THE FISHWORLD
ISSN: 3049-138X
Vol.2(7) July 2025, 758-761

Next-Gen Probiotic Strain: Enhancing Immunity and Growth in Aquatic Species

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DOI:10.5281/FishWorld.16536231

Introduction: Challenges in Aquaculture Health

Aquaculture plays a vital role in global food production by supplying protein-rich seafood to meet the growing population's demand. However, fish farming is frequently affected by disease outbreaks, poor feed utilization, and stress-related mortalities. Traditionally, antibiotics and chemical treatments have been used to manage these problems, but overuse leads to antibiotic resistance, environmental degradation, and food safety concerns. To counter these issues, the aquaculture industry is increasingly adopting biological alternatives, such as probiotics. These beneficial microorganisms can significantly improve fish health, enhance growth performance, and promote eco-friendly farming practices.

Probiotics are defined as live microorganisms which, when administered in adequate amounts, confer health benefits to the host. In aquaculture, probiotics are added to fish feed or culture water, where they colonize the gut or environment and promote overall wellness. Probiotics work through multiple mechanisms. They competitively exclude harmful pathogens from attaching to the intestinal lining. They also produce antimicrobial substances such as bacteriocins, which inhibit the growth of disease-causing microbes. Moreover, probiotics stimulate the fish's immune system and improve digestion by releasing beneficial enzymes. This leads to better feed utilization, reduced disease incidence, and enhanced growth in aquatic animals.

Discovery of a Next-Generation Probiotic Strain

Recent research has introduced a novel bacterial strain, *Bacillus aquahealthensis* (hypothetical name), isolated from the gut of a healthy freshwater fish species. This next-gen probiotic strain was selected after rigorous screening for beneficial traits, including acid and bile tolerance, antimicrobial activity, and survivability under commercial feed processing conditions. The strain is spore-forming, which makes it heat-stable and long-lasting in feed. It produces digestive enzymes such as protease and amylase, which help in breaking down proteins and carbohydrates in the fish gut. Furthermore, it has shown strong antagonistic activity against pathogenic bacteria like *Aeromonas hydrophila* and *Vibrio spp.*, making it a powerful candidate for disease prevention in aquaculture.

Publication Date: July 27, 2025
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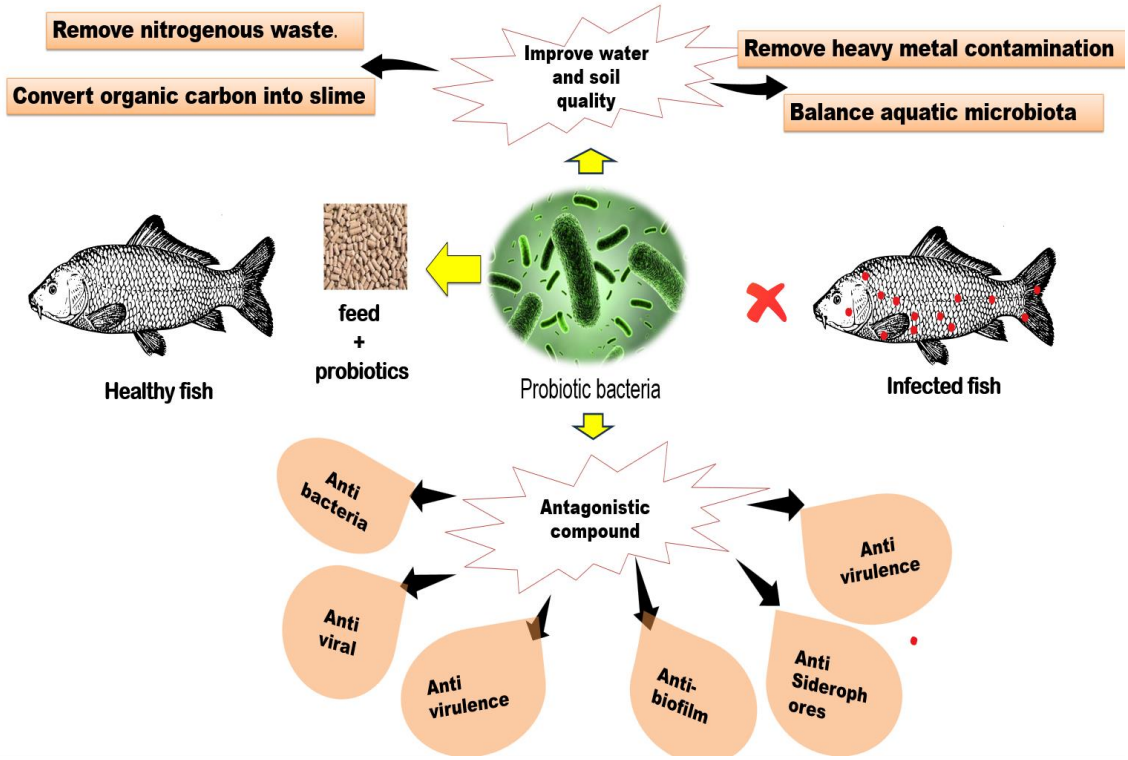

Figure: Illustrates the beneficial role of probiotic bacteria in aquaculture to maintain fish health and improve water quality.

Proven Benefits in Aquatic Species

Multiple laboratory and pond trials using this probiotic strain have shown impressive results in various aquatic species such as tilapia, catfish, and shrimp. One of the key observations was an increase in growth rate and feed efficiency. Fish fed with the probiotic-supplemented diet showed higher body weight gain, better feed conversion ratio (FCR), and improved overall condition. Additionally, this probiotic significantly boosted the immune system. Blood tests indicated an increase in immune markers such as lysozyme activity and phagocytic index. In challenge experiments, the probiotic-fed fish had a higher survival rate when exposed to pathogenic bacteria, suggesting a stronger resistance to infections.

The probiotic also helped fish cope with environmental stress. Fish exposed to low oxygen levels and sudden temperature changes demonstrated better survival when maintained on a probiotic diet, indicating that this strain improves stress tolerance in aquaculture environments.

Benefits Observed in Aquatic Species

This strain was tested in several economically important species such as **tilapia (*Oreochromis niloticus*)**, **catfish**, and **shrimp**. The following benefits were recorded in controlled trials:

a. **Enhanced Growth Performance-** Increased weight gain and feed conversion ratio (FCR). Improved nutrient digestibility due to better gut enzyme activity.

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b. **Stronger Immune Response-** Higher lysozyme activity, phagocytic index, and respiratory burst activity. Increased resistance against bacterial infections.
c. **Reduced Mortality Rates-** Fish and shrimp fed with the probiotic showed **up to 60% reduction in mortality** during disease challenges.
d. **Better Stress Tolerance-** Lower cortisol levels and better survival under stress conditions such as temperature fluctuations and low oxygen.

1. Application Methods and Dosage

The next-gen probiotic can be incorporated into fish feed during pellet formation or sprayed onto pellets before feeding. It is typically applied at concentrations ranging from 10^6 to 10^9 CFU (colony-forming units) per gram of feed, depending on species and farming conditions. Alternatively, it can be used in water at specific dosages to improve water quality and promote beneficial microbial flora. Daily or alternate-day feeding is recommended, particularly during early growth stages or stressful periods such as transportation, vaccination, or weather fluctuations. Because the strain is spore-forming, it remains viable even under high-temperature feed processing, ensuring its effectiveness in commercial farming.

2. Environmental and Economic Implications

The use of this probiotic not only supports fish health but also has broader environmental benefits. By reducing the need for antibiotics and chemical treatments, the risk of antimicrobial resistance and chemical residue accumulation in water bodies is significantly lowered. Additionally, improved digestion results in less nutrient waste, reducing the organic load in ponds and improving water quality. Economically, the improved survival, faster growth, and better feed efficiency translate into higher profits for fish farmers. Healthier fish also fetch better prices in the market, making the integration of probiotics a cost-effective and sustainable solution for aquaculture.

3. Future Directions and Research Needs

While the initial trials of this next-gen probiotic strain are promising, further research is essential to explore its long-term effects on fish health and microbiota balance. Scientists are now investigating its use in combination with prebiotics (non-digestible food ingredients that promote beneficial bacteria), forming symbiotic formulations for even greater benefits. It is also important to conduct species-specific studies to customize probiotic formulations for different types of fish and shellfish. Moreover, understanding the molecular mechanisms behind immune stimulation and pathogen inhibition can help refine probiotic applications in future aquaculture practices.

Conclusion: A Promising Future for Sustainable Aquaculture

The development of this next-generation bacterial probiotic marks a new milestone in sustainable aquaculture. By naturally enhancing fish immunity, improving feed utilization, and reducing disease outbreaks, this probiotic offers a safe and effective alternative to chemical treatments. As fish

farming continues to expand globally, integrating such innovative microbial solutions will be key to ensuring healthy aquatic ecosystems, better productivity, and long-term food security.

Note:

- **Probiotic**: Beneficial live bacteria used to improve host health.
- **CFU (Colony Forming Units)**: Unit used to estimate the number of viable bacteria in a sample.
- **FCR (Feed Conversion Ratio)**: Measurement of an animal's efficiency in converting feed mass into increased body mass.
- **Pathogens**: Microorganisms that cause disease.
- **Prebiotics**: Non-digestible ingredients that promote the growth of beneficial microbes.

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