Building Resilient Shrimp Production with Microbial Management and Nature-Based Solutions

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ABSTRACT:
The intensification of shrimp aquaculture has led to a reliance on antimicrobial use to control devastating diseases like Vibriosis. This practice not only poses significant risks by driving antimicrobial resistance (AMR) but also disrupts the delicate microbial ecology of the pond environment and the shrimp gut microbiome, making the production system more vulnerable to pathogens. Importantly, this reliance on antibiotics introduces a critical food safety risk—the potential for antimicrobial residues in the final product and the transmission of drug-resistant bacteria to the human food chain. Here, we propose a holistic, nature-based strategy to enhance shrimp health and resilience, moving beyond conventional antibiotic use. This approach integrates the two key pillars, i) microbial management through the application of beneficial bacteria (probiotics), microbial-enhancing nutrients (prebiotics), and their synergistic combinations (synbiotics) to shape a healthy, diverse gut microbiome, and ii) targeted pathogen control using a bio-formulation called "ShrimpGuard," which combines specific bacteriophages with immune enhancers to combat Vibriosis without contributing to AMR. We hypothesize that this multi-component approach will provide disease-resistant production system. These combined strategies are being tested at laboratory, pilot, and hatchery scales, considering environmental factors and climate change. Our research will employ advanced 'omics' platforms, particularly metagenomics and transcriptomics, to monitor changes in the microbial community structure and the shrimp's immune response, providing an evidence-based framework for our interventions. This project is not only an innovative solution to reduce antimicrobial use but also a model for sustainable development. The project's output will strengthen a multi-disciplinary network for evidence-based AMR policy across low-and-middle-income countries, fostering a more resilient and equitable future for global aquaculture.

KEYWORDS:
Antimicrobial resistance, sustainable aquaculture, microbiome, bacteriophages, food safety