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Research Progress on Key Technologies for Disease Prevention and Control in Shrimp Aquaculture

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Abstract This study reviews the research progress and development trends of key technologies for disease prevention and control in shrimp aquaculture. With the shift toward high-density and intensive farming systems, viral, bacterial, and parasitic diseases have become increasingly prevalent, posing significant constraints on the sustainable development of the industry. This paper systematically summarizes the major disease types and their epidemiological characteristics, and analyzes the effects of pathogen-host interactions, environmental factors, and farming practices on disease occurrence. On this basis, recent advances in disease detection and monitoring technologies are reviewed, including conventional methods, molecular and immunological techniques, as well as rapid detection and intelligent monitoring systems. Furthermore, key prevention and control strategies are discussed, such as aquaculture management and ecological regulation, microbial modulation and antibiotic alternatives, immunostimulation, and disease-resistant selective breeding, along with their application outcomes. The current challenges are also addressed, including pathogen variation and emerging disease risks, antibiotic misuse and antimicrobial resistance, and the lack of technology transfer and standardization. Finally, future perspectives are proposed, highlighting a transition toward integrated management approaches centered on biosecurity. This study provides a reference for developing green, efficient, and sustainable shrimp health management systems.

Keywords Shrimp aquaculture; Disease control; Biosecurity; Microbial regulation; Intelligent monitoring

1 Introduction

With the rapid development of global aquaculture, shrimp farming has become one of the fastest-growing and most economically valuable sectors. It not only provides an important source of animal protein for regions such as Asia and Latin America, but also generates substantial export revenues. Among the major cultured species, Pacific white shrimp (*Litopenaeus vannamei*) and Chinese shrimp have been widely promoted worldwide due to their rapid growth, strong environmental adaptability, and high market demand. In crustacean aquaculture, marine shrimp dominate both production volume and economic value. However, while high-density and intensive farming systems have significantly increased production, they have also intensified environmental pressure and reduced system stability, leading to increasingly severe disease problems that have become a major bottleneck for sustainable industry development (Bhassu et al., 2024).

In recent years, viral and bacterial diseases have repeatedly occurred in major shrimp farming regions worldwide. Typical diseases include white spot syndrome virus (WSSV), acute hepatopancreatic necrosis disease (AHPND), Enterocytozoon hepatopenaei (EHP) infection, and vibriosis. These diseases are characterized by rapid transmission and high mortality, often causing large-scale outbreaks and severe economic losses within a short period (Chowdhury et al., 2024). Since the 1990s, such diseases have frequently affected major aquaculture countries such as India and Thailand, resulting in cumulative losses of billions of dollars. Studies have shown that disease outbreaks are not only closely associated with pathogenic microorganisms, but are also driven by multiple factors, including water quality deterioration, environmental degradation, inadequate biosecurity measures, and the globalization of seedstock and live animal trade. Their impacts extend beyond production losses to include reduced employment and socio-economic instability in coastal regions (Bhassu et al., 2024; Chowdhury et al., 2024).