An Overview on Understanding the Basic Concept of Fish Diseases in Aquaculture

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Abstract- Fish health management is concerned with the care and proper measures in managing the healthy living of fish in aquaculture. Disease issues are of great concern in aquaculture production. This is because disease is considered one of the important factors to decrease in fish production, both in farming system and in wild condition. Production costs are increased through investment lost in dead cultured animals, cost of treatment, and decreased quality and quantity of yields. This study became necessary as there were various efforts to increase fish supply through aquaculture production to bridge the gap between the declining fish supply from capture fisheries and the increasing food fish demand. This study reviews fish disease in aquaculture and is focused on the nature, types, causes and significance of fish diseases in aquaculture production to provide hands-on information on diseases and health management in aquaculture production, and create relevant awareness on cultured fisheries management and practices.

Indexed Terms- Aquaculture Development; Disease; Infectious; Non-infectious; Economic Loss;

I. INTRODUCTION

Aquaculture is the fastest growing industry around the world and Nigeria is no exception. Aquaculture production, especially pond aquaculture, is depends upon sources of obtaining increased fish production in order to supply and feed the ever-increasing population of the world (FAO 2010). New technological advances and increased demands for fish as a source of animal protein are the main reasons for the industry's growth. Because of expansion of the industry, the culture methods have become more intensive for producing higher yields (Rico *et al*., 2012). Recently, the sector attracted great attention and it is growing rapidly through the development of aquaculture (Kubecka *et al*., 2016). The advent and anticipation of aquaculture is to enhance food production; more income generation and good health for the people. However, like other farming sectors, disease is a substantial source of constraint to aquaculture development and sustainability; from both social and economic points of view (Blanco *et al*., 2000; Allsopp *et al*., 2008 and Bostock *et al*., 2010). Huge loss of production in aquaculture is occurring because of many reasons. Among these causes, a disease is the most serious constraint that causes damage to the livelihood of farmers, loss of job, reduced incomes, and food insecurity. Disease outbreaks have long been recognised as a significant constraint to aquaculture production and economic viability (Sarig 1971 and Bondad-Reantaso *et al*., 2005). Studies showed that almost fifty percent of production loss is because of diseases which are more severe in developing countries. This is because ninety percent of the aquaculture firm is in the developing world. The annual loss of revenues because of disease reaches up to 6 billion dollars (Leung and Bates, 2013, Hien *et al*., 2020). Disease is a condition in living organisms in which normal physiological functions are being impaired due to alteration in the body systems and typically manifested by distinguishing signs and symptoms (pathological symptoms) (Idowu *et al*., 2016). Disease is one of the major constraints to aquaculture and limiting factor for economic and social developments in different countries of the world (Bagun *et al*., 2013). Production costs are increased through investment lost in dead cultured animals, cost of treatment, and decreased quality and quantity of yields (Francis 2005). Disease is considered one of the important factors to decrease in fish production, both in farming system and in wild condition. Large-scale mortality of fish often occurs in ponds due to

environmental stress followed by parasitic invasion and bacterial, fungal, protozoan and monogenean infections (Hossain *et al*., 2011).

II. NATURE AND TYPES OF FISH DISEASE

Healthy fish have adequate resistance against diseases; they can adapt to reasonable environmental changes and in turn resist diseases (AFCD 2009 and Govind *et al*., 2012). Nevertheless, diseases occur in fish, but before an active fish disease is developed in a culture system pathologically linked factors are involved. These include; Presence of environmental pathogens, Low resistance of the fish and Unfavorable water environment (Idowu *et al*., 2017 and Hien *et al*., 2020). Development of an active disease in fish results from the effect of the association among these (pathologically linked) factors. In a pond, when the pathogen load increases due to external factors (environmental problems such as poor water supply, or other stressors), above what the natural resistance of the fish can cope with, fish become vulnerable to pathogenic infections and diseases. Also, external factors may cause drastic changes in water quality and lower fish resistance. When these happen, fish become susceptible to diseases, even the risks of fish kill are heightened (Idowu *et al*., 2017).

III. FORMS OF FISH DISEASES

There are two broad forms of diseases affecting fish. Fish diseases may be subdivided into:

- Infectious diseases
- Non-infection diseases

1) Infectious Diseases

This is also referred to as biotic disease. Infectious diseases are caused by living factors – pathogenic organisms (viruses, bacteria, fungi or parasites) present in the aquatic environment or carried by other fish. Fish become vulnerable to pathogenic infections when there are stressors (environmental abnormalities, water quality deterioration, unbalanced nutrition, or bodily injuries) which weaken fish natural resistance (immune system). Infectious diseases pose a unique problem of diagnosis (Govind et al., 2012). The emergence of infectious diseases is usually triggered by ecological changes, often associated with human interventions, such as transfer of organisms, environmental degradation, agricultural practices or technology (Jones *et al*., 2008). Infections can occur internally and externally affecting tissues, organs and other fish body parts. They are mostly contagious diseases and some types of treatments may be necessary to control the disease outbreaks (Idowu *et al*., 2017).

- The Common Examples of Infectious Diseases Are Discussed Below.

i. Parasitic Diseases

Parasites are organisms that live in (endo) or on (ecto) another organism (called host) of different species upon which it depends on nourishment at the expense of their host. They can be found in virtually all living things and in normal natural conditions exist side by side with their host. Most parasite species rarely cause problems in the natural environment but in aquaculture, parasites often cause serious outbreaks of disease (Roberts 2012). They play an important role in determining the productivity, sustainability, and economic viability of aquaculture. Parasite infections cause serious socioeconomic, ecological, and welfare consequences in global finfish aquaculture (Menezes *et al*., 1990, Barber 2007, Shinn *et al*., 2015). Fish parasites infest the gills, skin, gut, or as a grub-like worms in fish muscle tissue causing irritation, impaired function, weight loss, and eventually fish kill (Francis 2005). Parasites of fish are not strictly pathogens, but they make a convenient classification as infectious disease of fish (Paperna, 1996 and Fiala *et al*., 2015), as they are often accompanied or followed by secondary bacterial or fungal infection.

- Examples of Parasitic Disease Are Given Below with Their Various Causative Organisms.

i) Protozoan Diseases

- Ichthyophthiriasis (*Ichthyophthirius multifiliis*)
- Ichthyobodosis (*Ichthyobodo necatrix*)
- Chilodonelliasis (*Chilodonella hexasticha*)
- Amoebic gill disease (*Neoparamoeba perurans*)

ii) Metazoan Diseases

- Whirling Disease (*Myxobolus cerebralis*)
- Diplostomiasis (*Diplostomum spathaceum*)

- Proliferative kidney disease (*Tetracapsuloides bryosalmonae*)
- Lernaeosis (*Lernaea cyprinacea*)

iii) Zoonotic Diseases
- Capillariasis (*Capillaria philippinensis*)
- Diphyllobothriasis (*Diphyllobothrium latum*)

Source: (Ali and Faruk, 2018, Idowu *et al*., 2017).

ii. Bacterial Diseases

Bacteria are usual component of aquatic environment. They become problem when fish are exposed to stressors (Omojowo and Sogbesan, 2003). Bacterial diseases are responsible for heavy mortality in both wild and cultured fish. The actual role of these micro-organisms may vary from that of a primary pathogen to that of an opportunist invader of a host rendered moribund by some other disease process (Richards & Roberts, 1978 and Abowei & Briyai, 2011). The specific susceptibility of aquatic animals to various bacteria can be observed only in the species that are cultured, or atleast kept in captivity for a while. Bacterial infections are considered the major cause of mortality in aquaculture (Govind et al., 2012). Bacteria are very common in the aquatic environment. Most bacterial disease agents are part of the normal flora of the water. They cause disease only when the fish are stressed due to poor environmental conditions, inadequate diet and poor husbandry techniques (Tendencia, & Lavilla-Pitogo, 2004). Bacteria are important pathogens for both cultivated and wild fish, and are responsible for serious economic losses. Some bacteria cause only surface diseases as skin or gill infections, especially flexibacteria, but some inflict systemic disease (Inglis *et al*., 2001). They can infect a single fish and multiply rapidly to cause a substantial fish kill in a few days or weeks. Bacterial diseases are often internal infections and usually require treatment (with antibiotics added to feeds or water). However, bacterial diseases can also be external which may result from rough handling or effects of parasitic infection (Idowu *et al*., 2017). *Bacterial* diseases are often internal infections

- Examples of Some Important Bacterial Diseases in Aquaculture with their causative organisms

i) Columnaris Disease (*Flavobacterium columnare*)
ii) Enteric Septicemia Disease (*Edwardsiella ictaluri*)
iii) Coldwater (Peduncle) Disease (*Flavobacterium psychrophilum*)
iv) Bacterial kidney disease (*Renibacterium salmoninarum*)
v) Franciselliosis (*Francisella noatunensis*)
vi) Furunculosis (*Aeromonas salmonicida*)
vii)Myxobacteriosis (*Fiexibacter maritimu*)
viii) Edwardsiliosis (*Edwardsiella tarda*)
ix) Fin rot (*Flexibacter maritimus*)
x) Vibriosis (*Vibrio sp*)

Source: (Tendencia, & Lavilla-Pitogo, 2004 and Pekala & Agnieszka,2018).

iii. Viral Diseases

Viruses are very small infectious agents that multiply only within the living cells of an animal or plant host. Because they are so small, viruses are often difficult to detect. Viruses occur in particles and they are obligate pathogens. They depend on the synthesizing structure of the host cells for replication. Viral diseases of fish are difficult to diagnose and control with medications (Francis, 2005). The viruses affecting the fishes grow at lower temperatures and have specific tolerance to temperature. Most of the viral diseases affecting the fishes are geographically limited. In most of the viral infections, it causes high mortality in fishlings but adults become carrier to these viruses (Ganguly, 2017). Fish are susceptible to many viral pathogens, some of which are readily identifiable, whereas others remain obscure. Identification is not always possible owing to lack of resources or inability of the virus to grow in available fish cell lines. In many instances viral infection may remain latent until adverse environmental conditions, such as poor water quality, overcrowding, or rough handling, trigger the onset of disease (Bernoth & Crane, 1995). Some viral infections are serious diseases of groupers causing heavy mortalities. In most cases, larval stages are the most susceptible stage. With the carnivorous nature of groupers, they can readily ingest viral pathogens from live fish food or trash fish that carry the viral pathogens. Moreover, viruses are able to effect vertical transmission from broodstocks that are likely carriers of the virus (Lio-Po *et al*., 2004). Viruses are probably the cause of a wide spectrum of fish diseases. Although relatively few virus diseases of fish are known today, some of the diseases of unknown

etiology, as well as some diseases presently accepted as due to bacteria, protozoa, fungi or nutritional deficiencies, possibly will be recognized eventually as virus diseases (Stanely, 1954 and Wise *et al*., 2004).

- Examples of Some Important Viral Diseases in Aquaculture with their causative organisms

i) Lymphocystis disease (*Lymphocystivirus*)
ii) Infectious Pancreatic Necrosis (*Aquabirnavirus*)
iii) Viral Haemhorragic Septicaemia (*Novirhabdovirus*)
iv) Infectious Haematopoietic Necrosis (*Novirhabdovirus*)
v) Nodavirosis (*Betanodavirus*)
vi) Goldfish Iridovirus
vii) Snakehead Rhabdovirus
viii) Bluegill Hepatic Necrosis Reovirus
ix) Grass Carp Reovirus
x) Channel Catfish Virus Disease

Source: (Barja, 2004 and WOLF, 1988)

iv. Fungal Diseases

Fungal diseases of fish have become increasingly important over the past 20 years. Fungal infections in fish generally are considered secondary to some other factor or pathogen, a consequence of water quality problems, poor condition, trauma (rough handling or aggression), bacterial disease, or parasites. Fungi, however, can cause disease under a variety of other circumstances. Some may be more aggressive and play a more primary role. Fungi can be external or internal and systemic (Yanong, 2003). The fungal diseases occur in brood stock as well as all life stages of fish and eggs. Fungal infection causes low yield of fry and low production in fish culture (Kwanprasert *et al*., 2007). Fungal infections (fungal infections are called mycoses) are among the most common diseases seen in temperate fish because fungal spores are found in all fish ponds and create problems in stressed fish. Poor water quality can also lead to an increase in fungal infections in an otherwise healthy fish population. Most fungal infections invaded on external tissues and only few fungal infections affect the internal organs of fish (Verma, 2008).

- Examples of Some Important Fungal Infection in Aquaculture with their causative organisms

i) Saprolegniasis (*Saprolegnia parasitica*)
ii) Dermocystidiosis (*Dermocystidium marinum*)
iii) Ichthyophonosis (*Ichthyophonus hoferican*)
iv) Exophialiasis (*Exophiala salmonis*)
v) Branchiomycosis (*Branchiomyces sanguinis*)
vi) Aspergillomycosis (*Aspergillus spp*)

Source: (patel *et al*., 2018)

2) NON-INFECTIOUS DISEASES

Non-infectious diseases (also referred to as systemic diseases) are caused by non-living/abiotic factors. Compared with infectious diseases and disorders, few non-infectious diseases and disorders in cultured fish have severe biologic or economic impact. Culture practices, however, often establish environments that promote infectious disease by weakening the immune response or by promoting conditions that favor infectious agents. Generally non-infectious diseases and disorders result from adverse physical, chemical and biological factors and from poor nutrition. Adverse factors can be changes in temperature, pH, and dissolved gases, suspended solids, endogenous toxins, anthropogenic toxicants, solar radiation and physical damage such as from predation (Hawkins, 2002). The diseases are either congenital (such as genetic anomalies or neo plastic conditions) or iatrogenic (induced by external conditions such as environmental or nutritional problems) (Idowu *et al*., 2017).

Non-infectious diseases can be broadly categorized as;

- Environmental
- Nutritional
- Genetic.

i. Environmental Diseases

Environmental diseases are the most important among the non-infectious diseases in commercial aquaculture. Environmental diseases result from inadequacies in the physical and chemical characteristics of the pond water. These include low dissolved oxygen, high ammonia, high nitrite or natural or man-made toxins in the aquatic environment (Francis, 2005). Environmental problems include depletion of dissolved oxygen, extremes in pH, high ammonia, high nitrite, natural or man-made toxins, or mechanical trauma (caused by rough handling, overcrowding, low water levels, or predation). Proper

water quality management and handling are necessary in preventing most environmental problems (Idowu *et al*., 2017).

- Examples of Some Frequently Occurring Environmental Diseases in Aquaculture

i) Gas Bubble Disease
ii) Swimbladder Stress Syndrome
iii) Asphyxiation/Hypoxia
iv) Sunburn Disease
v) Brown Blood Disease
vi) Acidosis and Alkalosis Disease

Source: (Erazo-Pagador, 2001., Erazo-Pagador, & Cruz-Lacierda, 2004)

ii. Nutritional Diseases

Nutritional diseases are those which the results in due to excess nutrient or nutritional deficiency in fish than the normal requirements (Idowu *et al*., 2017). Nutritional diseases of fish may develop as a result of deficiency (undernutrition), excess (overnutrition), or imbalance (malnutrition) of nutrients present in their food. The disease usually develops gradually because animals have body reserves that make up for nutritional deficiency up to a certain extent (Amar & Lavilla-Pitogo, 2004). Symptoms appear gradually when one or more components in the diet drop below the critical level of the body reserves. Most nutritional diseases are difficult to diagnose because of their chronic nature, with the condition only manifesting over a long period of time (Abowei *et a*l., 2011). When there is too much food, the excess that is converted to fat and deposited in fish tissues and organs, may severely affect physiological functions of the fish (Amar & Lavilla-Pitogo, 2004). Nutritional diseases arising from dietary imbalances, continues to cause problems to fish in cultured condition (Aly, 2013). Diets that are inadequate with respect to protein, amino acid, essential fatty acids, vitamins and minerals lead to gross malnutrition and high disease susceptibility. Proper feeding of a nutritious diet is important for growth and prevention of nutritional deficiencies, and to cope with a variety of disease-causing agents (Lall, 2000). Signs of nutritional disease can also be marked by secondary disease condition due to pathogens (Blanco *et al*., 2000).

- Examples of Some Nutritional Disease in Aquaculture

i) Lipodosis
ii) Fish scurvy
iii) Broken Back Syndrome
iv) Steatitis and white fat disease
v) Avitaminosis

Source: (Shoaibe and Mohammed, 2018)

iii. Genetic abnormalities

Abnormalities in fish include any changes that are obvious by looking at the outside (external) or inside (internal) of the fish. This can be discussed as Neo plastic And Genetic Anomalies. A neoplasm is an abnormal growth of cells, also known as a tumor. Neo plastic fish disease refers to abnormal growth in any of the organs with resultant loss of structural and functional ability of the affected organ. The resultant growth may be lethal or mildly pathologic (Abowei *et a*l., 2011). The hereditary factors involved in diseases and abnormalities are generally complex and difficult to detect, but the evidence for their existence is undeniable (Bernard and Michel, 1990). Malformations occurring in cultured fish or induced following hybridizations are of minimal significance; however, it is of importance to bring in unrelated fish for use as brood stock every few years to minimize inbreeding (Francis, 2005). This way, genetic abnormalities can be controlled.

IV. THE SIGNIFICANCE OF FISH DISEASE TO AQUACULTURE

Aquaculture industry plays a vital role in many countries in the world especially developing countries. Fish disease is a substantial source of monetary loss to aquaculturists. Production costs are increased by fish disease outbreaks because of the investment lost in dead fish, cost of treatment, and decreased growth during convalescence (Francis, 2005). Fish disease impedes both economic and social development in many ways: directly, through production losses and increased operational costs and indirectly, through cost to society (social, welfare and environmental), adjustment in market shares and increase in price due to lower supply. Fish diseases affect fish survival and growth rates resulting to poor yield (both in quality and quantity), the livelihood of people involved in the

culture production and the community in which they occur through reduced food availability, loss of earnings/employments and recreation, apprehension of healthy environment, consumption and handling of sick fish. Invariably, fish culturists and consumers suffer hefty socio-economic losses (Francis, 2005; Bondad *et al*., 2005; Brun *et al*., 2009; Oladele *et al*., 2011; Ali *et al*., 2014).

World Bank in 2006 reported global loss of about US $3billion per year to aquaculture production and trade due to disease (Subasinghe *et al.*, 2001, Brun *et al*., 2009). Significance of fish diseases can also be in form of investment in disease research and control, along with health management programmes (Bondad *et al*., 2005). Reported on the financial implications incurred from fish disease control programmes and fish disease legislation by various countries. Moreover, discovery of pathogens and unapproved drugs in aquaculture products has also continued to generate issues including rejection of products, enforcement actions against involved trade parties (country, industry, importer, etc.), serious trade disruption and heavy financial losses (Karunasagar, 2012).

CONCLUSION

Fish health management is an important area of aquaculture that needs to be taken seriously. Poor health management weakens the immune system of fish, thereby predisposes fish to disease and infection. Disease has become a primary constraint to sustainable aquaculture production and products trade, thereby affect the socioeconomic status of most developing countries. Though enormous loss is incurred due to diseases, less attention is given for disease management and a very few well trained persons are available in this field (Subasinghe *et al*., 2001 and Uddin *et al*., 2017). Diseases have brought about major setback in the development of the sector. Disease reduces supply of aquaculture products, increases cost of production, loss of income to the farmer, reduce quality of fish produced and many more effects. The rural farmers are still the most involving in aquaculture production (Faruk *et al*., 2004). Most of them are with little or no knowledge of aquaculture health management and with inadequate opportunities to improve management skills and respond effectively to disease problems. More enlightenment on the dangers and effects of disease should be preached to farmers across the globe. This way, the damage that is usually impaired by diseases on aquaculture will be reduced if not totally eradicated. The nature and types of disease is also and help or a guide as to know how effectively to tackle the rampant disease problem. Most importantly, the infectious diseases which are causes by several pathogens, this has to be quickly tackled because the danger of this disease is that is spreads rapidly among's the stock and can totally eliminate the full stock in a farm. Both the infectious and non-infectious disease is sometimes due to the negligence of farmers. Generally, prevention of this disease is far better than the control or treatment.

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