2025

ABSTRACT

The most crucial diagnostic method for toxicological investigations of contaminants is the analysis of haematological parameters. The effects of different contaminants in the aquatic environment cause a variety of physiological and metabolic changes in fish. So, this study attempts to study the effect on blood parameters of fresh water catfish *Clarias batrachus* that are exposed to lambda-cyhalothrin. Enumeration of red blood cells and white blood cells were done. Haemoglobin levels were estimated. Fishes exposed to the higher sub-lethal concentration showed a significant decrease (P<0.05) of 29.94% of total erythrocytes after 45 days of exposure to lambda-cyhalothrin. On comparison with the control group of fishes, haemoglobin content of the pyrethroid-exposed fishes of both groups showed a significant decline (P<0.05) on the 15th, 30th and 45th day of exposure. The total leucocyte count of the fishes exposed to the higher and lower sub-lethal concentration of the pyrethroid also showed a significant decline (P < 0.05) in comparison to the leucocyte count of the control group of fishes.

INTRODUCTION

Haematology is an important diagnostic tool in toxicological studies of pollutants (Thakur and Bias, 2000). It aids in the investigation of physiological and metabolic alterations in fish caused by pollutants of the aquatic environment. Blood is a major route for absorption of environmental mirror changes in metabolism and biochemical processes of organisms resulting from the effect of various pollutants (Saxena and Sharma, 1979: Thakur and Bais, 2000). Monitoring of blood parameters, both cellular and non-cellular may have considerable diagnostic value in assessing early warning signs of pesticide-poisoning (Pant et al., 1987).

Changes in haematocrit (% packed erythrocytes), blood haemoglobin concentrations and other haematological parameters of the blood tissue are widely reported as indicators of stress in fish (Thomas et al., 1980; Goss and Wood, 1988). While some pollutant stressors are reported to increase haematocrit and blood haemoglobin concentrations (Fletcher, 1975) others have reported a decreased haematocrit and blood haemoglobin concentrations or no significant changes in these parameters (Haux et al., 1985).

Lambda-cyhalothrin, synthetic pyrethroid highly toxic to fishes and aquatic invertebrates. However, little is known about the toxicity of sediment associated pyrethroid residues to aquatic organisms despite the agricultural use of these compounds for more than two decades. So, this study aims to evaluate the toxicity level of lambda-cyhalothrin on haematological parameters of fresh water catfish *Clarias batrachus*.

MATERIALS AND METHODS:

Acquisition of Lambda-cyhalothrin, Synthetic pyrethroid; collection, grouping, and maintaining the fresh water female catfish, *Clarias batrachus* for analysis was followed by the method (Gulati et al., 2025)

Enumeration of Red Blood Corpuscles and White Blood Cells:

The total erythrocyte and white blood cell count was determined by the method of Rusia and Sood (1992). The total number of RBC found in 5 groups of 16 squares is multiplied by 10,000 to give the number of cells in millions/mm^3 of blood. Total number of WBC in 4 squares is multiplied by a factor of 2,500 to give the count thousands/mm^3 of blood.

Estimation of Haemoglobin:

Haemoglobin was estimated by cyanmethemoglobin method of Drabkin (1946). The blood haemoglobin levels were expressed as g/dl.

The packed cell volume (PCV) was determined following the standard procedures of Schalm et al. (1975).

RESULTS:

The changes in the haematological parameters of the pyrethroid-exposed fishes are tabulated (Table 1a & 1b).

The total erythrocyte count of the fishes exposed to the lower sub-lethal concentration of the pyrethroid showed no significant variation in comparison to the erythrocyte count of the control group of fishes. However, the fishes exposed to the higher sub-lethal concentration showed a significant decrease (P<0.05) of 29.94% after 45 days of exposure to lambda-cyhalothrin in the higher sub-lethal concentration.

In comparison to the control group of fishes, the haemoglobin content of the pyrethroid-exposed fishes of both groups showed a significant decline (P<0.05) on the 15th, 30th and 45th day of exposure. While the fishes exposed to the higher sub-lethal concentration showed an overall decline of 33.88% in the haemoglobin content, the fishes exposed to the lower sub-lethal concentration showed a decline of 29.13%. A comparison of the haemoglobin content of the pyrethroid-exposed fishes at different durations of exposure showed significant variation (P<0.05) in both groups of pyrethroid-exposed fishes. A similar trend was also witnessed in the packed cell volume (PCV) of the experimental fishes exposed to the two different concentrations of the Pyrethroid. In comparison to the control group, a gradual and significant decline (P<0.05) was witnessed in the PCV of both the groups of experimental fishes on the 15th day of exposure which was followed by a significant increase (P<0.05). However, even after 45 days of exposure the PCV values still remained below the control levels.

The total leucocyte count of the fishes exposed to the higher and lower sub-lethal concentration of the pyrethroid also showed a significant decline (P < 0.05) in comparison to the leucocyte count of the control group of fishes. The decline in the leucocyte count was witnessed on the 15th, 30th and 45th comparison of the leucocyte count at different durations of exposure did not day show any significant variation in the leucocyte count on the different days of exposure in fishes exposed to the higher sub-lethal concentration, while in the group of fishes exposed to the lower sub-lethal concentration, a significant variation (P < 0.05) was witnessed between the leucocyte count of the fishes on the 30th and 45th day of exposure.

DISCUSSION

In the present study, the fishes exposed to higher sub-lethal concentrations of the pyrethroid showed a progressive reduction in the blood RBC count when compared to the animals eared in fresh water. However, the fishes exposed to the lower sub-lethal concentration showed no significant variation in the total erythrocyte count.

In the present study, a significant decline was witnessed in the haemoglobin content of the plasma throughout the period of exposure to lambda-cyhalothrin in both groups of experimental fishes. The decline in the ABC count and haemoglobin content under conditions of toxicant stress is probably due to the disruptive action of pesticides on the erythropoeitic tissue (Cakmak and Asiye, 2003).

Rockfishes exposed to cypermethrin also showed significant decline in the RBC count, haemoglobin content and PCV (Jee et al., 2005). Shah (2006) reported alterations in the haematological parameters of *Tinca tinca* due to exposure to different concentrations of lead with a significant decline in RBC levels and haemoglobin content attributing the alterations to the direct or feedback responses of structural damage to RBC membranes resulting in haemolysis and impairment of haemoglobin synthesis. A significant decline in the RBC count was also reported in *Tilapia guinesis* exposed to sub-lethal concentrations of chlorpyrifos (Chindah et al., 2004).

Erythropoietin is further known to regulate the production of pyridoxal phosphate, a co-enzyme for delta amino levulenic acid (ALA) synthase, a key enzyme for haemoglobin synthesis. Thus a decline in erythropoietin could be the reason for the decrease in the haemoglobin content of the fishes exposed present study. This finding is supported by the earlier findings of the two different sub-lethal concentrations of lambda-cyhalothrin in the Dattatreya Reddy (1996) and Saravanan et al. (2008), Rangaswami and Padmanabhnaidu et al. (1990) also reported a decrease in the RBC count and haemoglobin in the fish, *Clarias batrachus* exposed to 0.006 ppm of endosulfan and 35ppm of kelthane for 24 and 96 hours respectively.

Abidi (1986) reported a correlation between decrease in RBC and haemoglobin and lower values of PCV. Present study has also witnessed a similar relationship between RBC and haemoglobin and an inverse relationship with PCV. Campana et al. (1999) pointed out the genotoxic effect of lambda-cyhalothrin, revealed by an erythrocyte micronuclear test in *Cheirodon interruptus*.

In the present study, a significant elevation was witnessed in the PCV experimental fishes on the 15th day of exposure when compared to the control group of fishes. Changes in haematocrit values can be attributed to the erythrocyte swelling, release of blood cells from spleen and changes in plasma volume (plasma skimming) resulting in elevated PCV during hypoxia (Gallaugher and Farrell, 1998).

In the present study, a significant decline was witnessed in the WBC count of the experimental animals when compared to the control group throughout the exposure period indicating a state of toxicosis throughout the exposure. A significant decline in the WBC count was also reported in Tilapia guinesis exposed to sub-lethal concentrations of chlorpyrifos (Chindah et al., 2004).

REFERENCES

- Abidi R. Studies on the toxicity of certain pesticides on fishes. Ph.D. Thesis.1986; The University of Allahabad, India.
- Cakmak M, Başusta A. Toxic effect of a synthetic pyrethroid insecticide (cypermethrin) on blood cells of rainbow trout (*Oncorhynchus mykiss*, Walbaum). *J Biol Sci*. 2003 Aug 1:694–8. doi:10.3923/jbs.2003.694.698.
- Campana MA, Panzeri AM, Moreno VJ, Dulout FN. Genotoxic evaluation of the pyrethroid lambda-cyhalothrin using the micronucleus test in erythrocytes of the fish *Cheirodon interruptus interruptus*. Mutat Res. 1999 Jan 13;438(2):155–61. doi:10.1016/s1383-5718(98)00167-3. PMID: 10036336.
- Chindah A, Sikoki F, Vincent-Akpu I. Toxicity of an organophosphate pesticide (chlorpyrifos) on a common Niger Delta wetland fish – *Tilapia guineensis* (Bleeker 1862). *J Appl Sci Environ Manage*. 2005;8(2). doi:10.4314/jasem.v8i2.17233.
- Drabkin DL. Spectrophotometric studies; the crystallographic and optical properties of the hemoglobin of man in comparison with those of other species. *J Biol Chem*. 1946;164(2):703–23.
- Dattatreya Reddy. Study of the effect of the synthetic pyrethroid toxicity on some aspects of fish physiology. Ph.D. Thesis, 1996; Osmania University, Hyderabad, India.
- Fletcher GL. The effects of capture, "stress," and storage of whole blood on the red blood cells, plasma proteins, glucose, and electrolytes of the winter flounder (*Pseudopleuronectes americanus*). *Can J Zool*. 1975;53(2):197–206. doi:10.1139/z75-024. PMID: 1116072.
- Gallaugher P, Farrell AP. Hematocrit and blood oxygen-carrying capacity. In: Perry SF, Tufts BL, editors. *Fish Physiology*. Vol. 17. San Diego: Academic Press; 1998. p. 185–227. ISBN: 9780123504418. doi:10.1016/S1546-5098(08)60262-9.
- Goss GG, Wood CM. The effects of acid and acid/aluminum exposure on circulating plasma cortisol levels and other blood parameters in the rainbow trout, *Salmo gairdneri*. *J Fish Biol*. 1988;32(1):63–76. doi:10.1111/j.1095-8649.1988.tb05335.x.
- Gulati S, Priyadarssini M, Logeswari E, Revathi K. Effect of lambda-cyhalothrin on the activity of glycolytic pathway and mitochondrial oxidative enzymes. The Bioscan. 2025;20(Suppl 2):873–9. doi: 10.63001/tbs.2025.v20.i02.S2.pp873-879.
- Haux C, Sjobeck M-L, Larsson Å. Physiological stress responses in a wild fish population of perch (*Perca fluviatilis*) after capture and during subsequent recovery. *Mar Environ Res*. 1985;15(2):77–95. doi:10.1016/0141-1136(85)90131-X.
- Jee JH, Masroor F, Kang JC. Responses of cypermethrin-induced stress in haematological parameters of Korean rockfish, *Sebastes schlegeli* (Hilgendorf). *Aquac Res*. 2005;36(9):898–905. doi:10.1111/j.1365-2109.2005.01299.x.

- Kumar S, Habib K, Fatma T. Endosulfan induced biochemical changes in nitrogen-fixing cyanobacteria. *Sci Total Environ*. 2008;403(1-3):130-8. doi:10.1016/j.scitotenv.2008.05.026.
- Pant J, Tewari H, Gill TS. Effects of aldicarb on the blood and tissues of a freshwater fish. Bulletin of environmental contamination and toxicology. 1987 Jan 1;38(1):36-41.
- Saravanan R, Revathi K, Balakrishna Murthy P. Effect of lambda-cyhalothrin a synthetic pyrethroid on some of the blood antioxidants in freshwater catfish Clarias batrachus (Bloch) Poll Res. 2008; 27 (2) 83-87 Scopus H index-17, NAAS rating- 4.75
- Rangaswami CP, Padmanabha Naidu B. Difference of Spectra of blood of *Tilapia mossambica* (Peters) exposed to endosulfan. Comp. Phsyiolo. Ecol., 12(3): 180-182.
- Rusia V, Sood SK. Routine haematological test. In: Mukerjee, K.L. (ed.), *Medical Laboratory Technology*, Tata McGraw Hill Publishing Company Limited, 1992; pp. 252–258.
- Saxena OP, Sharma BK. Studies on some biochemical and hematological parameters of Indian mud eel, *Amphipnous cuchi*. Proc. All Conf. Life Sci., 1979; 47-52.
- Schalm OW, Jain NC, Carroll EJ. Veterinary hematology. 3rd ed. Philadelphia: Lea & Febiger; 1975.
- Shah SL. Hematological parameters in tench *Tinca tinca* after short term exposure to lead. *J Appl Toxicol*. 2006;26(3):223–8. doi:10.1002/jat.1129. PMID:16389660.
- Thakur PB, Bais VS. Toxic effects of aldrin and danvalerate on some hematological parameters of fresh water teleost, *Heteropneustes fossilis*. J. Environ. Biol. 2000; 21: 161-163
- Thomas P, Woodin BR, Neff JM. Biochemical responses of the striped mullet *Mugil cephalus* to oil exposure I. Acute responses—Interrenal activations and secondary stress responses. *Mar. Biol.* 59, 141–149 (1980). https://doi.org/10.1007/BF00396861

TABLES:

Table 1a: Effect of lambda-cyhalothrin at higher sub-lethal concentration (5.768 ppm) on haematological parameters (Total Erythrocyte Count (TEC), Haemoglobin concentration (Hb), Packed Cell Volume (PCV), Total Leucocyte Count (TLC)) of *Clarias batrachus*

Parameter	F Value	P Value	Control	Experimental Days			Recovery
				15	30	45	
TEC (millions/mm³ blood)	11.496	0.000**	2.638[b] ± 0.293	2.703[b] ± 0.252 (+2.46)	2.580[b] ± 0.260 (-2.19)	1.848[a] ± 0.298 (-29.94)	2.088[a] ± 0.269
Hb (g/dl)	217.95	0.000**	11.552[d] ± 0.275	10.115[c] ± 0.240 (-12.43)	8.627[b] ± 0.229 (-25.32)	7.638[a] ± 0.253 (-33.88)	9.743[c] ± 0.237
PCV (%)	497.77	0.000**	39.633[d] ± 0.276	33.208[a] ± 0.343 (-16.21)	36.838[b] ± 0.193 (-7.05)	38.315[c] ± 0.297 (-3.32)	39.170[d] ± 0.292
TLC (Thousands/mm³ blood)	40.76	0.000**	1.818[c] ± 0.366	0.632[a] ± 0.156 (-5.23)	0.567[a] ± 0.203 (-68.81)	0.258[a] ± 0.085 (-85.80)	1.240[b] ± 0.281

Table 1b: Effect of lambda-cyhalothrin at lower sub-lethal concentration (2.884 ppm) on haematological parameters (Total Erythrocyte Count (TEC), Haemoglobin concentration (Hb), Packed Cell Volume (PCV), Total Leucocyte Count (TLC)) of *Clarias batrachus*

Parameter	F Value	P Value	Control	Experimental Days			Recovery
				15	30	45	
TEC (millions/mm^3 blood)	0.86	0.50 ^{NS}	$2.703^a \pm 0.282$	$2.685^a \pm 0.303$ (-0.66)	$2.577^a \pm 0.258$ (-4.66)	$2.460^a \pm 0.197$ (-8.99)	$2.547^a \pm 0.284$
Hb (g/dl)	132.813	0.000**	$11.905^d \pm 0.229$	$10.523^c \pm 0.232$ (-11.60)	$9.553^b \pm 0.222$ (-19.75)	$8.437^a \pm 0.259$ (-29.13)	$10.212^c \pm 0.380$
PCV (%)	196.12	0.000**	$39.582^d \pm 0.301$	$35.545^a \pm 0.270$ (-10.19)	$37.758^b \pm 0.222$ (-4.60)	$38.710^c \pm 0.277$ (-2.20)	$39.118^{cd} \pm 0.319$
TLC (Thousands/mm^3 blood)	48.19	0.000**	$1.892^c \pm 0.296$	$1.022^b \pm 0.256$ (-45.98)	$0.597^a \pm 0.098$ (-68.44)	$0.382^a \pm 0.113$ (-79.80)	$1.307^b \pm 0.217$