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A review on Effect of Cypermethrin on Hematology of Fresh Water Fish *Channa punctatus* (Bloch.)

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Abstract

Freshwater fish serve as an essential source of animal protein for humans. Nevertheless, they face significant threats from aquatic pollutants, particularly pesticides utilized in agricultural practices, which readily enter water systems. The effects of these pesticides can be direct, as they may be absorbed through the fish's skin, gills, intestines, or any injuries. Indirectly, pesticides can compromise water quality, such as by diminishing dissolved oxygen levels. The study of fish encompasses the examination of blood and blood-forming organs, including the kidneys and spleen, in vertebrates. This study entails the evaluation of several parameters, such as red blood cell count, hemoglobin levels, hematocrit, and mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration, white blood cell count, differential leukocyte count, and platelet count. The insecticide cypermethrin negatively impacts the biochemical markers in the blood and the behavior of grass carp (*Ctenopharyngodon idella*). During the experiment, the fish were sourced from a hatchery and kept in a controlled laboratory environment. Various concentrations of cypermethrin were applied, and blood samples were collected to assess the hematological and biochemical parameters. Research on the effects of cypermethrin on the hematology of *Channa punctatus* has employed various concentrations, exposure durations, and methodologies, revealing significant alterations in the hematological parameters of this species. Biochemical factors such as levels of protein, cholesterol, phosphorus, and calcium exhibited declines in both short-term and long-term cypermethrin-treated groups. As the duration of exposure extended from 24 hours to 15 days, the effects became increasingly pronounced, particularly in the groups subjected to short-term exposure.

Keywords*:* freshwater fishes, Cypermethrin, Hematology, *Channa punctatus*, insecticide

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Introduction

When it comes to fish, hemology is a key sign of how well their bodies are working. An examination was conducted on the effects of sub-lethal quantities of the synthetic pyrethroid insecticide deltamethrin (LC_{50} of 0.75 mg/l) on blood parameters of the freshwater fish *Channa punctatus*. For15,30, and 45 days, the fish were given varying amounts of the chemical, ranging from 0.075 mg/l to 0.15 mg/l. Haemoglobin levels, total red blood cell count, packed cell volume, mean corpuscular volume, and mean corpuscular haemoglobin concentration were all significantly lower in the fish exposed to both doses after 45 days compared to the control group. The opposite was true for the 30 and 45 days of exposure at both concentration levels; white blood cell count, mean corpuscular volume, erythrocyte sedimentation rate, and clotting time all increased significantly. Lymphocytes, neutrophils, and eosinophils increased, but monocytes and basophils decreased, according to differential white blood cell counts performed at 30 and 45 days. Deltamethrin also caused a marked decrease in red blood cell size and area in fish. This study emphasises the significance of using pesticides like deltamethrin with caution and moderation due to the negative effects it has on the haematological health of *Channa punctatus*. Lactate dehydrogenase (LDH), glucose, urea, serum glutamic pyruvic transaminase (SGPT), creatinine, and both the short-term and long-term exposure groups showed an increase in these enzyme levels with time. Red blood cell count (RBC), haemoglobin (HGB), haematocrit (HCT), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and red cell distribution width (RDW) were markedly decreased in both groups as exposure durations were prolonged. The platelet and white blood cell levels, on the other hand, rose. A synthetic pyrethroid pesticide, cypermethrin has wide-ranging uses in forestry, agriculture, public health, and even the home. Mosquitoes, flies, cockroaches, and mites are just some of the pests that it effectively combats. Nevertheless, cypermethrin's high toxicity, persistence, and bioaccumulation make it a possible threat to non-target creatures, particularly aquatic life. Because of changes in biochemical and blood parameters, this research confirmed that grass carp are harmful to cypermethrin both in the short and long term. The purpose of this study was to examine the haematological and behavioural changes in the freshwater fish *Channa punctatus*

after short-term exposure to commercial-grade Cypermethrin (10% EC) and to determine its acute toxicity. I measured Cypermethrin's median lethal concentration (LC_{50}) using a static acute toxicity experiment that lasted four days. Throughout the experiment, careful observation and documentation of the behaviours of the fish exposed to Cypermethrin and the control group were made. The haematological effects of Cypermethrin were evaluated at two sublethal concentrations (0.08 mg/L and 0.12 mg/L) after the acute toxicity assessment. The results demonstrated that *C. punctatus* was significantly killed by Cypermethrin, with an LC50 value of 0.263 mg/L after 96 hours. Fish that were exposed to Cypermethrin showed symptoms of being too active, easily irritated, swimming erratically, and frequently coming to the surface of the water. Compared to the control group, a short exposure to sublethal amounts of Cypermethrin resulted in a notable decrease ($P<0.05$) in total erythrocyte count (TEC), packed cell volume (PCV), mean corpuscular volume (MCV), and haemoglobin (Hb) concentration. On the other hand, average corpuscular haemoglobin concentration (MCHC) and total leukocyte count (TLC) were significantly higher in the pesticide-exposed groups ($P<0.05$). These results show that commercially available Cypermethrin is poisonous to C. punctatus and induces alterations in haematology and behaviour that may be signs of early Cypermethrin poisoning. The fisheries industry employs about 14 million people in India, and the country ranks third in the world for fish production. It is also home to more than 10% of the world's fish biodiversity. Research on this topic in the Aligarh area is limited. Both the water and the prevalent fish species, C. punctatus, in an aquaculture facility in Panethi, Aligarh, were found to contain high amounts of heavy metals. Puntius ticto, Heteropneustes fossilis, and *Channa punctatus* are fish species that are often eaten. This study aimed to determine the effects of heavy metals that have accumulated in the Buriganga and Turag rivers on these organs and the health risks that come with them. The aquatic ecology and the plants that depend on them are greatly threatened by heavy metal poisoning. Because of its many health benefits, including lowering the risk of cardiovascular diseases and brain haemorrhages, the demand for seafood has increased dramatically in recent years around the world. An abundance of vitamins, selenium, omega-3 fatty acids, and high-quality proteins can be found in fish and other seafood items. The existence of trace metals, even in minute quantities, is necessary for life because of their importance in a wide variety of biological processes. For example, enzymes, haemoglobin, and myoglobin cannot be synthesised without iron, a crucial mineral. A lack of iron in the body can make you weak, unable to focus, and more likely to get sick. Iron deficiency anaemia is one of the most common nutrient deficits worldwide, according to the World Health Organisation. The prevention of cardiac arrest, heart attacks, and strokes is aided by manganese. However, nickel is poisonous at high quantities and may increase the number of red blood cells while decreasing lung function. Alternatively, cadmium (Cd) and lead (Pb) are poisonous even at trace amounts and serve no apparent biological purpose. Kidney tumours, hypertension in adults, and delayed cognitive development in children and babies are all possible outcomes of lead exposure.

Definition, Importance and Relevance

To evaluate the state of aquatic ecosystems as a whole, research into the ways in which environmental pollutants affect aquatic life is essential. An example of a contamination is the pyrethroid pesticide cypermethrin, which is used extensively to manage pests but is extremely harmful to non-target creatures, such as fish. "A Review on Effect of Cypermethrin on Haematology of Freshwater Fish *Channa punctatus* (Bloch.)" seeks to comprehend the effects of this pesticide on haematological parameters, or blood-related measurements, in the spotted snakehead, or *Channa punctatus*, a form of freshwater fish. Pesticide exposure can have serious consequences for aquatic organisms' and the environment's health, which is why this review delves into the topic's definition, significance, and relevance. One synthetic pyrethroid pesticide that is widely used in agriculture for pest control is cypermethrin. When it gets into water systems by runoff or contamination, it can kill aquatic life and affects insects' neurological systems. The field of study known as haematology involves the analysis of blood and its components, such as white blood cells (WBCs), haemoglobin (Hb), and haematocrit (Hct). When assessing the condition of organisms exposed to harmful substances, variations in these parameters are commonly used.

Haematological Parameters: TEC Measured by Neubauer Haemocytometer (Dacie and Lewis, 1975), TLC Measured by Nebauer Haemocytometer (Dacie and Lewis, 1975), Hb Concentration Measured by Sahil's Method (Wintrobe, 1981), Plt Count, Hct Value, Packed Cell Volume (PCV) according to Sahil's Method (Wintrobe, 1981), Erythrocyte Sedimentation Rate (ESR) according to Wintrobe's Method (1981), Mean Corpuscular Haemoglobin (MCH), and Mean Corpuscular Haemoglobin Concentration (MCHC) according to Wintrobe (1981).

***Channa punctatus*(Bloch.):** A freshwater fish species that is extensively studied for its ecological relevance in Southeast Asia and the surrounding areas, as well as its widespread distribution and relative ease of handling. The state of this species' blood and how it reacts to outside threats are good indicators of its general health. This topic is significant because of its bearing on aquatic toxicology, a subfield of environmental science concerned with the study of how various pollutants affect aquatic life. Despite its efficacy in controlling pests, cyanethrin is extremely harmful to fish and other aquatic creatures. Knowing how these pollutants affect fish health is crucial for biodiversity preservation in light of the fact that agricultural runoff is polluting freshwater habitats at an alarming rate. In order to ascertain the sublethal consequences of pesticide exposure, haemodynamic evaluations offer vital information on the physiological stress that aquatic species endure.

Quick Identifying of Harmful Substances: Alterations in haematological parameters frequently serve as an early indicator of sub-lethal consequences in fish, as opposed to overt symptoms of toxicity such fish mortality. Problems with oxidative stress, immunological suppression, or anaemia due to pollutants like Cypermethrin might be shown by changes in parameters such as red blood cell count, haemoglobin levels, and white blood cell count. Keeping an eye on these changes in blood can assist determine how polluted water bodies are and allow for prompt measures to prevent more extensive ecological damage. Effects on the Environment and the Economy: Both people and other animals rely on fish as a food source, making them an essential part of freshwater ecosystems. The delicate

ecological balance is jeopardised when fish health declines as a result of exposure to harmful pollutants. Local economies rely heavily on species like *Channa punctatus*, which are commonly cultivated for their fins. To guarantee sustainable operations in aquaculture and agriculture, it is crucial to understand the effects of pesticides like Cypermethrin on their health. Pesticides like cypermethrin can make their way into the food chain and end up in people's bodies through infected fish. The hazards to human health from eating polluted fish can be better assessed by looking at the toxicological impacts of pesticides on aquatic organisms. Knowledge of Cypermethrin's effects on fish haematology may shed light on possible dangers to humans, particularly in areas where fish is an important part of the diet.

Developing Policies and Regulations: The effects of Cypermethrin on the haematology of fish such as *Channa punctatus* can teach regulatory bodies and lawmakers about the pesticide's safe use and any possible dangers it poses to the environment. Protecting freshwater ecosystems, biodiversity, and human health against pesticide poisoning requires the establishment of safe concentration limits in aquatic habitats. The extensive contamination of aquatic ecosystems is a direct outcome of the rising usage of pesticides in farming. The environmentally persistent pesticide cypermethrin finds its way into water bodies, where it can kill fish and other aquatic organisms. It is crucial to understand how this chemical affects aquatic creatures, particularly fish, in the ecosystem because of its extensive use and toxicity potential. To further comprehend its wider ecological effects, it is necessary to conduct a thorough analysis of its effects on the haematology of *Channa punctatus*.

Taxonomic Classification: Research on pollution often makes use of the bioindicator species *Channa punctatus*. Its status as a freshwater fish makes it a useful indicator of potential contamination levels in the environment. Its haematological responses to pollutants like Cypermethrin can provide insight into the state of freshwater ecosystems as a whole. For ecotoxicological research, this species is important because it sheds light on how various pollutants, such as agricultural runoff and industrial discharge, affect freshwater ecosystems. Studies on toxicology have shown that cypermethrin has both immediate and delayed fatal effects on fish, with the latter having an impact on the former's immune system, reproductive health, and chances of survival. This review will be of great interest to ecotoxicologists since these effects can be measured with haematological markers. In addition, the physiological mechanisms of pesticide toxicity can be better understood through this type of research, which in turn can guide regulatory procedures and future investigations. Long-Term Viability in the Food and Fishing Industries: A rising global concern is the need for sustainable farming practices that minimise the usage of pesticides. Misuse of pesticides like cypermethrin can have unintended consequences, affecting both the intended and unintended targets, such as fish. In nations where agricultural and fishing activities rely on freshwater supplies, it is especially important to comprehend the effects of Cypermethrin on *Channa punctatus*. Findings from this study can help push for more environmentally friendly herbicides and more sustainable farming methods that are gentler on aquatic ecosystems.

Worldwide Water Purity: Contamination of freshwater bodies is a global problem caused by human activities. Among the various chemicals that cause water contamination, pesticides like cypermethrin are among the most significant. It is critical to comprehend the ecotoxicological impacts of these compounds on aquatic life since freshwater is essential for human consumption, agricultural use, and biodiversity. Water quality management strategies that take a holistic view are necessary, since this issue is important not only for *Channa punctatus* but for all species and ecosystems on Earth.

Literature Review

To monitor the effect of harmful compounds on fish metabolism, biochemical investigations are helpful indicators, according to Kajare *et al.*,(2000). Team Citarasu, *et al* .Due to the presence of dynamic standard segments such as alkaloids, flavonoids, pigments, phenolics, terpenoids, steroids, and basic oils, the use of regular plant items has been reported in finfish and prawn larvae farming as anti-stress, for development advancement, appetite stimulation, tonic and immune stimulation, and to possess antimicrobial effects (2001). In a *et al.*,2002 study, Joshi As a result of heavy metal poisoning, anaemia might develop, which is a very delicate pathological condition. An increase in the number of white blood cells (WBCs) may be associated with a surge in antibody production, which helps stressed fish survive and recover, according to research by Joshi *et al.*,(2002). Deterioration of haematopoietic organs causes a decrease in red blood cell (RBC) count by suppression of erythropoiesis and an increased rate of RBC observation. The haemoglobin content can be used to estimate the function of red blood cells and the likelihood of anaemia (Hari Krishnan R *et al.*, 2003). In contrast to the red blood cell count, the data showed that haemoglobin content was rising. According to Rahman and Siddiqui (2003), GOT and GPT activities are drastically reduced in many species when they are intoxicated with pesticides and heavy metals like cadmium, lead, and mercury. This is because these substances cause serious damage to the structures of the cells. Red blood cells (RBCs) and other haematological components may be particularly vulnerable to environmental contaminants, according to research by Adhikari *et al.*,(2004). As a result, they are commonly used to assess the physiological condition of fish. There is a threat to both human and environmental health from Damien *et al.*,(2004). Pesticides are a major problem for many land and water-dwelling animals, according to Leiss *et al.*,(2005). Pesticides can compromise fish immune systems, according to Maskaoui *et al.*,(2005). Pyrethroids have a considerable stress-inducing capability, which Sarkar *et al.*, (2005) investigated. In 2005, Choudhury *et al.*,noted Using water samples taken at specific locations near Pratapgarh, this haematological investigation found that white blood cell (WBC) counts rose dramatically in the treatment groups (Agrahari *et al* ., 2006). Blood parameter evaluations may help monitor pesticide-induced stress and provide valuable information on how fish's body responds to different environments. In 2006, Shinde and Chaudhary tested the groundwater and P.H.E. tap water in Jhabua (M.P.) to determine their potability as drinking water sources. According to research by Winkaler *et al.*,(2007), stressed fish have a higher reactivity to gluconeogenesis, which is essential for meeting their increased energy demands. In their study, Dudhnath *et al.*, (2007) found that biomaterials could effectively remove alizarins red sulphur (Dye) from dye waste water.Wastewater collected in Bihar's industrial zone was subjected to a physicochemical analysis by Thakur *et*

al.,(2007).It was described by Dural *et al*.,(2007) Compared to other tissues like muscle, active metabolic organs like the gills, liver, and kidneys have a tendency to accumulate larger quantities of heavy metals. In 2007, Thakur *et al.*, conducted a physicochemical analysis of effluent water retrieved from Bihar's industrial zone. In the context of power plant chemistry, Grey *et al.*, (2008) emphasised the significance of detecting dissolved oxygen and Oxidation-Reduction Potential (ORP). According to Banaee *et al.*, (2008), pesticides can be dangerous to fish and other aquatic creatures due to the fact that they are present in various water bodies at varied amounts. The role of dissolved oxygen and organic reactive potential (ORP) in the functioning of power plants was further investigated by Grey (2008). Liver and muscle cholesterol levels were shown to be lower (Remia *et al* ., 2008). Lower cholesterol due to reduced absorption of dietary cholesterol and inhibition of cholesterol production in the liver. Exposure to monocrotophos also reduced the lipid content of Tilapia mossambica. The study conducted by Marigoudar *et al*.,(2009) documented that Labeo rohita exhibited a variety of behavioural changes after being exposed to Cypermethrin, including swimming in an unpredictable and irregular manner, losing equilibrium, becoming too excited, and sinking. According to Babalola *et al*.,(2009), there has been a significant rise in solid and liquid waste due to India's fast industrialisation. This waste is often dumped into nearby natural water bodies, which causes a host of environmental problems and puts animals and plants at risk. Researchers Rathod *et al.*, 2009 reported in the effects of pollution are reflected in early signs of stress in the body, which are biochemical alterations. Methyl parathion was determined to cause 50% mortality, 80% mortality, and 100% death in Catla catla, respectively, even at low doses of 4.8 ppm, 8 ppm, and 10 ppm, according to Ilavazahan *et al*.,(2010). Cyprinus carpio, a freshwater fish, was studied for its effects on blood parameters and recovery in a study by Kumar *et al*.,(2010). It was noted by Franklin *et al*.,(2010) Pesticides aren't very selective, thus they can harm non-target creatures like fish as well as a variety of macrophytes. The authors Saravanan *et al*.,(2011) Potential biomarkers for sublethal toxic chemical evaluations include haematological and biochemical characteristics of aquatic species. Sediment analysis of heavy metals (Fe, Zn, Ni, Mn, Pb, Cu, Co, Cd, and Cr) was conducted at twenty-five sampling sites along the Cauvery River by Raju *et al*.,(2012) on a seasonal and spatial basis. Far *et al.*, (2012) one sign of compromised immunity in fish exposed to pesticide poisoning is a drop in the number of white blood cells, or leucocytes. Researchers Murthy *et al*. (2013) According to Ullah *et al*.,(2014), these channels include a wide range of substrates, including organic ones like mosses, algae, leaf litter, vascular hydrophytes, and branches, and inorganic ones like silt elements of varying sizes. The discharge or release of potentially harmful chemicals or substances into aquatic habitats includes pesticides, hydrocarbons, heavy metals, and other similar compounds. A substantial amount of pollution was found in the Ganga River's waters when Pandey *et al*. (2014) investigated the correlations among numerous interrelated water quality metrics. At Allahabad's Phaphamau site, researchers looked into the Ganga River's heavy metal accumulation sequence and found that, from most to lowest, the order was Fe > Zn > Cr > Co. It was reported by Vaiyanan *et al*.,(2015). Salam *et al*.,(2010) observed that in Barbonymus gonionotus exposed to quinolphos throughout the last decade, there have been cases of organophosphate-induced anaemia, defined by a significant decrease in haemoglobin levels. In 2015 Fish exposed to varying quantities of cypermethrin had significantly lower haemoglobin levels in their blood, according to the present study. Gangetic mystus may have impaired haematopoietic function under stress, which would explain the low haemoglobin levels. Common carp exposed to sumithion also showed a similar drop in haemoglobin. Heteropnuestes fossilis exposed to chlorpyrifos had an increase in neutrophils, basophils, and eosinophils and a decrease in lymphocytes and monocytes, according to Tiwari *et al*.,(2017). The River Ghaghara flows through the Indian states of Bihar and Uttar Pradesh. In 2017, Singh *et al.*, investigated heavy metal pollution of river sediments by a systematic investigation. According to Rao *et al*.,(2018), many fish species that were exposed to pyrethroid insecticides, such as permethrin, cypermethrin, and deltamethrin, showed a similar decrease in haemoglobin levels. According to Jasmin *et al*.,(2018), when fish experience metabolic stress, their blood oxygen-carrying capacity is enhanced by a compensatory mechanism that involves heightened haemoglobin levels and increased packed cell volume (PCV). There is evidence that pesticide stress causes fish to have a lower total leukocyte count (TLC). Fish are a great source of nutrients, including macro and micronutrients, as pointed out by Balami *et al*.,(2019). Proteins, fats, and small amounts of carbs are macronutrients, whereas vitamins and minerals are micronutrients. Pyrethrins, which come from Chrysanthemum cinerariifolium, are used to make pyrethroids, as pointed out by Ullah *et al* ., (2019). In their 2019 study, Agata *et al*.,evaluated the efficacy of different biological reactors in treating effluent from fish processing. Fish is a great source of healthy fats, proteins, vitamins, and minerals like magnesium and phosphorus, according to research by Ali *et al*.,(2020). Heavy metals were found in the effluent and sludge of specific South African municipal treatment facilities, according to Agoro *et al*.,(2020). According to Kalyabina *et al*.,(2021), pesticides are used extensively in modern farming, which causes nonpoint source contamination in agriculture and eventually makes their way into water sources. Surface runoff, soil erosion, and other natural processes endanger our drinking water supplies while also harming many non-target creatures, such as phytoplankton, zooplankton, and higher trophic level fish and their predators. In their study, Abdel-Latif *et al*. (2021) found that copper oxide nanoparticles have the ability to impact serum biochemical parameters, cause changes in histopathology, and influence the transcription of genes related to oxidative stress, cytokines, and hsp70 in Oreochromis niloticus. In a similar vein, Banaei *et al*. (2022) found that polyethylene microplastics caused oxidative stress, transcriptional alterations, and physiological reactions in common carp (*Cyprinus carpio*).

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