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Probiotics as Biological Modulators in Aquaculture: Effects on Growth, Immunity, and Disease Resistance

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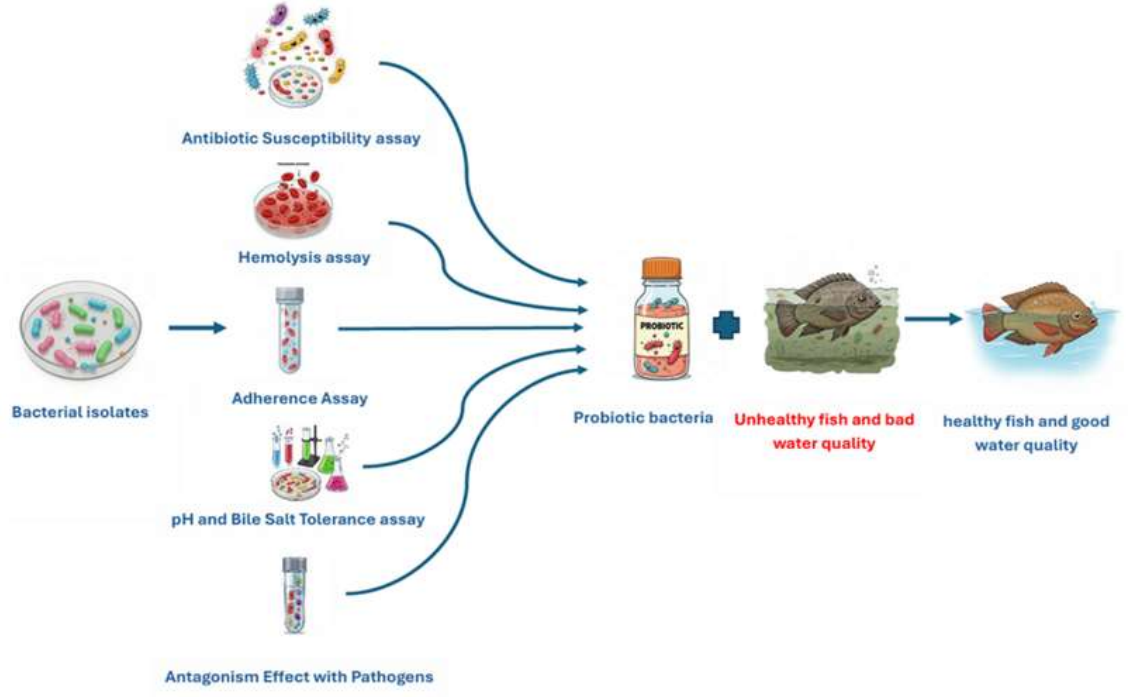
SUMMARY

Intensification of aquaculture has led to frequent occurrence of disease outbreaks. To deal with this issue antibiotics are a widely-preferred control strategy, but one that poses risks to the environment and humans, if used indiscriminately. In pursuit of an alternative, probiotics have emerged recently among viable alternatives for health management in aquaculture. The probiotics have noted positive effects on growth, activities of digestive enzymes and feed utilization, immunity elevation by way of immune-gene transcription, improvement of beneficial gut-microbes and positive modification of intestinal structure, and protective actions against diseases. These positive health influences have the additional benefit of being an eco-friendly approach to aquatic environmental management.

INTRODUCTION

The term *probiotic* is coined from Greek *pro* and *bios* (meaning "for life"), "a probiotic organism can be regarded as a live, dead or component of a microbial cell, which can be administered via feed or into rearing water, benefiting the host by improving growth performance, feed utilization, immune health status, infectious disease resistance, and stress responses which is achieved at least in part via improving the microbial balance in hosts or ambient environment". Among established mechanisms of action, immunomodulation appears to be actively involved in building resistance against viruses. Probiotics stimulate phagocytic activity, acid phosphatase, lysozymes and cytokines, all of which enhance the immunocompetence of shellfishes, increasing their resistance to viral diseases. Probiotics have been found to be effective in a variety of aquatic environments, including freshwater, marine water, and brackish water. The use of probiotics in a diverse range of fish and aquatic organisms such as African catfish (*Clarias gariepinus*), rainbow trout (*Oncorhynchus mykiss*), Nile tilapia (*Oreochromis niloticus*), European sea bass (*Dicentrarchus labrax*), rohu (*Labeo rohita*), snook (*Centropomus undecimalis*), and Red seabream (*Pagrus major*).



Common probiotic strains and modes of delivery

Frequently used probiotic genera in aquaculture include Bacillus, Lactobacillus/ Lacticaseibacillus, Pseudomonas, Shewanella, Vibrio (non-pathogenic strains), Aeromonas (selected strains), and yeast (e.g., Saccharomyces boulardii).

The most commonly used probiotics are from the lactic acid bacteria (LAB), including the genera *Leuconostoc*, *Pediococcus*, *Lactococcus*, *Oenococcus*, and *Enterococcus*.

Probiotics can be: In-feed (microencapsulated or coated). Water additives (for larval tanks, biofilm control, or pond microbiota restructuring). Bioaugmentation agents in recirculating systems to improve nitrification/denitrification.

Mechanism of probiotic action

Probiotics perform substantially better in the aquatic environment than they operate in terrestrial animal systems by functioning either directly on the host or indirectly on their surrounding environment in marine systems. It plays an integral role in preventing illness in shrimp species and other fishes and also serves in many ways to enhance the health of their potential host.

Benefits of probiotics in aquaculture

Pacific white leg shrimps have expanded at an annual rate of 16.8% during the last three decades, establishing aquaculture with the fastest rate of development in the world. Probiotics have drawn a lot of interest in various sectors, including aquaculture, because of their potential advantages for aquatic animals. Probiotics can help with digestion and gut health, disease prevention and control, absorption of nutrients and growth, and environmental impact reduction.

Impact on growth performance

Nutrition in fish farming, as in all living forms, is one of the keys that helps increase growth and production. Using probiotics with feed has an effect on growth rates, digestion and feed use and cost reduction. This positive effect on growth rates is the presence of growth promoters and some other important effector metabolites, such as hydrolytic enzymes, which help fish to maximize their nutritional benefits. Probiotics also help in reducing the harvest period and improving production efficiency, which is a key factor in meeting the growing global demand for fish.

Impact of probiotics on fish Immunity, disease resistance, and blood health

Probiotics improved the fish's ability to resist disease. Fish that fed on a diet supplemented with probiotics do not show any clinical signs or mortality. probiotics, such as *Enterococcus faecium*, have the ability to produce vitamins such as biotin and B12 and improve immunity, and they also increase hemoglobin (Hb), hematocrit (Ht), red blood cells (RBCs), and white blood cells, thus improving immunity and disease resistance and being effective against some pathogens, such as *Aeromonas hydrophila*. Probiotics also have the ability to increase cellular and humoral immunity.

Probiotic application and administration

To enhance resistance against pathogens, probiotics are typically added to the water in ponds, tanks, and feed. It's critical to investigate the most effective introduction strategies, recommended dosages, and required technical solutions to keep the probiotics alive in dry pellets. Significant viability losses are typically recorded during processing and storage, so this is an essential factor to consider.

Challenges and limitations

Probiotics must be used in shrimp farming in a holistic manner that takes into account both biological and environmental factors. An environment favourable for probiotic development and activity must be created by effective pond management, water quality control, and disease prevention techniques.

CONCLUSION

The review highlights the effectiveness of probiotics in aquaculture, showcasing their potential to enhance growth performance, prevent diseases, and mitigate environmental effects. The strategic utilization of probiotics presents significant potential for the sustainable advancement of aquaculture practices, with ongoing research continually uncovering new insights.

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