Different disease control methods in shrimp aquaculture: A review

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Abstract

Aquaculture has become an important economic activity in many countries all over the world. Shrimp production is depressed by disease particularly caused by luminous Vibrio viruses. Many antibiotics don't work or make pathogens stronger and harder to treat. Antibiotics are also a concern because they help bacteria become resistant to them. Antibiotics, which have been used in large quantities, are in many cases ineffective, or result in increases in virulence of pathogens and, furthermore, are cause for concern in promoting transfer of antibiotic resistance to human pathogens. This review article provides a brief explanation on Probiotics and Prebiotics to improve the host's immunity which considered a replacement for antibiotics. Also critical review on the immunostimulants available from plants, animals, and chemicals against WSSV in shrimps, the role of Immunostimulants for shrimp aquaculture and finally the microalgae which help to prevent and control diseases caused by *Vibrio* species.

Keywords: Aquaculture, Antibiotics, Probiotics, immunostimulants, Vibrio, Microalgae

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Introduction

The majority of shrimp and prawns production is in Asia and Latin America, the European Union and Japan. However, the percentage of shrimp in total trade has gone down and salmon has taken over as the most valuable commercial good (FAO, 2020). The impact of disease outbreaks and price variations associated with the boom-and-bust cycle have hurt the farmed shrimp sector. The high volumes of production in the last two years led to low market prices. An increase in Chinese shrimp imports, to a large extent attributable to a crackdown on illegal and unreported smuggling via intermediary countries such as Vietnam, has supported increases in export revenue for Ecuador, in particular (FAO, 2020). Due to the increasing demand for aquaculture products and the continued decline in wild catches, aquaculture has become the most important way to bridge the gap between fish demand and supply worldwide. Current production numbers are higher than catches at 18.32 million tons and are worth about US$250 billion. There are more than 300 different marine species in more than 190 countries (Anirudhan *et al*., 2021).

Bacterial diseases are the most devastating for aquaculture. They can survive in the water without their hosts. There have been reports of 13bacterial species affecting marine species. In the Southeast Asian region, vibriosis is the most important cause of death. The Washington coast was the first place to report vibriosis. (Anirudhan *et al*., 2021). This review focuses on the use probiotics and prebiotics, immunostimulants, antimicrobials, microalgae to prevent and control diseases in shrimp aquaculture

Immunostimulants for shrimp aquaculture

Diseases continue to be the main obstacle for most aquaculture enterprises. Vaccines are a good way to keep diseases under control in shrimp farming. The different types of vaccines used include:

Live attenuated vaccines, toxoids, and subunit vaccines are not the only types of vaccines used. Similarly, antibiotics like oxytetracycline, oxytonic acid and sarafloxacin have found their way into commercial projects. The immunostimulants can be administered as a supplement. Although chemical drugs haven't been used a lot to control disease pathogens in aquaculture, the emergence of drug-resistant pathogens has led to more attention being paid to other methods of disease control. In the last few years, a lot of research has been done on using biocontrol measures to prevent diseases. Below are some of them (FAO, 2020). White spot disease (WSD) is one of the most devastating viral diseases caused by white spot syndrome virus (WSSV) (Pradeep *et al*., 2012). Many host species have been recognized for WSD (Stentiford *et al*., 2009).

White spot disease is caused by the white spot syndrome virus. From the past several decades many researchers focus on the causes of WSD in farmed shrimps such as *Penaeus monodon*, *Fenneropenaeus indicus*, *Marsupenaeus japonicus*, *Litopenaeus vannamei*, *Penaeus merguiensis*, *Penaeus indicus*, *Penaeus chinensis*, *Penaeus duorarum*, *Penaeus vannamei*, *Penaeus japonicus*, *Litopenaeus setiferus*, *Macrobrachium rosenbergii*. The shrimp population can be affected by the disease in a few days. At this time, there is no absolute treatment for WSD. There are a number of reasons why no effective treatment is available. There are not enough host genome sequences, enough information about how WSSV works, or enough understanding of how proteins interact at a molecular level between the host and the pathogen in shrimp. Also, shrimp have an immune system. An immunostimulant is a substance that mimics the host's immune system. A naturally occurring substance mimics the immunostimulant of a host. There are several groups of immunostimulants depending on their sources: bacteria, algae, animal-derived, and hormones/cytokines. Polysaccharides from seaweeds have been tested as immunostimulants. The increase in defensive effectiveness has been shown by oral administration of immunostimulants. Recently, herbal extracts have shown that they can make shrimps immune systems stronger against yellow head virus YHV and white spot syndrome virus WSSV. Five diverse herbal medicinal plants, such as *Eclipta alba*, *Aegle marmelos*, *Tinospora cordifolia*, *Picrorhiza kursk*, and *Cyanodon dactylon*, displayed immunostimulatory properties and significantly reduced the viral load with an increase in survival rate (74%) of shrimp.

Antimicrobials and pathogens

The most important pathogen of shrimp is the photoluminescent *V. harveyi* (FAO, 2020). The effectiveness of antibiotics in fighting these bacteria is generally very weak. In 1996, a large loss of shrimp production was caused by vibrato lumesca disease in the Philippines and many farms stopped production. All antibiotics tested, including chloramphenicol, furazolidone, oxytetracycline and streptomycin, were ineffective against the Vibrio species present, and the bacteria were found to be more virulent than in previous years. Some strains of bacteria that carry genes for resistance survive when antibiotics are used to kill them. Their competitors are then eliminated, and they grow rapidly. It's possible for any pathogen that returns to the pond or hatchery to exchange genes with resistant bacteria and survive new antibiotics. Because of this, pathogenic strains are developing antibiotic resistance quickly (Moriarty, 1999).

Microalgae

Microalgae, also known as "green water" technology, is the most commonly used technology for disease control in aquaculture. Microalgae help prevent and control diseases caused by *Vibrio* species._The growth rate and resistance to diseases in freshwater shrimp have been reported to be increased by *Chlorella vulgaris* (FAO, 2020).

Algae supplements have been reported to contain various compounds that act as non-specific immunostimulants, enhancing the animal's innate defense mechanisms and thus improving resistance to pathogens (Shah *et al*., 2018). Finally, the antimicrobial compounds that are produced by many species of microalgae may be effective against some pathogens (Falaise *et al*., 2016).

Some microalgae species contain biomolecules that serve as immune stimulators, and they exhibit natural anti-bacterial activities (Shah *et al*., 2018). In order to address the issue of bacterial infections in shrimp and fish feed, crude algal extracts and whole cells have been used (Yaakob *et al*., 2014). Members of the *Vibrio* bacterial genus are most often used to test the ability of microalgae to stop bacteria from growing. A microalgal homogenate from *Tetraselmis suecica* showed good antibacterial activity against a number of shrimp pathogens such as *Vibrio alginolyticus*, *Vibrio anguillarum*, *Vibrio parahaemolyticus*, and *Vibrio vulnificus* (Austin and Day, 1990). Several studies have shown that eicosapentaenoic acid, as well as algal sterols, have anti-bacterial properties and can be effective against both Gram-positive and Gram negative organisms. (Benkendorff *et al*., 2005).

Therefore, adding microalgae to the diet of aquatic animals is likely to help prevent bacterial infections. Vitamin C, which is found in high amounts in many microalgae species, was said to improve immunity in shrimp, which led to a lower death rate from *Vibrio* species (Kanazawa, 1995; Kontara *et al*., 1997).

The protection against viral pathogens can be enhanced by the use of immune stimulators. A diet with 80 mg/kg of astaxanthin, which is found in high amounts in green algae like *Haematococcus pluvialis* and is usually used to improve color, helped protect and immunize against white spot syndrome virus (WSSV) in *L. vannamei* (Wang *et al*., 2015). This astaxanthin also caused an increase in antioxidant enzymes. Since *Dunaliella salina* species contains high amounts of beta-carotene, it was found most applicable for protection against the virus (Charoonnart *et al.,* 2018).

Probiotics and prebiotics

The term "friendly or healthy bacteria" is used to describe the organisms. Microbial that are beneficial for the hydrobionts are considered an important alternative to environment-friendly treatments for the outbreak of diseases. Through the action in the stomach, it is possible to improve the health of a host through improved feed value, antimutagenic and anticarcinogenic actions, and an increase in the number of beneficial organisms. Several studies have shown that commercial probiotics improve shrimps growth, survival, immunity, and disease resistance (Anirudhan *et al*., 2021).

Fuller (1989) said that a probiotic is "a live microbial feed supplement that improves the intestinal microbial balance of the host animal" (Fuller, 1989). The host's health status can be improved by the consumption of the beneficial bacteria (Kumar *et al*., 2016). They improve the host's immunity and are considered a replacement for antibiotics. The animal's host can provide the source of the probiotics. It can be a single type of nonpathogenic bacteria or a culture of mixed nonpathogenic bacteria. The introduction into the culture system of harmless and beneficial bacteria will have a competitive advantage over potential pathogens and also to colonize the ecological niche, according to its work (Kumar *et al*., 2016). The survival of the host can be improved by the presence of the probiotics (Moriarty, 1999).

Verschuere suggested that "probiotics in aquaculture" be defined as "a live microbial examination that has a positive effect on the host by changing the host's ambient microbial community, improving its food, or enhancing its nutritional value and also by improving the host's response to disease or improving the quality of its environment (Verschuere *et al.,* 2000). Shrimp health is improved by probiotics through resistance to colonization by pathogens, through the release of metabolites that prevent growth of pathogens, and through increasing shrimp resistance to diseases. Many researchers have shown that probiotics can be used to control diseases in shrimp aquaculture. This is because there is a demand for an eco-friendly approach to aquaculture. However, many full-scale trials are still needed (Dawicki, 2012). Improved nutrition, healthy digestion, and disease prevention are some of the benefits of using the use of probiotic bacteria.

The control of shrimp and other aquatic animal diseases has been done successfully (Newaj-Fyzul *et al*., 2014). Shrimp health is improved by probiotics through two mechanisms. First, they compete with pathogens for resources, reducing the likelihood of colonization. Second, they produce metabolites that inhibit pathogen growth, further increasing the shrimps' resistance to disease (Moriarty, 1999). This qualified probiotic needs to be applied for the safe management of shrimp diseases in aquaculture, according to Wang *et al*. (2005). It is important to develop tests that measure and monitor the immune status of shrimp. These tests can help prevent shrimp diseases, just as tests for human and animal health can help prevent other diseases. Regular health controls will let us find out if shrimp have Immune problems.

This will help with the development of strategies to decrease disease susceptibility and improve environmental quality. In order to assist shrimp production in the long term, we should focus research on developing disease-resistant shrimp (Bachère *et al*., 1995). We can do this by pursuing parallel research in immunology and genetics (Strittmatter and Wegener, 1993).

Quantitative genetic selection for increased resistance to disease could be achieved through measurement of defense reactions and the characterization of immune genes. Another strategy for obtaining resistant strains may be genetic transformation. The expression of immune encoding genes could be modified or the expression of foreign genes could be used to confer resistance on shrimp (Bachère, 1998).

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