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IMPACT OF HAEMOTOXICPESTICIDES IN IMMUNOMODULATION OF CHANNA PUNCTATUS

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ABSTRACT

The genus *Channa*, commonly known as the snakehead fish, is a significant freshwater species in many parts of Asia and Africa, both ecologically and economically.However, the increasing use of pesticides in agriculture has raised concerns regarding their impact on aquatic organisms, particularly in fish.Haemotoxic pesticides, which affect the Blood and circulatory systems, pose a unique threat to fish health and immune function.This literature review aims to summarize existing research on the effects of toxic pesticides on the immunomodulation of *Channa*. Haemotoxic pesticides are chemicals that can disrupt normal Blood function, leading to anemia, impaired immune responses, and increased susceptibility to diseases.Common examples are organophosphates, carbamates, and pyrethroids. These substances can enter aquatic ecosystems through runoff, affecting fish populations and the immune system.

KEYWORDS: *Clarias batrachus*, Fish, Haemotoxic, Immunity, Nutrition, Pesticides, Population.

INTRODUCTION

Importance of the project and justification for study

The use of pesticides in agriculture has become a double-edged sword, providing significant benefits to crop yield while posing serious risks to non-target organisms, particularly aquatic species.*Channa punctatus*, commonly known as the spotted snakehead, is a prevalent freshwater fish in South Asia and is often used as a model organism for ecotoxicological studies.The increasing use of toxic pesticides—chemicals that adversely affect blood and immune functions—has raised concerns about their impact on aquatic ecosystems.

Pesticides are widely used to enhance agricultural productivity; however, their adverse effects on non-target organisms, especially aquatic organisms, are a growing concern.Haemotoxic pesticides, which affect the blood and immune systems of organisms, can lead to significant ecological imbalances.*Channa punctatus*is an ideal model organism for studying the impact of these chemicals because of its ecological significance and sensitivity to environmental changes.

Haemotoxic pesticides, including organophosphates and carbamates, can disrupt normal physiological processes in fish, leading to hematological and immunological alterations. These pesticides can induce oxidative stress, which is characterized by an imbalance between Reactive Oxygen Species (ROS) production and antioxidant defences, resulting in cellular damage and impaired immune responses (Gupta and Kumar, 2018; Jha and Singh, 2020).The immune system of fish plays a crucial role in maintaining health and resilience against pathogens; thus, any compromise in immune function can lead to an increased susceptibility to diseases and mortality (Bhatnagar and Kumar, 2018).

Research has shown that exposure to pesticides can lead to significant changes in hematological parameters, such as reduced Red Blood Cell counts and hemoglobin levels, indicating potential anemia (Kaur and Singh, 2019; Das and Mukherjee, 2020). Furthermore, immunological assessments have revealed that pesticide exposure can impair lymphocyte proliferation and macrophage activity, which are essential components of the immune response in fish (Dutta & Choudhury, 2019; Manna and Mukherjee, 2021).Given the ecological importance of *Channa punctatus* and the potential consequences of pesticide exposure, this study aimed to investigate the impact of toxic pesticides on the immunomodulation of this species, focusing on hematological changes, immune responses, and oxidative stress levels.

Haemotoxic pesticides are designed to disrupt the normal functioning of the blood system in target organisms, often leading to coagulopathy, anemia, and other hematological disorders.Common examples include organophosphates and carbamates that inhibit cholinesterase activity and can lead to neurotoxic effects.Studies have shown that pesticides can induce oxidative stress, leading to cellular damage and inflammation in various aquatic organisms (Kumar et al. 2020; Singh et al. 2021).

The immune systems of fish, including *Channa*, are complex and involve both innate and adaptive responses. The key components include leukocytes, antibodies, and various cytokines.Immunomodulation refers to the alteration of immune responses, which can either upregulate or downregulate immune functions.Environmental stressors, including chemical pollutants such as pesticides, can significantly impact these immune responses (Baker et al., 2019).

Research indicates that exposure to toxic pesticides can lead to significant immunological changes in *Channa*.For instance, studies have demonstrated that exposure to sublethal concentrations of organophosphates results in a decrease in total leukocyte counts and alterations in the differential leukocyte profile (Rani et al., 2022).This suggests a compromised immune response, which makes fish more susceptible to infections and diseases. Moreover, oxidative stress induced by these pesticides has been linked to increased levels of reactive oxygen species (ROS), which can damage immune cells and impair their functions (Patel et al., 2023).Modulation of cytokine production has also been observed, with some studies reporting an increase in pro-inflammatory cytokines, which may lead to chronic inflammation and further immunosuppression (Verma et al., 2021).

The immunomodulatory effects of hemotoxic pesticides on *Channa* not only have implications for the health of fish, but also for the broader aquatic ecosystem.As *Channa* plays a crucial role in the food web, any decline in its population owing to compromised immunity can have cascading effects on biodiversity and ecosystem stability (Zhang et al., 2022).Furthermore, consumption of contaminated fish poses health risks to humans, particularly in regions where *Channa* is a dietary staple (Nguyen et al., 2023).

Objectives: -

The primary objective of this study was to investigate the impact of haemotoxic pesticides on the immunomodulation of *Channa punctatus*.Specifically, this study aims to:

1. The hematological changes in *Channa punctatus* exposed to various concentrations of haemotoxic pesticides were assessed. -RBC, WBC, MCV, MCH, MCHC,DLC, PLT, Hb

2. Immunological responses, including the activity of immune cells and production of immune-related biomarkers, in fish subjected to pesticide exposure. – Phagocytic, Lymphocyte , Cytokine,Immunoglobin,Lysozyme, C-Reactive Protein.
3. Determine the oxidative stress levels induced by haemotoxic pesticides and their correlation with immunological alterations in *Channa punctatus*. - SOD, CAT, GPx, TBARS, MDA.
4. **Approach to the problem explaining the methodology and technique to be followed**
   The study involved exposing *Channa punctatus* to sub-lethal concentrations of selected hemotoxic pesticides over a defined period. The following parameters were assessed.
5. **Hematological Analysis**
   Hematological analysis is a critical component of clinical diagnostics, providing insights into the overall health of an individual through the evaluation of blood components. Blood samples are collected to assess various parameters, including Red Blood Cell (RBC) count, hemoglobin levels, and hematocrit levels.

Total Leukocyte Count (TLC): This measures the total number of white blood cells (WBCs) in a given volume of blood. An elevated TLC can indicate infection, inflammation, or other medical conditions, while a low count may suggest bone marrow disorders or autoimmune diseases (Bennett et al., 2010).

Differential Leukocyte Count (DLC): This test categorizes the different types of white blood cells, including neutrophils, lymphocytes, monocytes, eosinophils, and basophils. Each type plays a unique role in the immune response, and their proportions can provide valuable diagnostic information (Bennett et al., 2010).

Hemoglobin (%Hb): Hemoglobin is the protein in red blood cells responsible for oxygen transport. Measuring hemoglobin levels helps diagnose anemia and other blood disorders. Normal ranges vary by age and sex, but low levels typically indicate anemia (Camaschella, 2015).

Lymphocyte Count (%LC): This percentage reflects the proportion of lymphocytes among the total white blood cells. Changes in lymphocyte counts can indicate various conditions, including infections, stress responses, and hematological malignancies (Bennett et al., 2010).

Hematocrit: This test measures the proportion of blood volume that is occupied by red blood cells. It is expressed as a percentage and is crucial for diagnosing conditions like anemia and polycythemia (Camaschella, 2015).

Immunological Assays

Immunological assays are essential for evaluating the immune system's functionality. Techniques such as flow cytometry and enzyme-linked immunosorbent assay (ELISA) are commonly employed to assess immune cell activity.

Cell-Mediated Immunity: This aspect of the immune response involves T cells and is crucial for combating intracellular pathogens. Flow cytometry can be used to analyze T cell populations and their activation states, providing insights into the cellular immune response (Mellor and Munn, 2008).

Humoral Immunity: This involves B cells and the production of antibodies. ELISA is frequently used to quantify specific antibodies in serum, helping to assess the humoral immune response to infections or vaccinations (Khan et al., 2019).

6. Biochemical Analysis

Biochemical analysis focuses on the assessment of oxidative stress markers, which are indicative of cellular damage and overall oxidative status in the body.

Malondialdehyde (MDA): MDA is a byproduct of lipid peroxidation and serves as a marker for oxidative stress. Elevated levels of MDA are associated with various diseases, including cardiovascular diseases and cancer (Yagi, 1997).

Glutathione Peroxidase (GPx): This enzyme plays a crucial role in protecting cells from oxidative damage by catalyzing the reduction of hydrogen peroxide. Measuring GPx activity can provide insights into the antioxidant defense mechanisms of the body (Huang et al., 2018).

Superoxide Dismutase (SOD): SOD is an important antioxidant enzyme that catalyzes the dismutation of superoxide radicals into oxygen and hydrogen peroxide. Its activity is often measured to assess the oxidative stress status in various pathological conditions (Fridovich, 1995).

Catalase (CAT): Catalase is another key enzyme that decomposes hydrogen peroxide into water and oxygen, thus protecting cells from oxidative damage. Its activity can be indicative of the body's ability to manage oxidative stress (Aebi, 1984).

Thiobarbituric Acid Reactive Substances (TBARS): TBARS are used as a measure of lipid peroxidation and oxidative stress. Elevated TBARS levels are often associated with various diseases, including neurodegenerative disorders and metabolic syndrome (Ohkawa et al., 1979).

7. Statistical Analysis

Data were analyzed using appropriate statistical methods to determine the significance of observed changes.

Significance

The present study is having several significances which are summarised as follows

- **Minimal or non-existent water exchange**

Minimal or non-existent water exchange refers to a situation where there is very little or no movement of water in and out of a particular system or environment. This can lead to stagnant or isolated conditions, potentially impacting the ecosystem and its inhabitants.

- **Greater productivity (It improves fish culture systems' feed conversion, growth performance, and survival rate).**

Increasing productivity in fish culture systems leads to improved feed conversion, enhanced growth performance, and higher survival rates of the fish.

- **Increased biosecurity**

Increased biosecurity refers to the implementation of heightened measures and protocols to prevent and control the spread of infectious diseases and biological threats.

- **Decreases disease introduction and dissemination risk and water pollution**

Implementing proper waste management and sanitation practices decreases disease introduction and dissemination risk while also reducing water pollution.

- **Affordable feed production.**

To achieve affordable feed production, focus on optimizing ingredient sourcing, minimizing waste, and implementing efficient production processes.

❖ **It lowers the expense of conventional feed and the utilisation of protein-rich feed.**

It reduces the cost of traditional feed and minimizes the need for protein-rich feed, leading to more cost-effective livestock or poultry farming.

❖ **It reduces the burden on capture fisheries, i.e., the use of less expensive food fish and trash fish in the preparation of fish feed**.

Using less expensive food fish and trash fish in the preparation of fish feed helps reduce the burden on capture fisheries.

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