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Health Management in Coastal Aquaculture System

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Aquaculture is moving at a rapid pace and is the great hope to fulfill the protein requirement of future world population. However, with the increased stocking densities disease has almost become an integral part of aquaculture bringing huge mortalities and economic losses. An effective health management practice is therefore required to tackle this problem and avoid major losses. More efforts should be made in preventing the disease occurrence through the use of vaccines and immuno-stimulants. Similarly, plant based natural substances and biological control strategies should be adopted for treatment purpose. Wherever necessary, antibiotic use should be restricted. Indiscriminate use of other chemicals should also be avoided to prevent the adverse effect on host immune system. Modern technologies like CRISP-R based methods, RNAi and development of vaccines through Virus like particles (VLPs) should be effectively used to develop aquatic animal health management strategies. Climate change is predicted to generate worst effect through creation of more virulent pathogens and therefore effective better management practices can be developed to tackle the problem.

(***Key words:*** *Aquaculture, Health management, Modern technologies, Prevention*)

As a multibillion-dollar industry, aquaculture is moving at a rapid pace and has spread its tentacles throughout the world. With the limitation in capture fisheries, this sector provides the hope to continue with fish as a staple cheap protein source. Apart from fulfilling a substantial amount of protein requirement for a large portion of world population, fisheries sector also considerably contributes to the overall economy improvement (Bene *et al*., 2015) and in this regard, aquaculture is the only hope to continue this trend. Over the past 3 decades, aquaculture has been growing at an average rate of 8.2% per annum (FAO, 2016) and due to which more than half of fish consumption at present is contributed by farmed fish. Steady world population increase suggests a scenario (World Bank, 2014) where the aquaculture production needs to be doubled by 2030 to meet the demand. Because of this continuous higher demand, the industry has been evolving and expanding through intensification (Rico *et al*., 2012). However, to meet further higher demand, species diversification and super-intensification are highly essential.

Coastal aquaculture in India is almost synonym to shrimp culture practice as fin fish and culture of other species is yet to start in large scale. Initially it started as traditional practice with the native tiger shrimp, *Penaeus monodon*, and subsequently moved into modified ones like semi intensive, intensive and super intensive cultures. Accordingly, the production also started to increase substantially. Subsequently due to several issues, the tiger shrimp culture was not able to move forward and farmers started looking for an alternate species when the Pacific white shrimp, *Penaeus vannamei* appeared as the best substitute. With thorough risk analysis and associated precautionary measures, Government of India permitted the import of specific pathogen free (SPF) *P. vannamei* brooders. The impact was felt immediately with popular adoption by farmers and steady increase in production.

Disease is a major constraint on the way to success of any aquaculture practice. All kinds of microorganisms such as virus, bacteria, fungi and parasites have been found to be associated with both fish and shellfish diseases. Invariably viruses are the most virulent ones and have been responsible for severe mortality and huge economic loss. However, other microorganisms like bacteria, as in case of acute hepato-pancreatic necrosis disease (AHPND), can also cause equal havoc. The annual losses due to disease have been estimated to be

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more than $6 billion (World Bank, 2014). However, the actual figure may be much more than this as systematic studies in this regard are lacking and many of the cases are either not reported or under reported. In some of the individual cases like shrimp, which is considered as a high value product, the total loss due to disease sometimes has been reported to be more than 40% (Israngkura and Sae-Hae, 2002). Apart from infectious diseases, aquatic animals also suffer mortality and industry face huge losses due to sudden environmental and climatic changes. Therefore, management is an essential aspect either to totally prevent or minimise the loss.

Major health management practices for aquatic animals

Prevention is better than cure

Maintenance of proper biosecurity

The best way to avoid disease is to prevent the entry and spread of pathogens into/out of the system. Biosecurity is one part of effective management through which pathogens can be prevented entering into aquaculture practices (Phu *et al*., 2016). This starts from zero levels both in farms and hatcheries. Starting from effective preparation of the system, sanitization of equipments and workers, effective barricades to prevent the entry of pathogens as well as carrier animals, regulating the entry, proper quarantine, regular disease monitoring/surveillance, treatment of farm/hatchery water, treatment of discharge water etc. are part of this procedure. All these steps are part of better management practices (BMPs) and if followed meticulously, it will be possible to prevent the disease occurrence to great extent.

Maintenance of effective immune system to fight against disease

Vaccines (where the immune system is developed, for example fin fishes) and immuno-stimulants (where the immune system is less/under developed, for example shell fishes), wherever available, should be used to prevent disease. Compare to the earlier periods, there has been much improvement in vaccination programme of aquatic animals for which multivalent vaccines have been developed and mass vaccination has been made possible (Plant and LaPatra, 2011). However, still in large cases it has not been possible either to develop or use vaccines/ immuno-stimulants. In many of the cases, though it has been possible to develop vaccines, field application has been a major bottleneck. Advancement in vaccine development and application can solve major problems in aquatic animal health management. Though some of the vaccines are currently approved for use in aquaculture, the entire vaccination concept for aquatic animals still has to go a long way to achieve success. The story in case of shell fishes like shrimp is more complicated where use of vaccines has not been possible. In these cases, use of immuno-stimulants has been useful to some extent (Deveraj *et al*., 1998) at least to provide protection against less virulent pathogens. Prebiotics are also considered as immuno-boosters. These substances are resistance to digestion by endogenous enzymes and can safely reach the targets to stimulate the growth of natural probiotics bacteria which in turn boost the host immune system.

Adoption of better culture practices like biofloc system

Biofloc is a well-developed technology for high density aquaculture. In this system adjustment of carbon and nitrogen ratio creates heterotrophic bacterial and algal growth that produces floc. This floc can be used as a bio-remediator to clean and thus provide a healthy environment for culture organisms. Most importantly, the floc can also be used as feed by cultured organisms which reduces the cost and improves immune system that provides better protection against diseases (Panigrahi *et al*., 2018; Panigrahi *et al*., 2019). Added to it, very less water exchange is required due to self-purification process and therefore less chance for pathogen entry. Biofloc technology has been proved to be effective both for finfish and shell fish culture. Very recently, it is more used for very high density shrimp aquaculture.

Disease treatment

Though prevention is better than cure, many times it becomes inevitable to go for a treatment protocol when the situation becomes worse.

Proper disease diagnosis

This is the first step towards disease treatment. Accurate disease diagnosis helps to identify the actual causative agent and this follows the exact treatment protocol. If a pond is diagnosed with viral infection, it will be just wastage of money, material and time to use antibiotics to cure the disease. Rapid, sensitive and cost effective diagnostic protocols help to diagnose the causative agent accurately and quickly. When a disease is diagnosed at early stage, the chance to control is always easier. Many of the modern molecular methods have been helpful in accurate disease diagnosis for aquatic animals (Kim *et al*., 2017). Recently developed CRISP-R technology can be added to those modern technologies for more accurate and quick diagnosis of aquatic pathogens. In most cases field level diagnostic methods should be developed which can be easily used by the farmers themselves and diagnose the disease at the right time to take a proper decision on the treatment or harvest of the crop.

Natural antimicrobials vs. antibiotics

Many of the plant based antimicrobials have been proved to be efficient in controlling bacterial and parasitic diseases (Reverter *et al*., 2014). Either the whole plant or the active ingredient can be used after proper extraction. On the other hand, use of antibiotics in aquatic environment is highly discouraged as it can develop drug resistance strains. Wherever it is inevitable, only approved antibiotics should be used (Rogers and Basurco, 2009). Similarly, indiscriminate use of many of chemical antimicrobials should also be avoided. These substances can pollute the aquatic system, kill the beneficial microbes and moreover exhibit adverse effect on the immune system of cultured species.

Biological control

One of the best approaches in aquatic animal health management is to control the infectious agents through biological agents (Maqsood *et al*., 2011). As the biological agents used to control the infectious agents from the culturing environment itself, no adverse impact is expected. Bacteriophages have been best used for this and found to be effective. Similarly, large number of beneficial bacteria have been isolated from the environment and used as probiotics. These microbes have ability to kill the pathogens directly through their extracellular products or indirectly prevent the infection through immune boosting of cultured organisms.

Other modern treatment strategies

It is always difficult to control viral agents and same is in the case for aquaculture. Major loss due to disease is therefore from viral infections. However, some of the modern technologies like RNAi have provided hope in this regard. This technology has been proved to be effective at laboratory-based methods (Amarnath *et al*., 2019) and development of a proper field application will be of great use for farmers to avoid major economic losses.

Specific structures from viral entities can be developed, tertiary structure of which mimics that of native virus and such structures are called as virus like particles (VLPs). These VLPs have a great future for the development of next generation vaccines in aquaculture (Jeong *et al*., 2020). However, lot of challenges are there in producing such VLPs and developing a field application method. Nevertheless, these modern treatment strategies, if standardised, can take aquaculture to greater heights.

Climate change and aquatic animal health management

Major elements of climate change those are predicted to affect overall aquaculture production includes global warming, extreme weather patterns, change in monsoon pattern, sea level rise, change in ocean circulation pattern etc. (De Silva and Soto, 2009). As most of the cultured aquatic animals are poikilothermic, any major change in climatic conditions will affect their body physiology and metabolism. This will subsequently influence their natural disease resistance pattern. Similar is the case of pathogens, climate change affects the distribution, prevalence and virulence of pathogens as well as the susceptibility of the host and thereby may increase the risk for aquaculture (Harvell *et al*., 1999). Changes in essential water quality parameters due to climatic change may have adverse effect on the immune system. Further, if the change parameters favour the proliferation of pathogens, worse situation may arise.

Appropriate management strategies for aquaculture need to be developed to cope up with the change in climatic condition. Resistance species those can well withstand adverse environmental conditions should therefore be developed through specific breeding programme for culture practice. Climate change specific better management practices should be forecasted and developed to manage the pathogens.

Major constraints in aquatic animal health management

In view of the aquatic animal health management, it is essential to have a thorough knowledge on the host. Most of the aquatic animals are less studied and knowledge on their body physiology and immune system are still lacking. In such case, it is difficult to take appropriate decision and suggest treatment. Similarly, less is known about aquatic pathogens, particularly when it is an emerging disease with respect to its origin, nature and virulence. In most cases, it becomes difficult to diagnose the actual causative agent and, in such cases, it takes much longer time for the effective management practices. Moreover, aquatic environment itself also possesses a major problem where the spread of disease is very easy and treatment process is difficult. Last but not the least, the regulatory mechanism which is complex and vary from region to region. Most of the regulatory processes are derived from terrestrial animal protocols and many countries are yet to have their own regulatory processes for the health management of aquatic animals.

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