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IMPACT OF A NEUROTOXIC PESTICIDE (β-HEXACHLOROCYCLOHEXANE) IN IMMUNOMODULATION OF CLARIAS BATRACHUS (LINN).

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ABSTRACT

The genus *Clarias*, commonly known as the mangur 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. Neurooxic 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 *Clarias.* Neurotoxic 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 Asian catfish, or *Clarias batrachus*, is a significant freshwater species both economically and environmentally. For aquatic species to be disease-resistant and healthy generally, their immune systems must remain intact. The identification of a neotype clarifies the identity of *Clarias batrachus*, a species formerly believed to be broadly spread throughout South and South-East Asia. *Clarias batrachus* (Linn.), a freshwater edible catfish, was subjected to sub lethal levels of two distinct pesticide groups: organophosphorus and phorate pesticide, and carbaryl, a carbamate. A major issue with water pollution is the acute poisoning caused by pesticides in runoff water from agricultural areas, which can lead to fish and other aquatic life poisoning and long-term environmental impacts. (Jyothi and Narayan, 1999).

Examining the immune-modulatory effects of neurotoxic pesticides on *Clarias batrachus* (commonly known as the catfish) requires an understanding of several interconnected concepts, including the mechanisms of toxicity, the impact on immune function, and the broader ecological consequences. Pesticide contamination, bioaccumulation, persistence, and the unique characteristics of neurotoxic pesticides such as carbamates and organophosphates. Acetylcholinesterase is an enzyme that neurotoxic pesticides, especially carbamates and organophosphates, target by blocking its activity. (Ranjan et al., 2024).

Fish exposed to pesticides had lower survival rates when they contracted infections. Exposure to sub-lethal pesticides contributes to long-term immuno suppression. The immune cells are damaged by oxidative stress. Changes in the creation of antibodies, phagocytic activity, and cytokines. Studies conducted in labs and the field documenting how neurotoxic chemicals affect *Clarias batrachus* decrease in phagocytic activity and leukocyte count. Histopathological alterations in the spleen, and thymus, which are lymphoid organs. (Slaninova et al., 2009).

Fish immune suppression indicators include: biochemical indicators, such as superoxide dismutase and glutathione peroxidase. Molecular indicators, such as the degree of expression of genes linked to immunity, such as interleukins and interferons. Implications for fisheries and aquaculture that depends on *C. batrachus*. Possible ripple effects on food webs in water. (Singh,et al., 2014).

The production of reactive oxygen species (ROS) by natural or artificial waterborne pollutants, such pesticides, can result in oxidative stress, highlighting the part ROS play in pesticidetoxicity. When ROS, including superoxide anion radical, H_2O_2, and highly reactive OH^{-}, interact with macromolecules, they can cause oxidative stress by causing lipid peroxidation (LPO), DNA damage, and proteinoxidation. Enzymes including superoxide dismutase (SOD), Glutathione Peroxidase (GPx), Catalase (CAT), glutathione S-transferase (GST), and low molecular weight scavengers like glutathione (GSH) are part o of the antioxidant defense system and work to combat the toxicity of reactive oxygen species (Reddy, 2016).

Objectives

The primary objective of this study was to investigate the impact of neurootoxic pesticides on the immunomodulation of *C. batrachus*. Specifically, this study aims to:

1. To study the Immune Response Suppression Organophosphates and carbamates are examples of neurotoxic pesticides that can inhibit both innate and adaptive immune responses.
2. To study the Stress from Oxidation The body of *Clarias batrachus* produces Reactive Oxygen Species (ROS) as a result of exposure to neurotoxic chemicals. Increased oxidative stress causes damage to lipids, proteins, and DNA in cells, which impairs immune cells like lymphocytes and macrophages.
3. To study the Modified Production of Cytokine signalling, which is essential for immune modulation, is impacted by Pesticides.

Approach to the Problem Explaining the Methodology and techniques to be followed

1. Approach to the problem explaining the methodology and technique to be followed: -

The study involved exposing *Clarias batrachus* to sub-lethal concentrations of selected hemotoxic pesticides over a defined period. The following parameters were assessed.

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).

1. 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).

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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