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Toxic Effect of Chlorpyrifos Ethyl on Liver Cholesterol, Serum Cholesterol, and Alkaline Phosphatase Activity in Climbing Perch (*Anabas Testudineus*)

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ABSTRACT

Pesticide contamination in aquatic ecosystems has raised considerable concern due to its potential toxic effects on non-target species. This study evaluates the impact of sub-lethal concentrations of Chlorpyrifos ethyl—a commonly used organophosphate pesticide—on liver cholesterol, serum cholesterol, and alkaline phosphatase (ALP) activity in *Anabas testudineus* (climbing perch). Fish were exposed to sub-lethal concentrations (0.2 mg/L and 0.4 mg/L) of Chlorpyrifos for 21 days. Results revealed significant alterations in cholesterol levels and enzyme activity, indicating hepatic dysfunction and physiological stress. The findings emphasize the ecotoxicological threat Chlorpyrifos poses to aquatic organisms.

KEYWORDS: *Chlorpyrifos, Anabas testudineus, Liver Cholesterol, Serum Cholesterol, Alkaline Phosphatase, Toxicity, Biomarkers, Pesticide Pollution*

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1. INTRODUCTION

Aquatic ecosystems across the globe are increasingly threatened by **agricultural runoff**, which carries **toxic substances like organophosphate pesticides**. Among them, **Chlorpyrifos ethyl**, a widely used insecticide, is frequently detected in water bodies near farmlands (Racke, 1993; USEPA, 2000). This compound is known for its neurotoxic effects through acetylcholinesterase (AChE) inhibition (Costa, 2006), but its chronic toxicity on **non-target aquatic organisms**, especially fish, remains inadequately studied.

Fish serve as sensitive bioindicators of environmental contamination because of their ability to bioaccumulate pollutants and display biochemical and physiological changes (Fırat et al., 2011; Authman et al., 2015). Among various fish species, ***Anabas testudineus*** (climbing perch) is a hardy, euryhaline teleost frequently found in contaminated freshwater habitats. It is a suitable model for toxicological studies due to its resilience and economic importance (Mishra & Mohanty, 2018).

The liver plays a crucial role in **detoxification and metabolism**, and exposure to toxicants often results in hepatic dysfunction. Alterations in **liver cholesterol** and **serum cholesterol** levels are commonly used to assess lipid metabolic disturbance caused by toxicants (Pandey et al., 2001). Furthermore, **alkaline phosphatase (ALP)**, a membrane-bound enzyme, acts as a reliable biomarker for hepatic damage and altered metabolism in toxicological assessments (Sastry & Sharma, 1980; Abdel-Moneim et al., 2012).

This study aims to evaluate the toxic effects of Chlorpyrifos ethyl on **liver cholesterol, serum cholesterol**, and **ALP activity** in *Anabas testudineus*

following sub-lethal exposure. Understanding these biochemical responses can help identify early signs of physiological stress and liver dysfunction caused by environmental pesticides.

2. Materials and Methods

2.1. Chemicals

Chlorpyrifos ethyl (purity >99%) was procured from Sigma-Aldrich. All other chemicals used were of analytical grade.

2.2. Test Animal

Healthy adult *Anabas testudineus* (average weight 30±5 g, length 12±2 cm) were procured from a local hatchery and acclimatized in dechlorinated tap water under laboratory conditions for 15 days. Fish were fed commercial feed and maintained under 12:12 h light-dark cycles.

2.3. Experimental Design

After acclimation, fish were divided into three groups (n=10 each):

Group	Treatment
I (Control)	No pesticide exposure
II (Low Dose)	0.2 mg/L Chlorpyrifos
III (High Dose)	0.4 mg/L Chlorpyrifos

Exposure continued for 21 days. Water was renewed every 48 hours with fresh pesticide solution. Fish were not fed 24 hours before sampling.

2.4. Biochemical Assays

- **Liver and serum samples** were collected after sacrificing fish under anesthesia.
- **Liver cholesterol** and **serum cholesterol** were estimated using the method of Zlatkis et al. (1953).
- **ALP activity** was measured spectrophotometrically by the method of Bessey et al. (1946).

2.5. Statistical Analysis

Data were expressed as Mean ± SD. One-way ANOVA followed by Tukey's test was used for comparison. A p value < 0.05 was considered statistically significant.

3. Results

Table 1: Effect of Chlorpyrifos on Liver Cholesterol (mg/g tissue)

Group	Mean ± SD
Control	7.85 ± 0.42
Low Dose	6.34 ± 0.38*
High Dose	5.12 ± 0.41**

*p < 0.05, **p < 0.01 compared to control

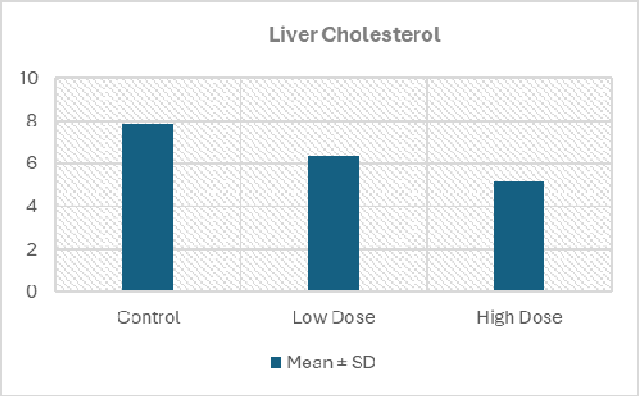

Fig: Graphical Representation of Effect of Chlorpyrifos on Liver Cholesterol (mg/g tissue)

Table 2: Effect of Chlorpyrifos on Serum Cholesterol (mg/dL)

Group	Mean ± SD
Control	102.6 ± 4.7
Low Dose	89.3 ± 4.2*
High Dose	76.5 ± 3.8**

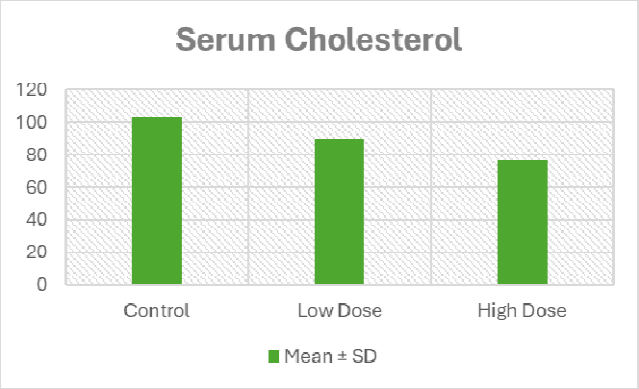

Fig 2: Graphical Representation of Effect of Chlorpyrifos on Serum Cholesterol (mg/dL)

Table 3: Effect of Chlorpyrifos on Alkaline Phosphatase Activity (U/L)

Group	Mean ± SD
Control	132.1 ± 6.3
Low Dose	162.7 ± 7.2*
High Dose	185.4 ± 8.1**

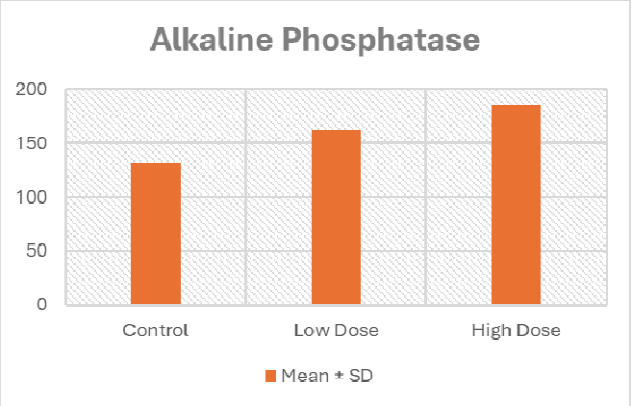

Fig 3: Graphical Representation of Effect of Chlorpyrifos on Alkaline Phosphatase Activity (U/L)

4. Discussion

Exposure to Chlorpyrifos ethyl caused **significant alterations in biochemical parameters**, indicating toxic stress and liver dysfunction in *Anabas testudineus*. These changes reflect the compound's systemic toxicity and its ability to interfere with essential metabolic processes.

Liver cholesterol levels declined significantly in both exposed groups, particularly at the higher concentration. The liver is central to lipid metabolism, and reduced hepatic cholesterol may result from impaired synthesis or increased degradation triggered by pesticide stress (Ghosh & Chatterjee, 1989). Disruption in membrane integrity due to oxidative stress can also lead to cholesterol leakage or utilization in repairing damaged membranes (Kavitha et al., 2010).

Serum cholesterol levels also exhibited a dose-dependent decline, consistent with earlier findings where exposure to organophosphates like dimethoate and malathion caused hypocholesterolemia in fish (Rao et al., 2003; Abdel-Moneim et al., 2012). This may be due to inhibited activity of key enzymes involved in cholesterol biosynthesis, or alterations in lipoprotein transport due to hepatic damage.

One of the most significant findings was the **elevation in ALP activity**, which is a classical marker of liver dysfunction. ALP is released into circulation upon cellular damage or bile duct obstruction (Fırat et al., 2011). In the present study, increased ALP activity suggests hepatocellular damage and cholestasis. Similar ALP induction has been reported in *Oreochromis mossambicus* and *Channa punctatus* exposed to organophosphates (David et al., 2004; Kavitha et al., 2010).

Mechanistically, Chlorpyrifos is known to induce **oxidative stress**, resulting in lipid peroxidation, mitochondrial dysfunction, and enzyme leakage from hepatocytes (Kumar et al., 2015). The fish's antioxidant defense system may be overwhelmed by continuous exposure, leading to observed biochemical disruptions.

From an ecological standpoint, the altered cholesterol metabolism and enzyme profiles may impair **growth, reproduction, and survival** of fish in contaminated habitats. These disruptions, if persistent, could affect population dynamics and ecosystem health.

5. Conclusion

This study demonstrates that Chlorpyrifos ethyl induces **dose-dependent toxic effects** on liver cholesterol, serum cholesterol, and ALP activity in *Anabas testudineus*. The observed alterations serve as early biomarkers of hepatic and metabolic stress. These findings emphasize the **need for strict regulation** and **monitoring of organophosphate pesticide contamination** in aquatic environments to safeguard fish health and biodiversity.

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