Chapter

Challenges in Controlling Vibriosis in Shrimp Farms

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Abstract

Recently the shrimp farming has blooming as a crucial counterpart in the aquaculture industry which contribute the remarkable role in sea food production as well economy of the country. However, this could be fluctuated every year through several circumstances such as unfavorable (Poor water and soil quality) environmental factors. The environmental factors includes disease causing bacterial pathogens in the soil and water which causes the bacterial diseases in the aquatic animals, like this hectic problems are prevented through bioaugmentation strategies. The pond environment plays a vital role in determining the healthy culture system, but there is high risk for manipulation by bacterial community which takes care of waste generated in the system through *in situ* bioremediation. Due to the impact of rapidly growing bacterial diseases of shrimps throughout the world, numerous studies have been carried out to find immunostimulants, immunomodulators and biotic component that can be used against vibrio causing pathogens, and can also be used as an alternative for antibiotics. Recent research focus towards the marine resources such as microalgae, seaweed, live feeds (like artemia, copepods, rotifers), bacteriophage, and probiotics have been found to have higher potential in reducing vibriosis. Eco-based shrimp farming includes green water technology, phage therapy bio-floc technology (BFT) and integrated multi-trophic aquaculture (IMTA), these methods hold a promising alternative to antibiotics in the near future. Bacterial diseases caused by vibrios have been reported in penaeid shrimp culture systems implicating at least 14 species and they are *Vibrio harveyi, V. splendidus, V. parahaemolyticus, V. alginolyticus, V. anguillarum, V. vulnificuslogei* etc.

Keywords: Immunity, Hypoxia, Salinity, pH, Vibriosis, Probiotics

1. Introduction

Vibriosis is a bacterial disease caused by *Vibrio* which is Gram-negative, motile, facultative anaerobe bacteria of the family Vibrionaceae. It is ubiquitous throughout the world and in all marine crustaceans, including shrimp. Vibriosis is one of the major disease problems in shellfish and finfish aquaculture, especially in shrimp farming. Vibriosis is a bacterial disease responsible for mortality of cultured shrimp worldwide. Various studies has been done to find a remedy for vibriosis in rearing as well as shrimp culture ponds. Certain studies show that usage of microalgae, bacteriophage, and probiotic bacteria have been found to have higher potential in reducing vibriosis. Vibriosis is a series of bacterial infections caused by a bacterium belongs to the genus *Vibrio*. Black shell disease, bacterial septicemia,

hepatopancreatic necrosis, brown gill disease, swollen hindgut syndrome and luminous bacterial disease [1]. High density of the bacterial species in culture pond increases the probability of getting viral diseases, especially white spot syndrome

The pacific white shrimp (*Litopenaeus vannamei*), Indian white shrimp (*Fenneropenaeus indicus*), Black tiger shrimp (*Penaeus monodon)* are important commercial species of the penaeid family. *Fenneropenaeus indicus* supports commercial fisheries in both marine and brackish water environments on the east and west coasts of India. India is one of the major suppliers of shrimp to Japan, Europe, Thailand and USA [2]. The secondary infection of vibrios in *P. monodon* occurs due to poor water quality, stress, high stocking density, unstable environmental conditions, toxins and virion particles. Vibriosis is caused by a number of bacteria belongs to *vibrio* species which includes; *Vibrio harveyi, V. splendidus, V. parahaemolyticus, V. alginolyticus*. There have been occasional reports of vibriosis caused *by V. damsella, V. fluvalis* and other undefined *vibrio* species [3].

2. Vibrio diseases

2.1 Bacterial septicemia

This is one of the severe systemic diseases caused by bacteria, which affects shrimps and exhibits the symptoms such as lethargic, show abnormal swimming behavior, expansion of chromatophores, followed by reddish color change in the pleopods which can be seen in the abdominal musculature. In chronic cases, the gill covers appear flared up and eroded along with the melanized black blisters on the carapace and abdomen. The disease caused by *Vibrio alginolyticus, V. anguillarium or V. parahaemolyticus* and diagnosed based on gross signs like its swimming patterns, Food consumption ratio (FCR) and confirmed by analyzing the isolated pathogen from haemolymph or muscle sample by standard microbiological methods and histopathology. Bacterial septicemia can be prevented by maintaining good water quality and by reducing the organic load by increased water exchange. This can be prevented by giving high protein feed with antibiotics, repeated water exchange might help to decrease the density of disease causing pathogens [4].

2.2 Necrosis (Hepatopancreas, muscle and appendages)

Inflammation in the cells explores the proteins release from tissues and cells, which reflects on the color change of the animals as like milky white. This disease could be caused due to several unfavorable environmental conditions such as water quality, organic load, malnutrition and wastes producecd from the animals, in chronic cases, melanization of setae, antennae, appendages and muscle can be witnessed. Necrosis is usually caused by *Vibrio spp, Pseudomonas spp, Aeromonas spp* and *Flavobacterium spp* and can be diagnosed based on swimming patterns and other symptoms like white patches in cephalothorax and can be prevented by repeated water exchange and feeding nutrient rich feed. Necrosis is controlled by induced molting by applying 5–10 ppm fermented rice cake (**Figure 1**) [5].

3. Brown spot diseases: (Shell disease or rust disease)

This kind of disease in shrimps showed brown to black enodsed areas on the body surface and appendages, *Aeromonas spp*, and *Flavobacterium spp*., are the crucial causative agents involved in the pathogenisis through chitinolytic activity.

Figure 1.
Shrimps affected by Necrosis 1.

Major symptoms are stooped posture and brown to back spots on the exoskeleton, in extreme conditions it might even lead to necrosis [6]. Brown spot disease can be prevented by reducing organic load in water, with repeated water exchange and by feeding the shrimps with nutritional supplement.

3.1 Vibriosis in shrimp

Members of the microorganism genus *Vibrio* have become a major constraint on production and trading in shrimp industry. *Vibrio* is responsible for several diseases and causing mortalities up to 100 percent and global losses of around 4.5 billion USD. *Vibrio spp.* is a natural micro flora of wild and cultured shrimps, and become opportunistic pathogens when natural defense mechanisms are suppressed. In intensive

Figure 2.
Vibriosis in shrimp 1.

systems, crustaceans especially shrimps are often exposed to stressful conditions due to the high stocking density, leading to vibriosis [7]. *Vibrio* usually associated with etiological agents, however some vibrio species have been identified as primary pathogen. Several species of *vibrio* including *V. parahaemolyticus* and *V. harveyi* have been described as the main pathogenic species in shrimps (**Figure 2**) [8].

3.2 Filamentous bacterial disease

The disease was characterized by fouling of gills, setae, appendages and body surface. Molting is impaired and the larval shrimp may die due to stress and hypoxia, which is caused by filamentous bacteria such as *Leucothrix mucor*, which is diagnosed microscopically. This can be prevented by maintaining good water quality with optimal physical – chemical conditions controlled by 0.25–1 ppm copper sulphate bath treatment for 4–6 hours [9].

3.3 Factors responsible for disease outbreaks

- Unfavorable environment such as poor soil and water quality.
- Poor water exchange facilities with high stock density.
- Usage of poor quality feeds with low protein content.
- Accumulation of sludge in the pond bottom due to the presence of unutilized feed.
- Presence of gut micro flora and numerous virulent pathogens in the pond.

3.4 Disease controlling methods

3.4.1 Bacteriophage therapy

Bacteriophage therapy acts as a prophylactic alternative instead of antibiotics usage in shrimp industry. These are viruses that kill only specific disease causing pathogens and acts as therapeutic agents in pathogenic infections. Unlike antibiotics, bacteriophage therapy has no residual issues and has advantages of being specific to their host bacteria, without harming other micro-organisms [10]. In aquaculture hatcheries, bacterial diseases often cause considerable economic loss across globe for hatchery operators. Bacteriophages and their lytic enzymes are in use for therapy of bacterial infections in human and animals, as biocontrol agents for food protection also as tools in molecular biology, the penentration of phage DNA inside a bacteria is promoted by lysossome produced by the phage. In yellow tail fish, a pathogen named *Lactococcus garveyi* is inhibited by bacteriophage therapy in the early 1990s (**Figure 3**) [11].

3.4.2 Herbs as antibiotics

Herbs act as antibiotic for controlling or reduce the infection of pathogen in aquaculture sector and also increases the survival rate of organisms, during outbreak of disease managements. In *Fenneropeneaus indicus,* the *vibrio* disease controlled by garlic extract and hot water extracts of seaweeds *Sargassum sp* acts

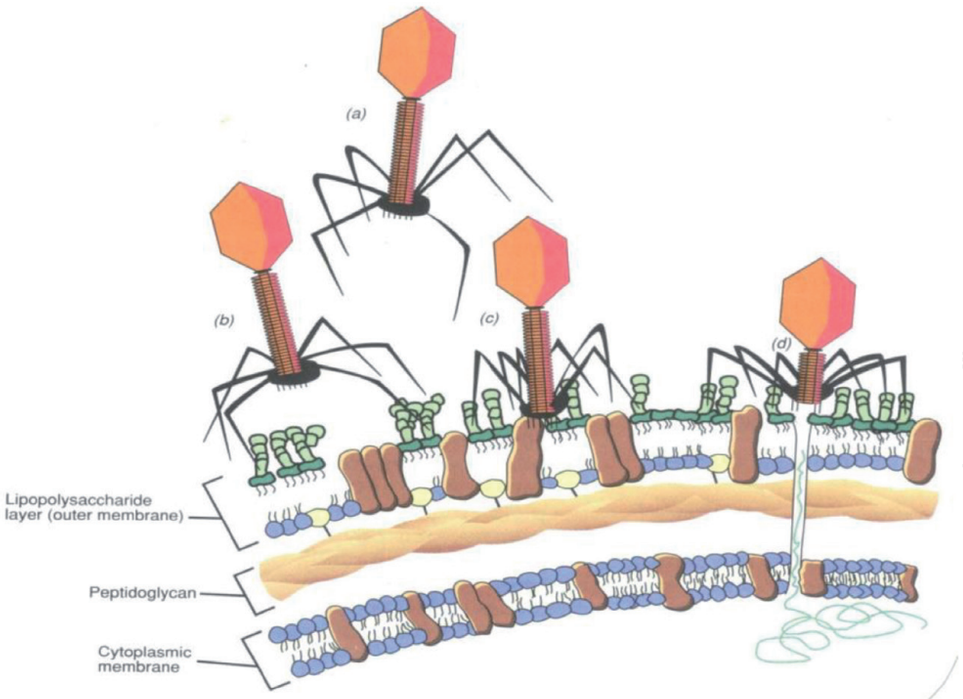

Figure 3.
Bacteriophage attached to bacterial cell 1.

as immunomodulator for white spot syndrome virus (WSSV) in shrimp *P. monodon*. Similarly, *Azardiracta indica* plant extract used as an ailment for *Citrobactor freundii* bacterial infection in *Oreochromis mosambicus* [12]. The majority of herbs act as anti-pathogenic agent, acts as antibiotic to strengthen the immune system of organisms prevent from disease or forming disease resistance variety in aquaculture sector.

3.4.3 Probiotics

Probiotics gaining more attention in recent scenario in all sectors including aquaculture, agriculture and animal husbandry when considering other remedies probiotics acts as a better option rather than incorporating antibiotics to control pathogens in aquaculture. The term probiotic has been defined as a mono or mixed culture of live microorganisms which can be applied to animal or human to enhance the immune system. The animal health is then improved by the removal or decrease in population density of pathogens and by improving water quality through more rapid degradation of waste organic matter (sludge). Environmental microbiology and biotechnology have advanced in the past decade, to the point that commercial products and technologies are available for treating large areas of water and land to enhance population densities of desired microbial species or biochemical activities. The practice of bioremediation is applied in many areas of interest, but success rate varies in different areas, depending on the environmental conditions, nature of products and the method of usage by the consumer, the probiotic that are added must be selected for specific functions. Bioaugmentation and the use of probiotics are significant tools for aquaculture but their efficiency depends on understanding the nature of competition between disease causing pathogens and desired strains of bacteria. *Bacillius* spp., *Lactobacillius* spp., *Pseudomonas* spp., nitrifying and denitrifying bacteria are some of the commonly used probiotic in shrimp culture.

3.4.4 Disease control

The disease control programmers in aquaculture must include examination of diseases and mortalities in a holistic manner and consider various factors such as stocking densities, environment (turbidity, temperature, pH, salinity, dissolved oxygen, H_2S,NH_3,NO_2, etc. of water and redox potential of soil), rate of water exchange, presence of toxic bottom dwelling algae, the type of feed and its FCR ratio by the shrimps, phytoplankton bloom, physiological status of shrimps, etc. [13]. Most of the disease control methods are based on preventive measures. They are,

- Better husbandry practices,
- Use of balanced nutritional supplement,
- Implementing nursery setup to avoid mortality in culture ponds,
- Use of GMO stocks for culture,
- Use of herbal extracts as antibiotics and
- Use of vaccines or drugs.

Diseases can be prevented by adapting better animal handling practices and providing adequate amount of nutrient rich feed [14]. Vibriosis is controlled by rigorous water management through ROS systems and sanitation to prevent the entry of vibrio in the culture water and to reduce stress on the shrimps. Good site selection, pond design and pond preparation are also important. An increase in daily water exchanges and a reduction in pond biomass by partial harvesting are recommended to reduce mortalities caused by Vibriosis. Draining, drying and administering lime/dolomite to ponds following harvest is also recommended [15].

4. Conclusion

In spite of all these recent advancements to eradicate all the bacterial diseases in shrimps, still there is a void for complete eradication of these diseases. Various techniques and medicines are introduced to cure these bacterial infections, but still there are certain side effects for consumers, by introducing antibiotics and other medicines for respective infections. So when it comes to large scale like commercial farming, the efficacy of the above mentioned techniques for prevention and cure of cultured shrimps from bacterial diseases is low when compared to laboratory conditions.

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