35

An introduction to fish health management

Vijayan, K. K. and N. K. Sanil

Marine Biotechnology Division, CMFRI, Cochin - 682 018, vijayankk@gmail.com

Introduction

Achieving food safety in terms of valuable protein for the ever growing population of Indian subcontinent is a major challenge in the 21st century. In this endeavour 'Aquafarming' is to play a major role, as agriculture and animal husbandry has been slowing down in growth. The strength of Indian aquaculture lies in (a) large water bodies suitable for aquaculture, (b) tropical Climate, (c) species diversity and (d) availability of cheap labour. While the weakness include (a) unregulated development, (b) disease problems and (c) lack of scientific approaches. It is estimated that about 5 million tones of aquatic animal products can be produced annually through aquaculture, in India.

As aquaculture production expands, diversifies, and becomes more intensive, the risk and effects associated with pathogen introduction, transfer, disease outbreaks, and pathogen spread are enhanced. The growth, economic viability and sustainability of aquaculture primarily depend on the successful prevention or control of disease outbreaks. Unlike the land based farming, disease problems in aqua farming are complicated due to the three-dimensional nature of culture system where the dynamic interaction of biotic fauna comprising the host and opportunistic pathogens and the environmental factors exists. Disease prevention in aquaculture is not merely a case of dealing with the pathogen and its elimination, but it has to be dealt with a broader perspective, which is now popularly termed as FISH HEALTH MANAGEMENT.

Mariculture – Indian scenario

Shrimp farming dominates Indian aquaculture scene. Importance and need of finfish and shellfish mariculture is coming into lime light, mainly due to the viral disease problem and related crop losses prevailing in the shrimp farming areas of coastal India. The accumulated losses due to white spot syndrome virus (WSSV) alone in India, during the past decade is about Rs. 3000 crores. The importance of finfish and shellfish mariculture is growing as an alternative for the diseases gripped inshore shrimp farming. The research efforts by CMFRI in the development of maricuture technologies of the candidate species such as bivalves, swimming crabs, sand lobsters, finfishes and marine ornamentals have shown initial success. Farming of the green mussel and edible oyster has become a popular livelihood activity by the self-help groups along the costal belt of Kerala, and the farming area is growing every year. CMFRI has succeeded in the hatchery rearing of swimming crabs, sand lobsters and marine ornamentals.

When the rearing activities are in the experimental and demonstrative level, which are at a lower level of intensity, the problem of microbial diseases may not be significant. The absence of clinical or obvious disease problems does not indicate that there are no disease causing pathogens or possibilities of epizootics. Along with domestication and the intense rearing comes an increase in the incidence of infection and potential for disease. Intensive systems lead to higher stocking densities and increasing stress. When animals become stressed, disease outbreaks often occur. Creation of Intensive rearing systems aiming for more and more production and profits, without proper planning and management, invite problems of infection and disease.

One of the most important factors in dealing with the disease is INFORMATION. Knowledge is required on the potential disease causing pathogens, role of environmental factors, health status of the host, diagnostics and therapeutic options.The four K's essential for scientific aquaculture health management are

- Knowledge about the disease process
- Knowledge about the pathogen
- Knowledge about the host and
- Knowledge about the environment.

These information forms the key elements in deciding upon the best means of dealing with a disease or formulating a health management strategy. Hence the best approach in collecting the information should be proactive, rather than waiting for a disease outbreak. One single piece of information, that the disease is caused by a viral pathogen and there is no cure, would desist the farmer from spending large amount of money for 'bogus' cure, and also from additional losses due to delay in harvesting

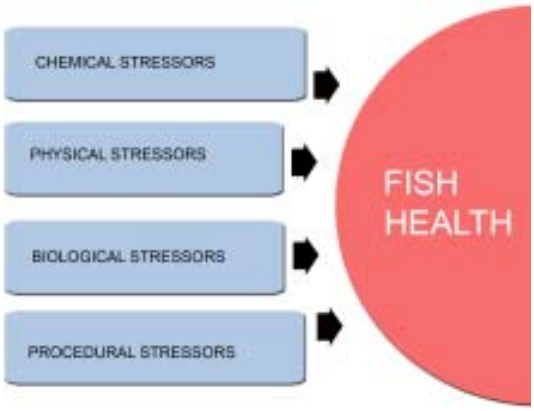
Diseases in aquatic animals can be caused by pathogens as well as by other factors. Common disease causing pathogens include parasites (both protozoan and metazoan), bacteria, fungi and viruses. Other agents causing diseases include toxins, chemicals/pollutants, nutritional imbalance etc. Disease development process is often complicated and involves host-pathogen-environment interactions.

The Genesis of Disease in Aquaculture/Mariculture

Disease is an abnormal condition characterized by a gradual degeneration of fish's/shellfish's ability to maintain normal physiological state due to various factors adversely affecting its well-being. Any impairment that interferes with the performance of normal functions of an animal can be termed a disease. Diseases can be caused by a variety of factors, the most important being pathogens. Other factors contributing towards the development of disease conditions include stress, environmental/water quality, physical agents, nutritional imbalance, toxins etc or a combination of these. Disease condition what we see is thus a complex situation resulting from the interaction/ modification of the primary disease condition by these biotic and abiotic factors. In culture conditions the health status of the animal can become weak due to different stress factors such as chemical stressors, biological stressors, physical stressors and procedural stressors.

Role of Stress in Disease Development

The role of stress in predisposing the fish/shrimp to infections is widely recognized and many of the routine aquaculture practices are known to induce stress. Stress is a non-specific response and



it involves series of changes in the animal in trying to adapt to the changed situation. The adaptive responses of the animal are extended beyond the normal range, which disturbs the normal functions, and the series of changes termed "stress response" tries to help the animal restore the normal homeostasis. This process has both advantages and disadvantages. During stress, hypothalamus-pituitary-interrenal axis (HPI axis) gets stimulated and increases the output of stress hormones called corticosteroids. These stress hormones help to mobilize additional energy during the response to regain the internal homeostasis. At the same time, these stress hormones are basically immuno-suppressive in nature. This can reduce the efficiency of both non-specific and specific immune system of fish significantly and can render the animal more susceptible to disease.

Common husbandry practices like handling, netting, transportation and the normal features of an intensive culture system like suspended solids, low oxygen, high organic matter, overcrowding, high ammonia, etc. can elevate the level of corticosteroids in the blood. Similarly, many of the pollutants at very low levels can also stress the fish and make them relatively more susceptible to infection. Most of the stressors encountered in intensive culture systems are of chronic nature and can keep the level of corticosteroids above basal levels for longer duration.

In such situations, opportunistic pathogens such as parasites, bacteria, fungi, and virus surrounding the animal invades the animal body, resulting in an infection. All infections need not result in disease manifestation. Only when the pathogen build-up disrupts the threshold of animal resistance, the animal succumbs to disease. The situation is a complex one where different factors such as the environment, the animal and the pathogen interacts continuously, making the health management a difficult proposition. This can be further complicated with the involvement of more than one pathogen resulting in a mixed infection which can lead to faulty diagnosis. This entails the need for an integrated management approach to tackle the disease problems with respect to the animal, environment and pathogen using diagnostics as a functional tool.

Disease process

A pathogen can cause a clinical disease only when it can establish on or in the host, proliferate, overcome the non-specific and/or specific defence barriers of the host, produce the pathogenic factors, cause cellular and tissue damage, produce significant pathological changes, impair the function of the target tissue and cause mortality. All infections need not result in disease manifestation. Only when the pathogen build up disrupts the threshold of animal resistance, the animal succumbs to disease condition. The sequence of events in an acute infection is as follows.

- Contact with the pathogen
- Infiltration into the body
- Development / proliferation - incubation (usually short in fishes)
- Spreads throughout the body

- Symptoms appear
- Pathogen restricts itself to specific target organ (mortality)

In the case of chronic infections the pattern of development is

- Slow
- May or may not show pathology / symptoms
- Remain in the body and serve as reservoir / carrier

The sequence of disease development will to a large extent depend on the nature of the pathogen (parasite, bacteria, fungi, virus), environmental factors, size of the host, pathogen load or intensity per unit area or unit weight of the host. The situation is a complex one making the health management a difficult proposition. This can be further complicated with the involvement of more than one pathogen resulting in a mixed infection. A mixed infection can lead to faulty diagnosis. This spells the need for an integrated management approach to tackle the disease problems with respect to the animal, environment and pathogen using diagnostics a functional tool.

Bacterial Diseases: Fish are susceptible to a wide variety of bacterial pathogens. Many of these bacteria become pathogens when fishes are physiologically unbalanced, nutritionally deficient, or there are other stressors, which allow opportunistic bacterial infections to proceed. Bacteria are known to cause infections / diseases in shellfish farming also.

Viral Diseases: Viruses are obligatory intracellular parasites requiring a living cell to replicate. Outcome of diseases due to virus infection is complex and depends on several factors including the immune status of individuals and infectious dose of virus. Mortality need not always be 100%. In some cases, virus remains at a low level of infection establishing a delicate balance with the host. In addition, there are carriers, which are survivors of a mass scale infection and mortality. Usually it is difficult to detect virus in carrier or latent infection stage. Viral diseases are the major cause of disease outbreak and economic loss and known to cause havoc in shrimp culture.

Specific drugs for viral disease treatment are not available or difficult to develop since virus is host cell dependent for all its metabolic machinery. Vaccines in general are not found to be effective in fish viral disease management. Protection from vaccines against viral disease in fish is found to be for short periods with variable results. Poor immune system of the fish and young age at infection are some of the responsible factors for susceptibility to disease. In the absence of successful drug or vaccine, avoidance of the virus in culture system, preventive approaches using quarantine & biosecurity, adoption of crop holiday etc are the best strategies to prevent viral disease in aquaculture, and is already practised in fish health management in the developed countries eg. salmonid culture to prevent IPN disease.

Fungal Diseases: Generally fungal diseases can be external or systemic and are difficult to cure. Except a few, they are generally considered less important pathogens of fishes.

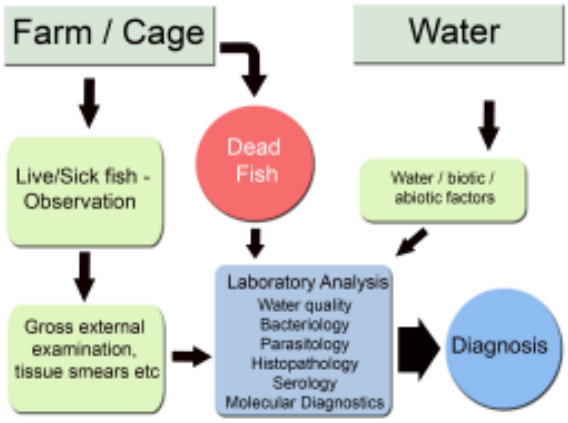
Parasitic Diseases: Parasitic diseases in fishes range from extremely pathogenic ones to those, which are practically harmless. Many of the protozoan parasites are important pathogens of fishes while metazoan parasites are generally less pathogenic in fishes.

Non-infectious Diseases: Feed-derived wastes also affect the culture environment through direct pollution, which in turn affects the culture organisms. Uneaten feeds, faeces and metabolic wastes

contribute to nutrient and particulate loading of the water and substrate which in turn induce stress, depress the growth of cultured organisms and increase their vulnerability to diseases. Improper diets can negatively influence the health of a fish by inducing nutrient deficiencies, imbalances or toxicoses. An impaired nutritional status contributes to defective host resistance. Malnourished fish may harbor latent infections, and certain physiological conditions and environmental stress may predispose them to infection.

Disease Diagnosis in Aquaculture

Diagnosis forms the first step in any disease control programme, which determines the ultimate success or failure of the programme.



Diagnostic Procedure: Once an infection or disease is suspected, the next step is to draw a diagnostic procedure, to fix the root cause of the problem. The diagnostic procedure may include a single diagnostic test or a combination of tests. In the case of routine pathogen watch or health monitoring, a set of selected diagnostic tests are performed to cover the potential pathogens. The approach generally followed is location specific and problem specific, where the first consideration is the availability of the diagnostic facility and expertise. There is no hard and fast method, which can be applied for all cases.

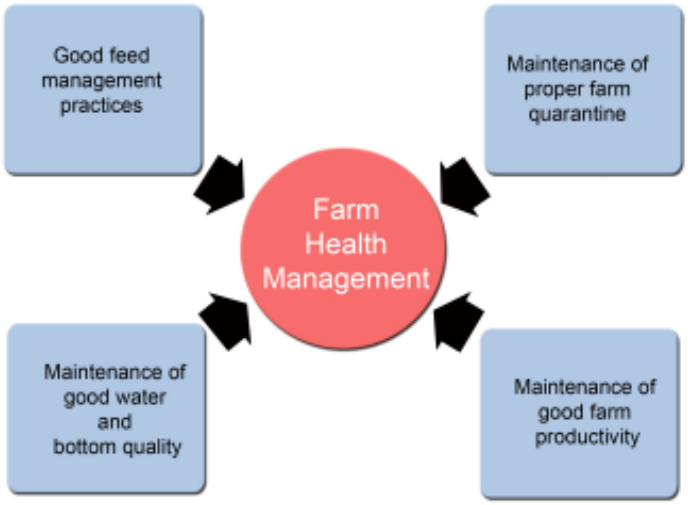
Methods available for disease diagnosis and pathogen detection

History	History of disease at facility or region , facility design, source of seed, type of feed used, environmental conditions etc.
Gross, clinical signs	Lesions visible, behavior, abnormal growth, feeding or food conversion efficiency, etc.
Direct microscopy	Bright-field, phase contrast, or dark field examination of stained or unstained tissue smears, whole-mounts, etc. of diseased or abnormal specimens
Histopathology	Routine histological or histochemical analysis of tissue sections
Electron microscopy	Ultrastructural examination of tissue sections, negatively stained virus preparations, or sample surfaces
Culture and bio chemical studies	Routine culture and isolation of bacterial isolates and identification using biochemical reactions
Enhancement	Rearing samples of the appropriate life stages under controlled conditions to enhance expression of latent or low level infections
Bioassay	Exposure to potential pathogens
Serological methods	Use of specific antibodies as diagnostic reagents in immunoblot, agglutination, ELISA, IFAT, or other tests.
Tissue culture	In vitro culture of pathogens in cell lines
DNA based Diagnostics	PCR, nested PCR, Multiplex, real time PCR

Diagnosis: Once the right diagnostic picture along with the water and soil parameters are available, control measures with respect to the causative factor(s) can be initiated. However, the diagnosis often gets complicated in the cases of mixed infections, with the involvement of primary, secondary and even tertiary pathogens.

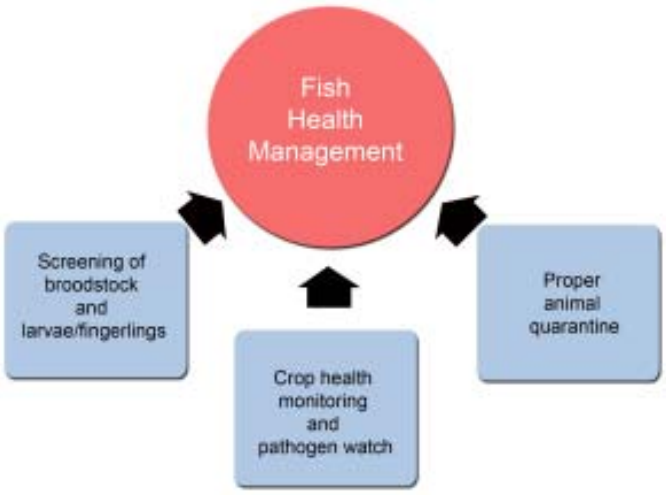
Treatment: Treatment or therapy is intended to restore the normal health of the diseased or infected animal. Drugs can be given oral, intramuscular, intraperitoneal, intravenous or topically as baths or dips. Selection of the proper route depends on the environmental situation, the species and condition of the animal, and the drug being delivered. Unlike the land-based animal rearing systems, where the diseased animals can be identified and treated individually, the scope for disease control in aquaculture through detection and treatment is only of limited value, mainly due to the co-existence of the pathogen and host in the aquatic rearing system. In the case of mariculture, where the extent of the water bodies are without boundaries, the scope of control over the host, pathogen and environment is all the more difficult than in the case of inshore/inland aquaculture. Chemotherapy is not advised in culture systems and should be used only as a last resort since the use of antibiotics can lead to residues in tissues as well as development of antibiotic resistant microbes in the environment, which in turn can create other public health issues. The fish is constantly bathed in potential pathogens, viz., parasites, bacteria, fungi and viruses. Separating the infected or diseased animals from the population and subjecting them to a treatment regime is impractical. Hence, disease treatment becomes a difficult proposition in aquaculture, and disease prevention remains the only natural choice and chemotherapy, if at all required, should be practised judiciously and restricted to broodstock alone.

Aquaculture Health Management: The management practices that are designed to prevent the occurrence of disease in a growout system is termed as the AQUACULTURE HEALTH MANAGEMENT. It is a holistic approach where the focus is given to the health of the animal rather than treatment. Therefore different components viz., animal quarantine, screening of broodstock and larvae/fingerlings, Specific Pathogen Free (SPF) animals, pond and water quality management etc. are involved. Fish health management primarily constitutes two aspects, the **farm health management** and the **fish health management**. Successful integration of these two aspects only can deliver a disease free environment.



Farm health management: It constitutes the maintenance of (a) good soil quality (b) good water quality (c) good farm productivity (d) feed management and (e) maintenance of proper farm quarantine to prevent horizontal transmission of disease causing pathogens.

Fish health management: It constitutes (a) proper animal quarantine b) screening of Broodstock and larvae/ fingerlings and (c) crop health monitoring and pathogen watch. Effective implementation of all the above three aspects of fish health management depends entirely on the early and accurate diagnosis of the disease causing agents. The failure of which can lead to faulty treatment resulting in multiple problems like indiscriminate use of chemicals and drugs, drug resistance, large-scale mortality causing crop failure and economic loss. Timely and early use of proper diagnostics can be used as an effective tool for health care management.



Effective implementation of fish health management depends entirely on the early and accurate diagnosis of the disease causing agents. The failure of accurate diagnosis of pathogens can lead to faulty treatment resulting in multiple problems like indiscriminate use of chemicals and drugs, drug resistance, large-scale mortality causing crop failure and economic loss. Timely and early use of proper diagnostics can be used as an effective tool for health care management. Emerging disease problems, particularly in developing countries, are often slow to be recognized. Thus pathogens become widely spread, often globally, before the seriousness of their nature is recognized and reliable methods of detection, treatment and prevention are developed. Methods for detecting, reporting and responding much more quickly to such emerging diseases should be developed. The recent epizootic of koi herpes virus (KHV) affecting koi and common carps (*Cyprinus carpio*) in Indonesia is a typical example. The design and implementation of effective disease surveillance programs, early warning and reporting systems and contingency plans for dealing with serious disease outbreaks will help in reducing the social, economic and biological impacts of disease.

The integrated approach using diagnostics with farm management, can avoid the introduction of the pathogens into the system. The success of this approach mostly depends on the right choice and use of diagnostics along with other farm management measures, to keep both the animal and its environment in a healthy condition.

The key elements of an ideal health management system can be summarized as:

- Control over the fish/animal stocks at hatchery / farm levels
- Identify excludable disease/pathogens of concern
- Vaccination
- Diagnostics for the detection of pathogens of concern
- Adequate environmental control to prevent the introduction of pathogens of concern (specific pathogen free stock)

- Routine management/husbandry practices to ensure pathogen exclusion (sterilization of influent water, pathogen free feed, prevention of pathogen transfer through men, material and vectors)
- Disinfection, treatment and pathogen eradication methods to contain and eradicate disease outbreaks due to pathogens of concern

In mariculture, development of species specific and location specific health management models with broader management approach for the control of farm/cage level environmental deterioration, pathogen (Virus, bacteria, parasites and fungi) introduction and disease outbreaks is imperative to ensure the sustainability and economic viability of the enterprise.

Suggested Reading

Andrew, C., Excell, A. and Carrington, N., 1988. The Manual of fish Health. Tetra Press, Morris Plains, NJ, USA.

FAO 1995. Regional expert consultation on Aquaculture Health Management in Asia and the Pacific. FAO Fisheries Report 529, 24pp.

Kautsky, N., Ronnback, P., Tedengren, M., and Torell, M., 2000. Ecosystem perspective on management of disease in shrimp pond farming. Aquaculture, 191, 145-161.

Lightner, D.V and Redman, R.M., 1998. Shrimp disease diagnostic methods. Aquaculture, 164, 201-220.

Mialhe, E., Boulo, V., Bachere, E., Hervio, D., Cousin, K., Noel. T., Ohresser, M., le Deuff, R.M., Despres, B., and Gendreau, S., 1992. Development of new methodologies for diagnosis of infectious disease in molluscs and shrimp aquaculture. Aquaculture, 107, 155-164.

Spotte, S., 1979. Fish and invertebrate culture. John Wiley and Sons, New York, 179p.

Subasinghe, B. and Barg, U., 1998. Challenges to Health Management in Asian Aquacultutre. Asian Fisheries Science, 11, 177-193.

Vijayan, K.K. and Santiago, T. C., 1999. Molecular diagnosis in Shrimp Disease diagnosis with special reference to PCR diagnosis of Indian white spot virus. *In Shrimp disease Diagnostics and Health Management Training Manual,* Central Institute of Brackish Water Aquaculture, Chennai, 56-71.