Therefore, effective disease prevention and control has become a critical component for ensuring shrimp health and maintaining industry stability. Traditional approaches based on antibiotics, chemicals, and disinfectants may provide short-term benefits, but are limited in controlling viral pathogens. Long-term use can also induce antimicrobial resistance in Vibrio spp., disrupt host microbial communities, and pose risks to the environment and food safety (Khanjani et al., 2024). In addition, due to the lack of a typical adaptive immune system in shrimp, the application of conventional vaccination strategies remains limited. As a result, preventive health management approaches have gradually become the mainstream, including strengthening biosecurity systems, using specific pathogen-free (SPF) and disease-resistant (SPR) stocks, optimizing culture environments, and applying functional feed additives for immune regulation (Nguyen, 2024). However, disease outbreaks remain frequent in practice; for example, nearly half of the production cycles in some regions are affected by diseases, indicating that single management strategies are insufficient to control complex disease systems (Bhassu et al., 2024).

This study aims to review the progress of green, efficient, and sustainable technologies for disease prevention and control in shrimp aquaculture. Advances in pathogen detection technologies, such as PCR, quantitative real-time PCR, monoclonal antibody-based assays, and lateral flow test strips, have significantly improved detection sensitivity and accuracy. Meanwhile, emerging technologies, including high-throughput sequencing, nanotechnology, biosensors, RNA interference, and CRISPR-Cas systems, have enhanced our understanding of pathogen–host interactions and provided valuable tools for disease-resistant genetic improvement. In addition, microbial-based products such as probiotics, prebiotics, and synbiotics, as well as bioactive compounds derived from plants and microalgae, have shown promising potential in regulating gut microbiota, enhancing immunity, and improving disease resistance. This study systematically analyzes major disease types and their epidemiological characteristics, examines key mechanisms and influencing factors, and reviews advances in biosecurity systems, SPF/SPR breeding, immunostimulants and functional additives, microbial regulation, and molecular and omics technologies. Finally, future development trends are discussed to provide a theoretical basis and practical reference for establishing green, efficient, and sustainable shrimp health management systems.

2 Major Disease Types and Epidemiological Characteristics in Shrimp Aquaculture

2.1 Major disease types

Shrimp aquaculture is affected by a wide range of diseases, among which viral, bacterial, and parasitic infections are the most common. These diseases have significant impacts on survival rate, growth performance, and overall economic returns. Previous studies have shown that viral diseases account for the majority of losses in shrimp farming, contributing approximately 60% of total disease-related losses, while bacterial diseases account for about 20%. Fungal and parasitic diseases generally occur at lower frequencies but can still cause substantial damage under specific environmental conditions (Hasan et al., 2024). Therefore, a systematic understanding of major disease types from a pathogen spectrum perspective is essential for establishing healthy aquaculture systems and implementing precise disease control strategies.

Viral diseases are widely regarded as the most severe threat in shrimp aquaculture. They are characterized by rapid transmission, high mortality, and a broad host range, and can easily cause outbreaks under high-density farming conditions. Major viral diseases of concern include white spot syndrome caused by white spot syndrome virus (WSSV), Taura syndrome caused by Taura syndrome virus (TSV), yellow head disease caused by yellow head virus (YHV), as well as infections caused by infectious hypodermal and hematopoietic necrosis virus (IHHNV) and infectious myonecrosis virus (IMNV). These pathogens can enter aquaculture systems through infected seedstock, broodstock carriers, waterborne transmission, and farming practices, and can rapidly spread under conditions of environmental deterioration or host stress. Due to their high pathogenicity and potential for transboundary spread, many shrimp viruses have been listed as notifiable pathogens by the World Organisation for Animal Health.

Bacterial diseases are mainly associated with infections by Vibrio spp., which are among the most common disease types under conditions of high temperature, high organic load, and poor management. Vibrio infections