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Review Article

CURRENT PERSPECTIVES ON BACTERIAL DISEASES IN SHRIMP AQUACULTURE: EMPHASIS ON *VIBRIO HARVEYI* INFECTIONS

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ABSTRACT

Shrimp farming plays a significant role in the world's seafood output, bacterial illnesses brought on by Vibrio species are becoming a bigger hazard. Serious illnesses including vibriosis, luminous vibriosis, and Acute Hepatopancreatic Necrosis Disease (AHPND) are caused by pathogens like *Vibrio harveyi, V. parahaemolyticus* and *V. alginolyticus,* which result in high mortality and financial losses. Inadequate management techniques, environmental stress, and poor water quality are all linked to disease outbreaks. This study highlights the significance of excellent disease prevention and sustainable treatment by summarizing the main bacterial diseases of shrimp, with a focus on vibriosis, its causative agents, clinical symptoms, and predisposing factors.

Keywords: Shrimp aquaculture, *Vibrio harveyi*, Vibriosis, AHPND, Bacterial diseases.

INTRODUCTION

One of the aquaculture industry's fastest-growing segments, shrimp aquaculture makes a substantial contribution to international trade, employment, and food security. Species like Penaeus monodon (giant tiger shrimp) and Penaeus vannamei (Pacific white shrimp) lead the shrimp farming industry owing to their swift growth, strong market demand, and ability to thrive in intensive aquaculture systems. According to the Food and Agriculture Organization (FAO), shrimp farming contributes billions of dollars annually to the global seafood industry and supports the livelihoods of millions of people, particularly in Asian countries such as India, China, Vietnam, Thailand, Indonesia, and Bangladesh. Shrimp output has expanded dramatically as a result of the industry's rapid intensification, but it has also made it easier for infectious diseases to arise and spread.

Shrimp's immune systems are weakened by high stocking densities, environmental stress, poor water quality, and frequent handling, leaving them more vulnerable to harmful microbes. One of the main factors preventing sustainable shrimp production globally is disease outbreaks. One of the most significant categories of pathogens among infectious agents that cause significant financial losses in shrimp aquaculture are bacteria. Disease outbreaks of the cultivated giant tiger prawn, Penaeus monodon, are largely caused by bacteria (Cheng, 1989). It has been documented that a number of Vibrio species can infect shellfish and finfish in both wild and farmed environments (Buchanan and Gibbons, 1984). Several Vibrio species were recognized as significant diseases of marine organisms by Colwell and Grimes (1984). Numerous researchers have documented Vibrio infections in penaeid shrimp. (Vanderzant *et al.,* 1970; Johnson, 1978; Lightner, 1983, 1985, 1988; Takahashi *et al.,* 1984, 1985; Baticados, 1988; Anderson *et al.,* 1988; Nash, 1988, 1990; Boonyanatpalin, 1990; Lavilla-Pitogo *et al.,* 1990; De la Peña *et al.,* 1993; Mohney *et al.,* 1994; Hameed, 1994). One of the most damaging bacterial illnesses affecting cultured penaeid shrimp is vibriosis. (Egidius, 1987).

Vibrio species are typically found in the microbial flora of shrimp, seawater, and sediments in marine and estuarine environments. These bacteria are innocuous in favorable environmental settings, but they can become opportunistic pathogens that can cause serious disease outbreaks due to environmental stress, poor husbandry, and host immunosuppression. *Vibrio harveyi, V. parahaemolyticus, V. alginolyticus, V. vulnificus, and V. campbellii* are

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common pathogenic species. The coastal states of Andhra Pradesh, Tamil Nadu, Odisha, West Bengal, Gujarat, and Kerala are the main locations for brackish-water aquaculture in India. One of the main drivers of both rural employment and seafood exports is shrimp farming. However, because of decreased survival, poor growth, higher production costs, and crop failures, bacterial infections brought on by Vibrio species still result in large financial losses. Antibiotics are commonly used by farmers to treat bacterial diseases, but their careless usage has led to environmental contamination, antimicrobial resistance, and worries about the safety of seafood. (Selvin *et al.,* 2009; Cano-Gomez *et al.,* 2009).

Bacterial diseases in shrimp culture

Over the past three decades, the growth and intensification of shrimp farming have significantly raised the prevalence of disease. Outbreaks of bacterial and viral diseases caused catastrophic output losses in a number of nations during the 1990s. Grow-out ponds, nurseries, and hatcheries were all severely impacted by these illnesses, which resulted in large financial losses. Shrimp are mostly afflicted by bacterial infections when they are larval, post-larval, juvenile, and sub-adult. Opportunistic pathogens enter weaker hosts through wounds, cuticles, gills, or the digestive tract. Shrimp are more vulnerable to bacterial infections due to stress brought on by poor water quality, temperature swings, low dissolved oxygen, an abundance of organic waste, ammonia build up and crowding.

Acute Hepatopancreatic Necrosis Disease (AHPND)

AHPND, previously known as Early Mortality Syndrome (EMS), is one of the most devastating bacterial diseases affecting cultured shrimp worldwide. The disease is caused by specific strains of *Vibrio parahaemolyticus* carrying the PirA and PirB toxin genes. The disease primarily affects the hepatopancreas, resulting in degeneration of epithelial cells, impaired digestion, reduced feed intake, and rapid mortality. Outbreaks usually occur within the first 30-40 days after stocking, with mortality rates reaching 100% under severe conditions.

Vibriosis

Several Vibrio species, such as *V. harveyi, V. alginolyticus, V. vulnificus, and V. campbellii,* can cause vibriosis, a widespread bacterial infection. Reduced feeding, lethargy, shell erosion, melanization, muscle necrosis, septicemia, and mortality are the hallmarks of the disease, which affects shrimp at every stage of development. An important factor in the development of disease is environmental stress.

Luminous Vibriosis

Vibrio harveyi is the primary cause of luminous vibriosis. The illness is frequently seen in hatcheries, where affected larvae glow in the dark. Larvae and post-larvae die quickly due to high bacterial loads, which causes significant financial losses.

Necrotizing Hepatopancreatitis (NHP)

Hepatobacter penaei is the cause of necrotizing hepatopancreatitis. Poor digestion, growth retardation, decreased feed consumption, and chronic death are all consequences of the disease's damage to hepatopancreatic tissues. The majority of NHP reports come from areas where warm-water shrimp are farmed.

Vibriosis

One of the most prevalent bacterial illnesses affecting marine shrimp worldwide is vibriosis. It is brought on by a number of harmful Vibrio species that are found in marine habitats. Because they often only cause illness when shrimp are subjected to environmental stress or develop impaired immune systems, these bacteria are regarded as opportunistic pathogens. The disease has been documented in grow-out ponds, nurseries, and hatcheries in Asia, Europe, and the Americas. Vibriosis continues to be one of the main reasons for production losses in *Penaeus vannamei* and *Penaeus monodon* farming systems in India. A number of Vibrio species, such as *Vibrio harveyi, V. alginolyticus, V. vulnificus, V. campbellii, and V. parahaemolyticus*, are implicated in illness outbreaks. Because of its capacity to create toxins, extracellular enzymes, biofilms, and quorum-sensing molecules that promote bacterial colonization and pathogenicity, *Vibrio harveyi* is regarded as one of the most virulent pathogens among them. Poor water quality, increased organic matter, high amounts of ammonia and nitrite, low dissolved oxygen, temperature swings, salinity stress, and overpopulation are all closely linked to disease outbreaks. Vibrio populations grow quickly in these circumstances and into shrimp through the gills, digestive tube, or broken exoskeleton.

Clinical Signs of Vibriosis

Depending on the Vibrio species involved, the intensity of the infection, the shrimp's developmental stage, and the current environmental conditions, vibriosis in shrimp can exhibit a variety of clinical symptoms. Shrimp that are infected usually show decreased appetite and feed intake, which hinders their growth and productivity. Affected people frequently exhibit slow swimming behavior, become tired, and become less receptive to outside cues. Soft shell syndrome, tail rot, black or brown melanized lesions on the exoskeleton, and gill discoloration are examples of external clinical symptoms that point to bacterial infiltration and tissue injury.

As the illness worsens, shrimp may experience hepatopancreatic degeneration, which hinders digestion and nutrient absorption, muscular opacity, and an empty stomach from stopping feeding. In extreme situations, the bacteria enter the bloodstream and cause septicemia and extensive tissue destruction, which eventually results in a high death rate. Due to their immature immune systems,

larval and post-larval stages are especially vulnerable to vibriosis. In poor climatic conditions, disease outbreaks can result in mortality rates that are close to 100%, particularly in hatchery operations.

Predisposing Factors

Several environmental, nutritional, and management-related factors increase the susceptibility of shrimp to vibriosis. Poor water quality is considered one of the primary predisposing factors, as the accumulation of organic matter, elevated ammonia and nitrite concentrations, and low dissolved oxygen levels create favorable conditions for the proliferation of pathogenic Vibrio species. Environmental stress caused by sudden fluctuations in temperature and salinity further weakens the immune system of shrimp, making them more vulnerable to bacterial infection. High stocking densities increase competition for food and oxygen while facilitating the rapid transmission of pathogens among individuals. Inadequate nutrition and nutritionally imbalanced diets can impair the immune response and reduce the shrimp's ability to resist infections. Furthermore, shrimp's natural defensive systems may be weakened by stress related to handling, grading, transportation, and other standard farm management procedures. The severity of vibriosis may be exacerbated by secondary infections brought on by additional bacterial, viral, or parasitic pathogens, increasing morbidity and death. Therefore, reducing the danger of vibriosis outbreaks in shrimp growth systems requires maintaining ideal water quality, adequate nutrition, suitable stocking densities, and sound farm management techniques.

CONCLUSION

Bacterial diseases, particularly vibriosis and Acute Hepatopancreatic Necrosis Disease (AHPND), remain major constraints to sustainable shrimp aquaculture, causing significant economic losses through reduced growth, poor survival, and crop failure. Environmental stress, poor water quality, high stocking density, and inadequate farm management create favorable conditions for the proliferation of pathogenic *Vibrio* species. Early diagnosis, continuous health monitoring, and proper water quality management are essential for minimizing disease outbreaks. The indiscriminate use of antibiotics has contributed to antimicrobial resistance and environmental concerns, highlighting the need for sustainable alternatives. The use of probiotics, biosecurity measures, immunostimulants, and improved nutritional strategies has shown considerable promise in preventing bacterial infections and enhancing shrimp health. Integrating these eco-friendly approaches with good aquaculture practices can significantly improve disease resistance, productivity, and profitability. Continued research on host-pathogen interactions, rapid diagnostic tools, and novel biological control strategies will further strengthen the sustainable development of *Penaeus vannamei*, *Penaeus monodon*, and other commercially important shrimp species.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

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AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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