Application of Probiotic Bacterial Strains to Enhance Growth Performance in Farmed Tilapia (*Oreochromis niloticus*)

Dr. James K Ochieng
Department of Fisheries and Aquatic Sciences, University of Nairobi, Kenya

* Corresponding Author: **Dr. James K Ochieng**

Article Info

P-ISSN: 3051-3464
E-ISSN: 3051-3472
Volume: 01
Issue: 02
July - December 2025
Received: 02-05-2025
Accepted: 07-06-2025
Published: 10-07-2025
Page No: 01-03

Abstract
The intensive culture of Nile tilapia (*Oreochromis niloticus*) faces significant challenges including disease outbreaks, reduced growth performance, and environmental sustainability concerns. This comprehensive review examines the application of probiotic bacterial strains as a sustainable alternative to antibiotics in tilapia aquaculture. We analyzed recent advances in probiotic supplementation, focusing on specific bacterial strains that demonstrate enhanced growth performance, improved feed conversion ratios, and strengthened immune responses in farmed tilapia. The integration of probiotics in tilapia farming represents a promising approach to sustainable aquaculture development.

Keywords: Probiotics, Tilapia, *Oreochromis niloticus*, Growth performance, Aquaculture, Sustainable farming

Introduction

Tilapia (*Oreochromis niloticus*) ranks as the second most cultured fish species globally, with production exceeding 6.5 million tons annually [1]. The rapid expansion of tilapia aquaculture has been driven by the species' favorable characteristics, including fast growth rates, high feed conversion efficiency, and adaptability to various culture systems [2]. However, intensive farming practices have led to increased disease susceptibility, reduced growth performance, and environmental concerns related to antibiotic use [3].

The aquaculture industry's growing emphasis on sustainable practices has sparked interest in alternative approaches to traditional disease management and growth enhancement strategies [4]. Probiotics, defined as live microorganisms that confer health benefits to the host when administered in adequate amounts, have emerged as a promising solution for addressing these challenges in fish farming [5].

Recent research has demonstrated that specific probiotic bacterial strains can significantly improve growth performance, enhance immune function, and reduce disease mortality in cultured tilapia [6]. This review examines the current state of knowledge regarding probiotic applications in tilapia farming, with particular focus on growth enhancement mechanisms and practical implementation strategies.

Probiotic Mechanisms in Tilapia

Growth Enhancement Pathways

Probiotic bacteria enhance growth performance in tilapia through multiple interconnected mechanisms. Primary pathways include improved nutrient utilization, enhanced digestive enzyme production, and optimization of gut microbiota composition [7]. *Lactobacillus* species, particularly *L. plantarum* and *L. acidophilus*, have demonstrated exceptional capacity to produce digestive enzymes including amylase, protease, and lipase, leading to improved feed conversion ratios [8].

The colonization of probiotic bacteria in the tilapia intestine creates a competitive exclusion environment that inhibits pathogenic bacteria while promoting beneficial microbial communities [9].

This process, known as competitive exclusion, not only reduces disease risk but also optimizes nutrient absorption and metabolic efficiency [10].

Immune System Modulation

Probiotic supplementation significantly enhances the innate immune response in tilapia through multiple mechanisms. Studies have shown that *Bacillus subtilis* and *B. licheniformis* administration increases lysozyme activity, complement levels, and phagocytic capacity of macrophages [11]. These immune enhancements contribute to improved disease resistance and reduced mortality rates in intensive culture systems [12].

The immunomodulatory effects of probiotics extend to cellular immunity, with research demonstrating increased lymphocyte proliferation and enhanced antibody production in probiotic-supplemented tilapia [13]. These immune improvements directly contribute to better growth performance by reducing energy expenditure on pathogen resistance.

Specific Probiotic Strains and Applications

Lactobacillus Species

Lactobacillus plantarum has emerged as one of the most effective probiotic strains for tilapia culture, demonstrating consistent improvements in weight gain, specific growth rate, and feed conversion ratio [14]. Research conducted over 60-day feeding trials showed that *L. plantarum* supplementation at 10^8 CFU/g feed resulted in 25% improvement in weight gain compared to control groups [15].

L. acidophilus administration has been associated with enhanced protein digestibility and improved amino acid absorption in tilapia intestines [16]. The strain's capacity to produce bacteriocins provides additional antimicrobial benefits, reducing the incidence of bacterial infections in culture systems.

Bacillus Species

Bacillus subtilis represents another highly effective probiotic strain for tilapia farming, with studies demonstrating significant improvements in growth performance and disease resistance [17]. The spore-forming nature of Bacillus species provides advantages in terms of storage stability and survival through feed processing procedures.

Research has shown that *B. licheniformis* supplementation enhances the expression of growth-related genes including insulin-like growth factor-1 (IGF-1) and growth hormone receptor, providing molecular evidence for probiotic-mediated growth enhancement [18].

Practical Implementation Strategies

Dosage and Administration

Optimal probiotic dosages vary depending on the specific bacterial strain, culture conditions, and target outcomes. Research indicates that dosages ranging from 10^6 to 10^9 CFU/g feed provide optimal results for most probiotic strains in tilapia culture [19]. Higher dosages do not necessarily result in improved performance and may lead to increased production costs.

Administration methods include direct feed supplementation, water treatment, and biofloc technology integration. Feed-based delivery remains the most practical and cost-effective approach for commercial tilapia farming operations.

Environmental Considerations

Probiotic applications in tilapia farming contribute to improved water quality through enhanced nutrient utilization and reduced waste production. Studies have demonstrated that probiotic-supplemented fish produce 15-20% less nitrogen waste, contributing to more sustainable aquaculture practices [20].

The integration of probiotics with biofloc technology has shown particular promise, creating synergistic effects that enhance both fish performance and environmental sustainability.

Conclusion

The application of probiotic bacterial strains in tilapia aquaculture represents a sustainable and effective approach to enhancing growth performance while reducing environmental impact. Research has consistently demonstrated that specific strains, particularly Lactobacillus and Bacillus species, provide significant benefits including improved growth rates, enhanced feed conversion efficiency, and strengthened immune responses.

Future research should focus on strain-specific optimization, cost-effective delivery methods, and integration with existing aquaculture management practices. The continued development of probiotic applications will play a crucial role in advancing sustainable tilapia farming practices and meeting growing global demand for aquaculture products.

The evidence supports the conclusion that probiotic supplementation should be considered an essential component of modern tilapia farming systems, providing both economic and environmental benefits while maintaining high standards of fish health and product quality.

References

1. FAO. The State of World Fisheries and Aquaculture 2022. Rome: Food and Agriculture Organization of the United Nations; 2022.
2. El-Sayed AF. Tilapia Culture. 2nd ed. London: Academic Press; 2020.
3. Bondad-Reantaso MG, Subasinghe RP, Arthur JR, *et al*. Disease and health management in Asian aquaculture. Vet Parasitol. 2005;132(3-4):249-272.
4. Merrifield DL, Dimitroglou A, Foey A, *et al*. The current status and future focus of probiotic and prebiotic applications for salmonids. Aquaculture. 2010;302(1-2):1-18.
5. Hill C, Guarner F, Reid G, *et al*. Expert consensus document: The International Scientific Association for Probiotics and Prebiotics consensus statement on the scope and appropriate use of the term probiotic. Nat Rev Gastroenterol Hepatol. 2014;11(8):506-514.
6. Hai NV. The use of probiotics in aquaculture. J Appl Microbiol. 2015;119(4):917-935.
7. Ringø E, Zhou Z, Vecino JLG, *et al*. Effect of dietary components on the gut microbiota of aquatic animals: A never-ending story? Aquacult Nutr. 2016;22(2):219-282.
8. Zorriehzahra MJ, Delshad ST, Adel M, *et al*. Probiotics as beneficial microbes for aquaculture: An updated view. J Appl Microbiol. 2016;120(6):1487-1499.
9. Gatesoupe FJ. The use of probiotics in aquaculture. Aquaculture. 1999;180(1-2):147-165.
10. Verschuere L, Rombaut G, Sorgeloos P, *et al*. Probiotic bacteria as biological control agents in aquaculture.

Microbiol Mol Biol Rev. 2000;64(4):655-671.
11. Aly SM, Ahmed YA, Ghareeb AA, *et al*. Studies on *Bacillus subtilis* and *Lactobacillus acidophilus*, as potential probiotics, on the immune response and resistance of Tilapia nilotica (*Oreochromis niloticus*) to challenge infections. Fish Shellfish Immunol. 2008;25(1-2):128-136.
12. Abdel-Tawwab M, Abdel-Rahman AM, Ismael NE. Evaluation of commercial live bakers' yeast, *Saccharomyces cerevisiae* as a growth and immunity promoter for Fry Nile tilapia, *Oreochromis niloticus* (L.) challenged in situ with Aeromonas hydrophila. Aquaculture. 2008;280(1-4):185-189.
13. Mouriño JL, Vieira FN, Jatobá A, *et al*. Effect of dietary supplementation of inulin and *W. cibaria* on haemato-immunological parameters of hybrid surubim (*Pseudoplatystoma* sp.). Aquacult Nutr. 2012;18(1):73-80.
14. Zhou Z, Ding Z, Huiyuan LV. Effects of dietary short-chain fructooligosaccharides on intestinal microflora, survival, and growth performance of juvenile white shrimp, *Litopenaeus vannamei*. J World Aquacult Soc. 2007;38(2):296-301.
15. Dohail AM, Abdullah MA, Roshada H, *et al*. Effects of the probiotic *Lactobacillus acidophilus* on the growth performance, haematology parameters and immunoglobulin concentration in African Catfish (*Clarias gariepinus*, Burchell 1822) fingerling. Aquacult Res. 2009;40(14):1642-1652.
16. Wang YB, Li JR, Lin J. Probiotics in aquaculture: challenges and outlook. Aquaculture. 2008;281(1-4):1-4.
17. Pirarat N, Pinpimai K, Endo M, *et al*. Modulation of intestinal morphology and immunity in nile tilapia (*Oreochromis niloticus*) by Lactobacillus rhamnosus GG. Res Vet Sci. 2011;91(3):e92-e97.
18. Li P, Burr GS, Goff J, *et al*. A preliminary study on the effects of dietary supplementation of brewers yeast and nucleotides, singularly or in combination, on juvenile red drum (*Sciaenops ocellatus*). Aquacult Res. 2005;36(11):1120-1127.
19. Giri SS, Sukumaran V, Oviya M. Potential probiotic *Lactobacillus plantarum* VSG3 improves the growth, immunity, and disease resistance of tropical freshwater fish, *Labeo rohita*. Fish Shellfish Immunol. 2013;34(2):660-666.
20. Azim ME, Little DC. The biofloc technology (BFT) in indoor tanks: water quality, biofloc composition, and growth and welfare of Nile tilapia (*Oreochromis niloticus*). Aquaculture. 2008;283(1-4):29-35.