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# Deltamethrin-Induced Hepato-Renal Protein Reductions In Heteropneustes Fossilis

**Authors: Dr. Shruti Kumari, Dr. Dhiraj Kumar and Dr. Mala**
**R.B. COLLEGE, DALSINGHSARAI, DIST-SAMASTIPUR, STATE-BIHAR**

**Abstract:** The widespread application of pyrethroid-based insecticides has raised increasing concern regarding their unintended consequences in aquatic environments. Deltamethrin, although valued for its effectiveness against insect pests and relatively rapid degradation under terrestrial conditions, may exert toxic effects on aquatic organisms when introduced into freshwater systems. The present investigation assessed the biochemical consequences of prolonged sublethal deltamethrin exposure by analyzing total protein content in the liver and kidney of the freshwater air-breathing fish Heteropneustes fossilis, a species of ecological and economic importance.

Adult fish were exposed to two sublethal concentrations of deltamethrin (0.05 mg/L and 0.1 mg/L) for periods of 14 and 21 days under controlled laboratory conditions. Protein levels in hepatic and renal tissues were quantified using a standardized colorimetric assay. A statistically significant decline in protein concentration was observed in both organs, with reductions intensifying at higher exposure concentrations and longer durations. Hepatic tissue consistently exhibited greater depletion compared to renal tissue.

The observed decrease in protein levels reflects metabolic disturbance likely associated with impaired biosynthesis, enhanced proteolysis, and pesticide-induced physiological stress. These findings demonstrate that tissue protein content serves as a sensitive biochemical marker for detecting sublethal pesticide toxicity and underscore the susceptibility of metabolically active organs to chemical stress in freshwater fish.

KEYWORD:Deitamethrin, Heteropneustes fossilis, Hepatic and Renal

## Introduction

Chemical insecticides play a vital role in modern agriculture and vector control programs; however, their widespread and indiscriminate application has led to increasing contamination of nearby freshwater ecosystems. Among the various classes of insecticides, synthetic pyrethroids are extensively used due to their high efficacy against insect pests and relatively low toxicity to mammals. Despite these advantages, numerous studies have demonstrated that pyrethroids are highly toxic to aquatic organisms, particularly fish, even at very low concentrations (Velisek et al., 2011; Kumar & Shukla, 2020).

Deltamethrin, a type II synthetic pyrethroid, is commonly detected in freshwater bodies as a result of agricultural runoff, spray drift, and improper disposal practices. Once introduced into aquatic environments, deltamethrin can persist long enough to disrupt normal physiological and biochemical processes in non-target organisms. Fish are especially susceptible due to their continuous exposure to contaminated water, high absorption efficiency through gills, and limited detoxification capacity for certain xenobiotics (David & Kartheek, 2016).

Fish have long been recognized as reliable biological indicators of environmental pollution because they exhibit quantifiable biochemical, physiological, and histopathological responses to toxic stress. Heteropneustes fossilis, an air-breathing freshwater catfish widely distributed throughout South Asia, is frequently employed in ecotoxicological studies owing to its ecological importance, resilience, and adaptive physiology. These characteristics make the species particularly suitable for detecting subtle biochemical changes under sublethal pesticide exposure (Reddy & Venugopal, 2017).

The liver and kidney are critical organs involved in metabolism, detoxification, and excretion of foreign substances. As primary targets of toxicant accumulation, these organs often exhibit biochemical alterations prior to the appearance of visible tissue damage. Changes in the biochemical composition of hepatic and renal tissues, especially total protein content, are widely used as sensitive indicators of metabolic dysfunction and toxic stress (Sarkar & Roy, 2018). Protein levels reflect the balance between synthesis and degradation processes and are closely linked to cellular energy demands and physiological integrity.

Although several studies have documented the toxic effects of deltamethrin on individual organs in various freshwater fish species, comprehensive information on the combined hepatic and renal protein responses in Heteropneustes fossilis following prolonged sublethal exposure remains limited. Previous investigations have primarily focused on species such as Channa punctatus, Clarias batrachus, and Anabas testudineus (Yadav & Singh, 2019; Pandey et al., 2021), leaving a significant knowledge gap regarding H. fossilis. Therefore, the present study was designed to evaluate organ-specific alterations in total protein content in liver and kidney tissues and to assess their usefulness as early indicators of deltamethrin-induced biochemical stress in freshwater fish..

## Materials and Methods

### i) Experimental Animals

Healthy adult specimens of Heteropneustes fossilis measuring 12–18 cm in length and weighing 60–90 g were procured from an authorized freshwater fish supplier. Fish were acclimatized for 15 days in glass aquaria containing dechlorinated tap water under a natural light–dark cycle (12 h:12 h). During acclimation, fish were fed a commercial pellet diet once daily. Feeding was suspended 24 hours prior to the start of exposure and before tissue sampling.

### ii) Chemicals

Technical-grade deltamethrin (98% purity) was obtained from a certified agrochemical source. Stock and working solutions were freshly prepared using distilled water. All chemicals and reagents used for biochemical estimation were of analytical grade.

### iii) Experimental Design

Fish were randomly assigned to three experimental groups, each maintained in triplicate:

- Control group (no pesticide exposure)
- Low-dose group (0.05 mg/L deltamethrin)
- High-dose group (0.1 mg/L deltamethrin)

Each replicate contained 10 fish. The experiment was conducted under semi-static conditions, with 50% of the test solution renewed daily. Exposure durations were set at 14 and 21 days.

**iv) Tissue Sampling**

At the end of each exposure period, fish were anesthetized using MS-222. Liver and kidney tissues were carefully excised, rinsed in chilled isotonic saline to remove adhering blood, blotted dry, and stored at −20°C until biochemical analysis.

**v) Estimation of Total Protein**

Protein content was determined using the Lowry method, employing bovine serum albumin as the standard. Tissue samples (1 g) were homogenized in ice-cold 0.1 M phosphate buffer (pH 7.4) and centrifuged at 10,000 rpm for 15 minutes at 4°C. The resulting supernatant was analyzed spectrophotometrically at 660 nm, and protein concentration was expressed as mg/g wet tissue weight.

**vi) Statistical Analysis**

Data were expressed as mean ± standard deviation. Statistical differences between control and treated groups were evaluated using one-way analysis of variance (ANOVA) followed by Tukey's post-hoc test. Differences were considered significant at $p < 0.05$.

## Review of Literature

The contamination of freshwater ecosystems by pesticide residues has become a major environmental concern, particularly in developing countries where agricultural intensification has increased the application of chemical insecticides. Among these, synthetic pyrethroids have gained widespread use due to their high insecticidal efficiency and relatively rapid degradation in terrestrial environments. However, despite their perceived safety, pyrethroids frequently enter aquatic systems through runoff and drainage, where they pose serious toxicological risks to non-target organisms, especially fish (Velisek et al., 2011; Kumar & Shukla, 2020).

Fish are highly sensitive to pyrethroid exposure because of their permeable gill surfaces and limited capacity to detoxify certain xenobiotics. Deltamethrin, a commonly used synthetic pyrethroid, has been reported to induce a range of biochemical, physiological, and behavioral disturbances in freshwater fish even at sublethal concentrations (David & Kartheek, 2016). Such disturbances are often reflected in alterations of key metabolic organs, particularly the liver and kidney, which play central roles in detoxification, metabolism, and excretion of toxic substances.

The liver is considered the primary organ involved in the biotransformation of pesticides and is therefore highly vulnerable to chemical-induced stress. Several studies have documented significant biochemical disruptions in hepatic tissue following pyrethroid exposure, including reductions in protein content, enzyme inhibition, and oxidative damage (Reddy & Venugopal, 2017; Pandey et al., 2021). Protein depletion in the liver is often attributed to suppressed protein synthesis, enhanced proteolysis, and increased utilization of amino acids to meet elevated energy demands under toxic stress conditions.

The kidney, although less frequently studied than the liver, is equally important in maintaining physiological homeostasis through its role in osmoregulation and waste elimination. Alterations in renal biochemical parameters, including protein content, may impair filtration efficiency and ionic balance, ultimately affecting overall organismal health. Sarkar and Roy (2018) reported that pesticide-induced renal stress leads to measurable biochemical changes that can serve as sensitive indicators of sublethal toxicity. However, comparative data on renal protein responses remain limited, particularly for many indigenous fish species.

Protein metabolism has been widely recognized as a reliable biomarker of environmental stress in fish. Decreases in tissue protein levels have been consistently reported in various species exposed to deltamethrin and other pyrethroids, including Channa punctatus (Reddy & Venugopal, 2017), Clarias batrachus (Yadav & Singh, 2019), and Anabas testudineus (Pandey et al., 2021). These studies collectively demonstrate that protein depletion is a common biochemical response to pesticide exposure and reflects metabolic imbalance and physiological exhaustion.

Despite the growing body of literature on pesticide-induced biochemical toxicity, information regarding the combined hepatic and renal protein responses in Heteropneustes fossilis remains scarce. Given the ecological and economic importance of this species, there is a clear need for detailed investigations focusing on sublethal pesticide stress. The present study seeks to bridge this knowledge gap by systematically evaluating protein alterations in both liver and kidney tissues of H. fossilis following deltamethrin exposure, thereby contributing to a better understanding of pyrethroid toxicity in freshwater ecosystems.

**Results**

| **Tissue** | **Group** | **Duration** | **Protein (mg/g) Mean ± SD** | **% Change from Control** |
|---|---|---|---|---|
| Liver | Control | — | 57.80 ± 1.24 | — |
| | Low Dose | 14 days | 48.36 ± 1.10 | −16.32% |
| | | 21 days | 42.95 ± 1.35 | −25.69% |
| | High Dose | 14 days | 39.42 ± 1.27 | −31.79% |
| | | 21 days | 33.25 ± 1.19 | −42.49% |
| Kidney | Control | — | 41.25 ± 1.18 | — |
| | Low Dose | 14 days | 35.88 ± 1.01 | −13.02% |
| | | 21 days | 30.12 ± 1.23 | −26.97% |
| | High Dose | 14 days | 28.75 ± 1.15 | −30.27% |
| | | 21 days | 24.06 ± 1.34 | −41.66% |

**Discussion**

The present investigation demonstrates that chronic exposure to sublethal concentrations of deltamethrin induces marked alterations in protein metabolism in Heteropneustes fossilis, as evidenced by a significant decline in total protein content in both hepatic and renal tissues. The progressive reduction observed with increasing exposure duration and pesticide concentration clearly indicates a dose- and time-dependent biochemical stress response. Such cumulative effects reflect the inability of the organism to restore metabolic homeostasis under sustained toxic pressure.

Among the two organs studied, the liver exhibited a comparatively higher degree of protein depletion. This enhanced sensitivity can be attributed to the liver's primary role in detoxification, biotransformation, and metabolic regulation. During pesticide exposure, hepatic cells are required to metabolize deltamethrin, leading to increased energy demand and diversion of amino acids toward stress adaptation processes rather than protein synthesis. Similar hepatic vulnerability has been reported in freshwater fish exposed to pyrethroids by Velisek et al. (2011) and later confirmed by David and Kartheek (2016), who observed suppressed protein biosynthesis due to oxidative damage to cellular machinery.

The observed protein decline may also result from enhanced proteolysis, as proteins are broken down to meet elevated energy requirements under toxic stress. Oxidative stress generated by deltamethrin exposure can disrupt ribosomal activity and impair transcriptional regulation, thereby inhibiting protein synthesis pathways. Yadav and Singh (2019) documented comparable protein depletion in Clarias batrachus, linking it to increased reactive oxygen species and compromised antioxidant defenses. These findings support the biochemical trends observed in the present study.

Although the kidney showed relatively lower protein depletion compared to the liver, the reduction was still significant and biologically relevant. Renal tissues are essential for osmoregulation, excretion, and maintenance of ionic balance, and any disturbance in protein content may impair these functions. Sarkar and Roy (2018) reported that pesticide-induced renal protein loss can adversely affect filtration efficiency and tubular integrity, leading to systemic physiological imbalance. The present findings are consistent with such observations and indicate that prolonged deltamethrin exposure compromises renal metabolic stability.

The pattern of protein reduction observed in this study closely aligns with previous reports on sublethal pesticide toxicity in fish species. Pandey et al. (2021) demonstrated significant alterations in liver protein levels of Anabas testudineus following deltamethrin exposure, emphasizing the sensitivity of hepatic biochemical markers. Likewise, Reddy and Venugopal (2017) reported concurrent biochemical and histopathological changes in Channa punctatus, highlighting the interrelationship between structural damage and metabolic disruption.

The consistency of protein depletion across different fish species and studies conducted between 2011 and 2021 underscores the reliability of total protein content as an early biomarker of pesticide-induced stress. Kumar and Shukla (2020) emphasized in their review that protein alterations serve as one of the most sensitive indicators of sublethal pyrethroid toxicity in aquatic organisms. The present study extends these findings to Heteropneustes fossilis, a species of ecological and economic importance, thereby contributing valuable region-specific data.

Overall, the results clearly indicate that deltamethrin poses a significant biochemical threat even at sublethal concentrations when exposure is prolonged. The documented depletion of hepatic and renal protein content reflects metabolic exhaustion and impaired physiological functioning. These findings highlight the need for strict regulation of pesticide usage and reinforce the importance of biochemical monitoring for early detection of aquatic pollution.

## Conclusion

The present investigation demonstrates that sublethal exposure to deltamethrin induces marked reductions in total protein content in the liver and kidney of Heteropneustes fossilis. Hepatic tissue showed a higher degree of alteration, reflecting its heightened vulnerability to chemical stress. Although non-lethal, these biochemical changes may adversely affect growth, immune function, and long-term survival.

The results emphasize the need for careful regulation of pesticide use near aquatic habitats and support the inclusion of tissue protein analysis as a routine biomarker in environmental monitoring programs aimed at safeguarding freshwater ecosystems.

## References

1. Begum, G. (2004). Carbofuran insecticide induced biochemical alterations in liver and muscle tissues of the fish Clarias batrachus. Pesticide Biochemistry and Physiology, 80(2), 94–102.
2. David, M., & Kartheek, R. M. (2016). Impact of deltamethrin on oxidative stress and biochemical markers in the freshwater fish Labeo rohita. Pesticide Biochemistry and Physiology, 134, 26–31.
3. De Silva, P. M. C. S., Samayawardhena, L. A., & Hettiarachchi, K. S. (1997). Effects of sublethal concentrations of lindane on the biochemical constituents of the freshwater fish Oreochromis mossambicus. Environmental Toxicology and Water Quality, 12(1), 53–59.
4. Fattorini, D., Notti, A., Di Mento, R., Cicero, A. M., Gabellini, M., & Regoli, F. (2013). Levels and chemical speciation of arsenic in biota and sediments of an Indian mangrove wetland. Environmental Science: Processes & Impacts, 15(4), 773–782.
5. Gopal, V., Parveen, F., & Kumar, A. (2012). Biochemical responses of freshwater fish exposed to synthetic pyrethroids. Asian Journal of Experimental Biological Sciences, 3(2), 384–390.
6. Jiraungkoorskul, W., Upatham, E. S., Kruatrachue, M., Sahaphong, S., Vichasri-Grams, S., & Pokethitiyook, P. (2002). Histopathological effects of Roundup, a glyphosate herbicide, on Nile tilapia (Oreochromis niloticus). ScienceAsia, 28, 121–127.
7. Kumar, R., & Shukla, S. (2020). Toxicological impact of pyrethroids on freshwater fish: A review. Journal of Aquatic Toxicology, 5(2), 45–52.
8. Lowry, O. H., Rosebrough, N. J., Farr, A. L., & Randall, R. J. (1951). Protein measurement with the Folin phenol reagent. Journal of Biological Chemistry, 193(1), 265–275.
9. Pandey, R., Mishra, S., & Verma, A. (2021). Sublethal exposure to deltamethrin affects serum protein and liver function in Anabas testudineus. Environmental Toxicology and Pharmacology, 84, 103594.
10. Reddy, K., & Venugopal, N. (2017). Histopathological and biochemical changes in Channa punctatus under pyrethroid stress. Indian Journal of Environmental Health, 59(4), 334–340.
11. Sarkar, S., & Roy, P. (2018). Pesticide-induced biochemical changes in liver and kidney of freshwater fish. International Journal of Fisheries and Aquatic Studies, 6(1), 23–28.
12. Singh, R. K., Singh, S. K., & Sharma, B. (2014). Pesticide-induced oxidative stress and biochemical alterations in freshwater fish. International Journal of Environmental Sciences, 5(2), 256–264.
13. Velisek, J., Stara, A., & Svobodova, Z. (2011). Effects of pyrethroid and triazine pesticides on fish: A review. Veterinarni Medicina, 56(10), 537–546.
14. Vutukuru, S. S. (2005). Acute effects of hexavalent chromium on survival, oxygen consumption, hematological parameters and some biochemical profiles of the Indian major carp, Labeo rohita. International Journal of Environmental Research and Public Health, 2(3), 456–462.
15. Yadav, A., & Singh, R. (2019). Deltamethrin-induced oxidative stress and protein alteration in freshwater fish Clarias batrachus. Biology and Environment, 120(3), 101–107.