



Immunostimulants: Nature's Secret Weapon for Healthier Fish and Shrimp

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Abstract

Aquaculture has emerged as one of the fastest-growing food production industries in the world, and it has made a substantial contribution to food security and economic development. However, infectious diseases caused by bacteria, viruses, fungi, and parasites are still major constraints in fish and shrimp farming. Conventional methods using antibiotics and chemotherapeutic agents have been widely practiced to control the spread of diseases. However, the overuse of antibiotics has led to antibiotic resistance, contamination of the environment, and the accumulation of residues in aquatic products, which is hazardous to human health and the sustainability of the ecosystem. Immunostimulants have been recognized as a promising and eco-friendly alternative to antibiotics in aquaculture. Immunostimulants are natural or synthetic substances that can stimulate the innate immune system of aquatic animals, thereby increasing their resistance to infectious diseases. They work by activating immune cells, increasing phagocytosis, and triggering the immune defense system. The application of immunostimulants has been found to increase survival rates, growth, and disease resistance in fish and shrimp.

Keywords: Aquaculture, Immunostimulant, antibiotic, disease, phagocytosis

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Introduction

Aquaculture has grown at a tremendous rate over the past several decades and has become a significant source of animal protein globally. The intensification of aquaculture practices, such as high stocking density and production pressure, has increased the vulnerability of fish and shrimp to infectious diseases. Outbreaks of infectious diseases in aquaculture, such as bacterial infections caused by *Aeromonas*, *Vibrio*, and *Streptococcus*, viral infections such as white spot syndrome virus (WSSV), and parasitic infections, have resulted in substantial economic losses in aquaculture systems (Maqsood *et al.*, 2011).

Conventional methods of disease control in aquaculture include the use of antibiotics and chemotherapeutic agents. However, the misuse and overuse of antibiotics have resulted in the development of antibiotic-resistant pathogens, the accumulation of drug residues in aquatic animals, and environmental pollution (Farooqi and

Qureshi, 2018). These issues have raised serious concerns about food safety and environmental sustainability.

To overcome these issues, alternative methods of disease control have been developed. These methods include vaccination, probiotics, and immunostimulants. Among these, immunostimulants have attracted considerable attention due to their potential to stimulate the natural immune system of aquatic animals and increase disease resistance without any adverse effects (Mehana *et al.*, 2015).

Concept and Definition of Immunostimulants

Immunostimulants refer to natural or synthetic substances that improve the immune system of aquatic animals, thus increasing their capacity to resist diseases. The substances work by stimulating the immune cells of the aquatic animals, including macrophages, lymphocytes, and phagocytes, thus improving the immune

response (Raa, 2000).

Immunostimulants work differently from antibiotics, which directly attack the disease-causing pathogens. Immunostimulants, on the other hand, improve the immune system of the host, thus increasing its capacity to resist diseases. Immunostimulants mainly act on the innate immune system of the aquatic animals, which is the first line of defense against pathogens. This is achieved through increased phagocytic activity, increased production of antimicrobial proteins such as lysozyme, and activation of immune cells (Mehana *et al.*, 2015).

Immunostimulants are very essential in improving disease resistance, reducing mortality rates, and improving the health status of fish and shrimp. The use of immunostimulants has become a key component of sustainable health management in aquaculture.

Sources and Types of Immunostimulants

Immunostimulants used in aquaculture can be divided into several groups depending on their source and chemical nature.

Plant-based Immunostimulants

Plant extracts and herbs have been widely used as natural immunostimulants in aquaculture. These include garlic, neem, turmeric, aloe vera, and seaweed extracts. Plant-based immunostimulants are rich in bioactive compounds like alkaloids, flavonoids, and phenolics, which increase the immune response and disease resistance (Maqsood *et al.*, 2011).

Microbial Immunostimulants

Microbial immunostimulants include yeast products, bacterial cell wall components, and β -glucans. β -glucans from yeast cell walls are the most commonly used immunostimulants in aquaculture. These bioactive compounds increase the immune response and provide resistance against bacterial and viral infections (Raa, 2000).

Nutritional Immunostimulants

Certain nutrients like vitamins, minerals, and nucleotides are known to play a significant role in boosting the immune system. Vitamins C and E have been found to increase the immune response and disease resistance in fish and shrimp (Farooqi and Qureshi, 2018).

Synthetic Immunostimulants

Certain synthetic compounds like levamisole and peptidoglycans have also been used as immunostimulants. These compounds act as

immune stimulants and increase the immune response, providing resistance against diseases.

Mechanism of Action of Immunostimulants

Immunostimulants work by stimulating the immune system of fish and shrimp by activating different immune mechanisms. Immunostimulants increase the ability of immune cells like macrophages and phagocytes to kill pathogens. They also increase the production of antimicrobial proteins like lysozyme and complement proteins, which are of great importance in defending against infections (Mehana *et al.*, 2015). Immunostimulants also increase the activity of natural killer cells and the production of antibodies, which provides greater protection against infectious diseases. This leads to increased survival rates, lower disease prevalence, and improved health status of aquatic animals (Maqsood *et al.*, 2011).

Applications in Fish and Shrimp Culture

Immunostimulants have many applications in fish and shrimp culture. They are applied in hatcheries to increase the survival rate of larvae and to develop the immune system. In grow-out cultures, immunostimulants are applied to decrease the incidence of diseases and to improve growth rates. Immunostimulants are also applied during stressful events such as handling, transportation, and changes in environmental conditions to increase stress resistance (Raa, 2000).

Advantages Over Antibiotics

Immunostimulants have many advantages over antibiotics used in aquaculture. Immunostimulants do not cause antibiotic resistance or the production of harmful residues in aquatic products, as antibiotics do. Immunostimulants are environmentally friendly and non-toxic to both aquatic animals and human consumers (Blazer *et al.*, 1992).

Immunostimulants enhance the natural defense systems of aquatic animals, which gives them long-term protection against diseases. The use of immunostimulants decreases the reliance on antibiotics and helps in the promotion of sustainable aquaculture practices (Farooqi and Qureshi, 2018).

Challenges and Future Perspectives

Although immunostimulants are beneficial, they also have some drawbacks. The efficacy of immunostimulants is dependent on factors like dose, duration of treatment, species, and environment. Overuse of immunostimulants can

lead to a reduction in their efficacy.

Future studies should emphasize the development of new immunostimulants, improving the efficacy of the existing ones, and developing new ways of their administration. The combination of immunostimulants with other disease management strategies, like probiotics and vaccines, can also help in improving disease management in aquaculture (Maqsood *et al.*, 2011).

Conclusion

Immunostimulants provide a promising and sustainable means of improving the health of fish and shrimp in aquaculture. They boost the innate immune system, and this improves resistance to diseases. Unlike antibiotics, immunostimulants do not lead to resistance and toxic residues, making them safe for use by aquatic animals and the environment.

They also improve survival rates, growth, and stress resistance, making them an important means of sustainable production. However, it is important to note that their application should be done in the right dosage and manner for optimal results. With the increasing concern about

antibiotic resistance, immunostimulants are expected to play an important role in the future of health management in aquaculture (Maqsood *et al.*, 2011; Mehana *et al.*, 2015; Farooqi and Qureshi, 2018).

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