

AQUACULTURE - AN OVERVIEW

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Abstract

Fish farming or pisciculture involves commercial breeding of fish, most often for food, in fish tanks or artificial enclosures such as fish ponds. It is a particular type of aquaculture, which is the controlled cultivation and harvesting of aquatic animals such as fish, crustaceans, molluscs and so on, in natural or pseudo-natural environments. Within the aquaculture sector, production of white leg shrimp (*Litopenaeus vannamei*) ranked first in value of farmed aquatic species. *Litopenaeus vannamei* is an omnivorous scavenger and is less aggressive. Shrimp aquaculture began incidentally centuries ago in Asia, then progressed into extensive, seasonal culture in India, Bangladesh, and Vietnam, until the twentieth century brought strides in research regarding the complex shrimp life cycle. The current paper covers a general aspect on aquaculture and shrimp cultivation.

Keywords: Aquaculture, *Litopenaeus vannamei*, Shrimp cultivation.

Background

Global demand is increasing for dietary fish protein. As of 2016, more than 50% of seafood was produced by aquaculture. In the last three decades, aquaculture has been the main driver of the increase in fisheries and aquaculture production, with an average growth of 5.3 percent per year in the period 2000–2018, reaching a record 82.1 million tonnes in 2018. Aquaculture also plays a crucial role in food security by providing jobs and improving 60 nutrition in developing countries (Bénéa et al., 2016).

Role of Aquaculture in Shrimp Cultivation

Aquaculture plays a significant role in food and nutrition security and is a source of people's livelihoods (Hassan et al., 2021a, b; Abidin et al., 2022). Intensification of the aquaculture industry aims at increase in overall production while minimizing land and water use (Avnimelech and Kochba, 2009). Within the aquaculture sector, production of white leg shrimp (*Litopenaeus vannamei*) ranked first in value of farmed aquatic species (Tacon, 2017). It has expanded to over three million tons annual global production. As white leg shrimp tolerate a wide range of salinities, a potential method to reduce impacts is freshwater inland culture, which would decrease operational and environmental costs. White leg shrimp also known as Pacific white shrimp or King prawn, is a species of prawn of the eastern Pacific Ocean commonly caught or farmed for food. Catch trends have remained relatively stable for wild capture fisheries, at approximately 90 million tons; aquaculture production has steadily increased, and is now over eight times greater than production in the 1950s (FAO, 2015). Growing at a rate of eight percent per year, the yield of aquaculture has increased faster than any other animal protein production source since the 1970s. Aquaculture now provides over half of the world's seafood, and its value will likely continue to increase as the global population is projected to reach 9.6 billion by 2050 (FAO, 2014).

Aquaculture has “numerous important social, economic and environmental benefits, including increased food security and poverty alleviation impacts, increased employment opportunities within rural communities, increased seafood supply and availability, improved human nutrition and well-being, increased foreign exchange earnings, improved wastewater treatment/water reuse and crop irrigation opportunities, and improved nutrient recycling” (Tacon and Halwart, 2007). Shrimp is the most highly traded seafood product (Cao, 2012) and “continues to be the largest single commodity in value terms, accounting for about 15 percent of the total value of internationally traded fishery products in 2012”. Shrimp were initially harvested mainly in the wild capture fishery, but are now also produced by aquaculture.

Shrimp aquaculture began incidentally centuries ago in Asia, then progressed into extensive, seasonal culture in India, Bangladesh, and Vietnam, until the twentieth century brought strides in research regarding the complex shrimp lifecycle (Alday Sanz, 2010). White leg (WL) shrimp, *Litopenaeus vannamei*, primarily comes from Asia and the Americas (FAO, 2016). This species dominates shrimp culture in the Western hemisphere (Araneda et al., 2008), but Thailand and China are the top two producers (Cao, 2012).

Litopenaeus vannamei cultivation- overview

Litopenaeus vannamei has a transparent white body, making it called as white shrimp. As an arthropod or animal that does not have a backbone, the morphology of the vannamei shrimp is divided into two parts. They are the fused head and chest (Cephalothorax) and the abdomen. Vannamei shrimp head consists of antennae as chemoreceptors, antennae for detecting predators, mandibles, two pairs of maxillae for crushing food, maxillipeds for filtering and delivering food to the mouth, a pair of facet eyes (compound eyes), rostrum, and peripods or walking legs. While the abdomen consists of six segments, segments 1-3 called as sternal region and segments 4-6 called as pleuron. On the abdomen of this vannamei shrimp, there are five pairs of swimming legs (pleopods) and a fan tail formed from uropods and telsons.

Litopenaeus vannamei grows to a maximum length of 230 mm (9.1 in), with a carapace length of 90 mm (Boone, 1931a). Adults live in the ocean, at depths to 72 m (236 ft), while juveniles live in estuaries. The rostrum is moderately long, with 7–10 teeth on the dorsal side and two to four teeth on the ventral side. White leg shrimp are native to the eastern Pacific Ocean, from the Mexican state of Sonora to as far south as northern Peru. It is restricted to areas where the water temperatures remain above 20 °C (68 °F) throughout the year (Boone, 1931b). It is mainly found on mud bottoms, down to a depth of 75 m. The maximum weight of the females in the wild is about 120 g. The males are smaller at 60-80g. It lives in the column and prefers clayey loam soil. For *Litopenaeus vannamei* the growth at 30°C is much higher than at 25°C. The optimal range of temperature for the species is between 30 and 34°C. At 20°C growth virtually stops. It can tolerate salinity levels of 0 to 50 ppt. Growth is uniform within 10-40 ppt. They can grow in freshwater also but the growth is slower below 10 ppt. pH range of 7 to 9 is tolerated with optimal growth at pH 8.0. Dissolved oxygen levels above 4.5 ppm are required for optimal growth. Turbid water with flocculated particles would lead to better growth than clean water mainly because of the presence of algae and bacteria. Ammonia -N and Nitrite - N levels should be less than 0.1 ppm and 1 ppm respectively (Sanzyme Biologics, 2019). Food intake is more during evening and night. Retention time of food in the gut is 2.2 to 5 hours. Growth of *Litopenaeus vannamei*, under confined culture conditions is similar to *Penaeus monodon* till they attain 20g size. Beyond that the growth rate was poor. The shrimp usually attain a size of 20g within a period of 100-120 days depending on the stocking density.

During the 20th century, *Litopenaeus vannamei* was an important species for

Mexican inshore fishermen, as well as for trawlers further offshore. In the late 20th century, the wild fishery was overtaken by the development of aquaculture production; this began in 1973 in Florida using prawns captured in Panama, that were used in hatcheries for larvae production.

In Latin America, the culture of *Litopenaeus vannamei* started to develop with the availability of hatchery larvae, the development of feeds, the technification of the growth processes, the freezing installations and market channels, among others. From Mexico to Peru, most countries developed in the 70s and 80s large production areas. Ecuador became one of the world leaders producers of this type of shrimp.

Around the beginning of the millennium, Asia introduced this species in their aquaculture operations (changing from *Penaeus monodon*). China, Vietnam, India and others have become major packers as well. The packing of shrimp from aquaculture origin has overpassed the quantity of ocean caught wild shrimp in recent years. Both origins, ocean caught and aquaculture, are subject to weather changes and diseases.

Vannamei has several stages of its life cycle that must be passed. Starting from eggs, nauplius, protozoa, mysis, post-larvae, juveniles, sub-adult, to adult shrimp. In 2016, *Litopenaeus vannamei* accounted for 53% of the total production of farmed crustaceans globally (World Review, 2018).

Cultivating *vannamei* shrimp pond is a very profitable business for farmers (Adhiana et al., 2023). *Vannamei* shrimp is a type of shrimp that grows quickly from fry to harvest. That is, one cycle only takes three months. *Vannamei* shrimp pond plays a crucial role in aquaculture. Because, in this pond, the shrimp will be raised until they are ready for harvest later. The pond preparation aims to support the formation of an ecosystem conducive to maintaining shrimp during one cultivation cycle. Good human resource preparation will result in neat pond data recording and more successful *vannamei* cultivation. Farmers must ensure that the combination of autotrophic and heterotrophic bacteria in the pond is balanced through this stage. In addition, make sure no pathogens and other pests remain in the pond because production of *Litopenaeus vannamei* is limited by its susceptibility to white spot syndrome, Taura syndrome, infectious hypodermal and haematopoietic necrosis, baculoviral midgut gland necrosis, and *Vibrio* infections.

Vannamei shrimp is a fishery commodity that has high economic value. Since it was first introduced to Indonesia, *vannamei* shrimp has become a prima donna among farmers. This is because the shrimp, which has the Latin name *Litopenaeus Vannamei*, has excellent

resistance to the environment and can adapt quickly. Not only that, market demand for vannamei shrimp also continues to increase due to its nutritious seafood option that offers a wide range of health benefits. It provides high quality rich protein, calcium and various extractable compounds and minerals for human body, while low in calorie and fat (Abdullah et al., 2009). Lipid of shrimp contains mostly polyunsaturated fatty acids (essential fatty acids). These essential fatty acids are available in shrimp provides health benefits for human e.g., eye (retina) and brain development and function (Conner et al., 1992). There are many inorganic elements in the body of shrimp that support associated vital physiological functions. Although shrimps are capable of extracting some of the elements from water, they do respond to dietary sources (Deshimaru and Yone, 1978; Kanazawa et al., 1984; Davis et al., 1992). Since these micronutrients are essential, their absence in the diet may lead to deficiency disease. Some elements, such as copper, zinc, manganese, iron and chromium have useful biological function and are found in shrimp at acceptable levels are very useful for human health (Abdullah et al., 2009).

Conclusion

India has a vast coastline, which allows for extensive exploitation of marine resource. Shrimp farming is one of the most rapidly expanding aquaculture sectors in Asia, Latin America, and, more recently, Africa. Until 2009, shrimp farming in India was linked with the monoculture of tiger shrimp, *Penaeus monodon* (Ramaswamy et al., 2013). Because of the availability of Specific Pathogen Free (SPF) and Specific Pathogen Resistant (SPR) brood stock, most South East Asian nations, including Thailand, Vietnam, and Indonesia, have moved to culture of exotic White leg shrimp, *Litopenaeus vannamei*, since 2001-02. Around 75% of farmed shrimp is produced in Asia, mostly in China and Thailand. The idea of a limitless market demand, high export prices, job creation, and increased foreign exchange profits have pushed several countries in the region rich in aquatic resources to prioritize the development of the shrimp farming business. Vannamei shrimp business is indeed promising, with fantastic profit potential, which has made it increasingly popular among the community.

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