

Hematological Alterations in *Labeo rohita* Induced by Sublethal Exposure to Malathion, an Organophosphate Pesticide

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Abstract-

Pesticide contamination in freshwater ecosystems has become a significant concern due to its adverse effects on aquatic organisms, particularly fish, which serve as key bioindicators of environmental health. The present study investigates the hematological responses of *Labeo rohita*, a widely cultured freshwater fish, upon sublethal exposure to Malathion, a commonly used organophosphate pesticide in agriculture. Fish were exposed to two sub-lethal concentrations of Malathion, determined based on 96-hour LC₅₀ values, over acute (96 hours), sub-chronic (15 days), and chronic (30 days) durations under controlled laboratory conditions. Hematological parameters, including hemoglobin (Hb), red blood cell (RBC) count, white blood cell (WBC) count, and packed cell volume (PCV), Lymphocytes were assessed. The results revealed significant hematological alterations in the Malathion-exposed groups compared to the controls, including marked reductions in Hb, RBC, and PCV, alongside an increase in WBC count, indicating an anemic and immunotoxic effect. These findings suggest that hematological parameters are sensitive biomarkers of pesticide-induced toxicity and highlight the potential ecological risks of Malathion contamination in aquatic habitats.

Keywords

Labeo rohita, Malathion, Hematology, RBC, WBC, Hemoglobin, PCV, Lymphocyte, Sublethal toxicity.

Introduction-

Water is the cornerstone of life, and among the various ecosystems on Earth, freshwater bodies such as rivers, lakes, ponds, and reservoirs play a critical role in maintaining ecological balance. These water sources not only support diverse life forms but also serve essential purposes for agriculture, fisheries, drinking water, and industry. Any deterioration in the quality of freshwater can have immediate and far-reaching effects on both aquatic organisms and human populations.

Within these freshwater ecosystems, fish occupy a vital position. They are not only an important component of the aquatic food chain but also act as effective bioindicators of environmental health. Fish are highly sensitive to changes in water quality, and their hematological and biochemical parameters often reflect early signs of ecological stress or contamination. Therefore, fish serve as both a valuable food resource and a biological monitoring tool for assessing the impact of pollutants in aquatic systems.

In recent decades, increasing agricultural activity and the widespread use of agrochemicals have posed serious threats to aquatic environments. Pesticides, in particular, though designed to protect crops, frequently enter nearby water bodies through runoff, leaching, and improper disposal. Once

in the water, these chemicals may persist and accumulate, posing toxic risks to non-target species, including fish. Such contamination can alter vital physiological processes in aquatic organisms and disrupt entire aquatic food webs.

Among the various classes of pesticides, organophosphates are known for their high toxicity and neurotoxic effects. Malathion, a commonly used organophosphate pesticide, is widely applied in agricultural and vector control practices. Although considered less persistent in the environment than some other pesticides, Malathion can still accumulate in aquatic systems, especially in areas with intensive pesticide usage. Exposure to sub-lethal doses of Malathion can induce significant alterations in the hematological, biochemical, and immunological systems of fish, making it a compound of concern in aquatic toxicology.

Freshwater fish, particularly carps, are central to Indian aquaculture and food security. Among them, *Labeo rohita*, commonly known as Rohu, is one of the most economically important and widely cultured species. Its high sensitivity to environmental pollutants, rapid physiological response, and ease of laboratory handling make it an ideal model organism for toxicological studies. Given its ecological and commercial value, understanding how Rohu responds to pesticide exposure at the hematological level is crucial.

In this context, the present study aims to evaluate the hematological responses of *Labeo rohita* upon sub-lethal exposure to Malathion over varying durations. This research seeks to explore the potential of hematological parameters as early biomarkers for pesticide-induced stress in freshwater fish, thereby contributing to both environmental monitoring and sustainable aquaculture practices.

Materials and Methods

Healthy specimens of *Labeo rohita* were acclimatized in laboratory aquaria for 15 days under controlled conditions. Sublethal concentrations (5% and 10% of the 96-hour LC_{50}) of Malathion were prepared, and fish were divided into four groups: Control, Acute (96 hours), Sub-chronic (15 days), and Chronic (30 days). Blood samples were collected from the caudal vein using heparinized syringes for hematological examination. Parameters such as Hb, RBC, WBC, PCV, and total lymphocyte count were analyzed following standard procedures. Results were statistically analyzed and expressed as mean \pm standard deviation (SD).

Results and Discussion

Table 1: Hematological profile of the Control group (0 $\mu\text{g/L}$ Malathion exposure).

Parameter	Unit	Mean \pm SD
Hemoglobin (Hb)	g/dL	10.4 \pm 0.25
RBC Count	$\times 10^6/\text{mm}^3$	2.85 \pm 0.10
WBC Count	$\times 10^3/\text{mm}^3$	5.40 \pm 0.35
PCV	%	35.2 \pm 1.2

Total Lymphocyte Count	cells/mm ³	3,200 ± 140
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Table 2: Hematological profile of Acute group (96-hour Malathion exposure).

Parameter	Unit	Mean ± SD
Hemoglobin (Hb)	g/dL	8.9 ± 0.28
RBC Count	×10 ⁶ /mm ³	2.40 ± 0.09
WBC Count	×10 ³ /mm ³	6.10 ± 0.42
PCV	%	31.4 ± 1.1
Total Lymphocyte Count	cells/mm ³	3,650 ± 160

Table 3: Hematological profile of Sub-chronic group (15-day Malathion exposure).

Parameter	Unit	Mean ± SD
Hemoglobin (Hb)	g/dL	7.8 ± 0.33
RBC Count	×10 ⁶ /mm ³	2.12 ± 0.07
WBC Count	×10 ³ /mm ³	6.85 ± 0.50
PCV	%	28.6 ± 0.9
Total Lymphocyte Count	cells/mm ³	3,980 ± 170

Table 4: Hematological profile of the Chronic group (30-day Malathion exposure).

Parameter	Unit	Mean ± SD
Hemoglobin (Hb)	g/dL	6.9 ± 0.30
RBC Count	×10 ⁶ /mm ³	1.85 ± 0.08
WBC Count	×10 ³ /mm ³	7.50 ± 0.55
PCV	%	25.3 ± 1.0
Total Lymphocyte Count	cells/mm ³	4,250 ± 180

The progressive decline in Hb, RBC, and PCV levels from acute to chronic exposure indicates anemia caused by the hemolytic action of Malathion and impaired oxygen transport. The consistent rise in WBC, leucocyte, and lymphocyte counts reflects the

activation of the immune system to counteract stress and tissue injury. Such hematological disruptions correspond with typical organophosphate toxicity patterns observed in fish, where erythrocyte damage and hematopoietic suppression lead to compromised physiological functions.

Conclusion

The study clearly demonstrates that sublethal exposure to Malathion induces duration-dependent hematological alterations in *Labeo rohita*. The decreasing trends in hemoglobin, RBC, and PCV values and the increasing WBC, leucocyte, and lymphocyte counts indicate anemia and immunotoxicity. These hematological parameters can serve as reliable indicators of pesticide-induced stress and are useful for monitoring environmental conditions in aquatic systems.

The present study clearly demonstrates that sublethal exposure to malathion causes significant hematological alterations in *Labeo rohita*. The observed decline in RBC count, hemoglobin concentration, and packed cell volume indicates anemia and impaired oxygen transport, while elevated WBC and lymphocyte levels suggest a defensive response to pesticide-induced stress. These alterations reflect physiological imbalance and disruption of normal hematopoietic function under toxic stress.

Furthermore, the results highlight that even low concentrations of organophosphates can exert chronic effects on fish health and survival. Continuous exposure to such pollutants not only affects fish metabolism but may also lead to long-term ecological disturbances in aquatic environments. Therefore, malathion contamination poses a serious threat to fish biodiversity and aquaculture productivity. Regular monitoring of water quality, implementation of safe pesticide practices, and awareness among farmers are essential to minimize these toxic effects. Future studies should also explore biochemical and molecular markers to understand the underlying mechanisms of pesticide toxicity in aquatic organisms.

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