Bio Vet Innovator Magazine

Volume 2 (Issue 1) JANUARY 2025

OPEN ACCESS

Popular Article

Enhancing Fish Health In Aquaculture: The Role And Benefits of Immunostimulants

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DOI: https://doi.org/10.5281/zenodo.14835160

Received: January 07, 2025

Published: January 11, 2025

Abstract:

Environmental stressors and infectious diseases made worse by intensive farming pose a threat to aquaculture, a vital component of the world's food production plan. Antibiotics and vaccinations are examples of conventional procedures that are constrained by environmental residues, drug resistance, and specificity. By boosting fish's innate and adaptive immune responses, immunostimulants provide a sustainable substitute. These substances, which include ß-glucans, chitin, lactoferrin, and vitamins, increase the generation of antibodies, strengthen disease resistance, and stimulate immune cells like neutrophils and macrophages. Aquaculture operations are made more flexible by the fact that immunostimulants can be given by feed, injection, or immersion. Immunostimulants work especially well in high-density farming settings because they strengthen broad-spectrum defences, as opposed to vaccinations, which offer pathogen-specific protection. They also lessen antibiotic dependence, increase the effectiveness of vaccines, and lessen their negative effects on the environment. Despite its benefits, there are issues that need for standardized procedures and more study, such as the variation in efficacy among species and administration techniques and the paucity of long-term studies. In aquaculture health management, immunostimulants have become an essential tool due to their ability to improve fish welfare, decrease disease outbreaks, and encourage environmentally favorable practices. Their incorporation into disease management plans guarantees increased industry productivity and sustainability, tackling important issues of ecological balance and profitability.

Keywords:

Immunostimulants; Fish health management; Aquaculture sustainability; Innate immunity; Disease prevention

Introduction:

Aquaculture, the cultivation of aquatic organisms such as fish and shellfish, has grown exponentially in recent decades, establishing itself as a crucial sector in global food production. This growth, however, has brought challenges, particularly in the form of infectious diseases that thrive in intensive farming environments. These

diseases, exacerbated by overcrowding and environmental stressors, pose significant threats to the aquaculture industry, often leading to substantial financial losses. Traditional methods for controlling these diseases, such as antibiotics and vaccines, have limitations, including residual effects in fish and the environment, and the emergence of drug-resistant pathogens. In response, the use of immunostimulants has emerged as a promising alternative. Immunostimulants are natural or synthetic compounds that enhance the immune response in fish, offering a safer and more effective method for disease prevention and control in aquaculture (Mehana et al., 2015).

Immunostimulants in Aquaculture:

Immune System and Disease Control in Fish:

Immunization plays a key role in preventing diseases in fish. Fish rely on both general and specific immune defenses. Their skin and mucus serve as the first line of defense against infections. If pathogens get inside, the fish's immune system activates different types of cells and proteins to fight off the invaders. Teleost fish have immune cells like macrophages, neutrophils, and lymphocytes, along with protective proteins like complement and lysozyme. The innate immune system, which includes these cells and proteins, is the fish's main defense and also helps guide the body's longer-term immune responses (Mehana et al., 2015). In fish farming, diseases, especially bacterial infections, are a major problem and can cause significant losses. These infections are often caused by specific types of bacteria that can lead to severe illness and death in both wild and farmed fish. To combat these issues, fish farms use antibiotics, chemicals, and immune-boosting substances. However, despite these measures, disease outbreaks still pose a serious economic risk to the aquaculture industry.

The Role of Fish Immunostimulants in Fish Health:

Immunostimulants play a vital role in enhancing the innate and adaptive immune systems of fish, helping to protect them against a wide range of pathogens. The innate immune system, the first line of defense in fish, includes physical barriers like skin and mucus, as well as cellular responses involving phagocytic cells such as macrophages and neutrophils.

Table 1. Types of immunostimulants in aquaculture

Source	Types
Synthetic chemicals	Levamisole, FK-565, 3-MDP (Muramyldipeptide).
Bacterial derivatives	ß-glucan, Peptidoglucan, FCA, EF203, LPS (Lipopolysaccharides), *Clostridium butyricum*, *Chromobacter sterohalis*, *Vibrio anguillarum* cells
Polysaccharides	Chitin, chitosan, Lentinan, Oligosaccharide
Animal Plant extracts	Ete (Tunicate). Hde (Abalone). Firefly squid, Quillajasaponin (Scaptree), Glycyrrhizin (licorice)
Nutritional factors	Vitamin C and Vitamin E
Hormones, Cytokines and others	Lactoferrin, Interferon, Prolactin

Immunostimulants enhance these non-specific defenses, increasing the activity of natural killer cells, complement systems, and lysozyme activity. Additionally, they boost the production of antibodies, further strengthening the fish's ability to combat infectious agents (Mehana et al., 2015). The use of immunostimulants in aquaculture has gained momentum due to their ability to improve fish welfare, enhance disease resistance, and reduce the reliance

on antibiotics (Table 1). Various types of immunostimulants, including ß-glucans, chitin, lactoferrin, and vitamins, have been shown to effectively modulate the immune response in fish. These compounds can be administered orally, through feed, or via injection, depending on the specific needs of the aquaculture operation (Kumar et al., 2023). Moreover, the application of immunostimulants is not limited to disease prevention; they are also used to improve the efficacy of vaccines, providing a more robust immune response in vaccinated fish.

Advantages And Challenges of Immunostimulants in Aquaculture:

The advantages of using immunostimulants in aquaculture are manifold. They offer a non-specific boost to the immune system, which is particularly useful in preventing outbreaks of diseases in high-density farming environments (Fig. 1).

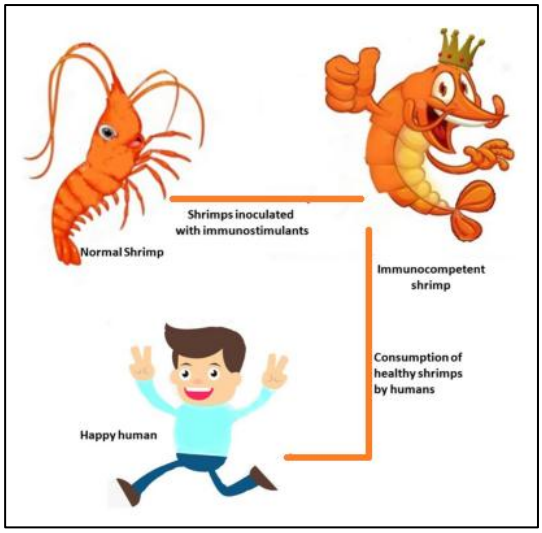

Figure 1. Effect of immunostimulants om shrimp culture and its environment (Source: Kumar et al., 2023)

Immunostimulants are also environmentally friendly, as they do not leave harmful residues in the water or the fish, unlike antibiotics and other chemicals. This makes them a safer option for both the aquaculture industry and the end consumer. Furthermore, immunostimulants can be used in combination with vaccines to enhance their efficacy, making them a versatile tool in disease management. However, there are challenges associated with the use of immunostimulants. The effectiveness of these compounds can vary depending on the species of fish, the type of immunostimulant used, and the method of administration. Long-term studies on the effects of immunostimulants are still limited, and more research is needed to fully understand their potential impacts on fish health and aquaculture productivity (Faruk et al., 2021). Additionally, while immunostimulants are generally safe, there is a need for standardized guidelines on their use to ensure consistent and effective results across different aquaculture systems.

Vaccines versus Immunostimulants:

Vaccines provide targeted, long-term protection by creating immune memory against specific pathogens. They require exposure to an antigen and typically protect against one or two specific diseases. In contrast, immunostimulants boost the immune system more broadly, enhancing general defenses like complement activation and phagocytosis, without targeting a specific pathogen. Examples include zymosan and glucans. While vaccines offer specific protection, immunostimulants strengthen the immune response against a wide range of infections (Farooqi and Qureshi, 2018).

Conclusion:

The aquaculture industry faces significant challenges in managing diseases that threaten fish health and productivity. Traditional methods of disease control, such as antibiotics and vaccines, have limitations that necessitate alternative approaches. Immunostimulants offer a promising solution, providing a natural and effective means of enhancing the immune response in fish. By improving disease resistance and reducing the need for antibiotics, immunostimulants contribute to more sustainable and profitable aquaculture practices. As research in this field continues to evolve, the use of immunostimulants is likely to become an integral part of fish health management, supporting the growth and sustainability of the global aquaculture industry.

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Citation: Avishek Bardhan, Binayak Maiti, Sourashish Sengupta, Soumili Halder. (2025). Enhancing Fish Health In Aquaculture: The Role And Benefits of Immunostimulants. In Bio vet innovator magazine (Vol. 2, Issue 1, pp. 1–4). Bio vet innovator magazine. https://doi.org/10.5281/zenodo.14835160