



Nutritional Diseases of Fish in Aquaculture and Their Management: A Review

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Abstract

This review was conducted to investigate the significance, underlying causes and negative effects of nutritional diseases of fish on aquaculture production and health safety. Information were collected from different secondary sources and then arranged chronologically. Investigation reveals that, Aquaculture is the largest single animal food producing agricultural sector that is growing rapidly all over the world. Nutritional disease is one of most devastating threats to aquaculture production because it is very difficult to identify nutritional diseases. Production cost get increased due to investment lost, fish mortality, treatment cost and decreased yield quality and quantity. Public health hazards are also in dangerous situation due to frequent disease outbreak and treatment involving synthetic drugs. It is very essential to control nutritional diseases to increase fish supply through aquaculture production. This study will be helpful to provide basic knowledge on nutritional diseases management in aquaculture and to raise awareness among the farmers fisheries management.

Keywords: Nutritional Diseases; Aquaculture; Management

Abbreviations

EPA: Eicosa-pentaenoic Acid; DHA: Docosahexaenoic Acid; UFA: Unsaturated Fatty Acid; EFA: Essential Fatty Acids.

Introduction

Aquaculture is currently the most growing agricultural sector in the world. Tremendous development have occurred in aquaculture during the last decades. Aquaculture production has shifted from extensive to semi-intensive and intensive culture systems [1,3]. Disease is an important constraint to aquaculture development and sustainability because production cost increases through investment loss as a result of fish mortality, cost of disease treatment and loss of product quality and quantity [4,5]. Due to frequent disease outbreak, public health and environmental safety are also threatened because human health hazards are related to disease occurrence and drugs resistance [1,2]. This sector is facing more

challenges to make sure its sustainable development due to the emerging of new disease. Disease is a disturbed condition of living organisms in which normal physiological function of different parts of the body get changed expressing distinguished signs and symptoms. Development of an active fish disease is directly associated to the effect of different pathogenic microorganism and also with the nutritional value of fish feed [1]. Fish diseases commonly outbreaks when fish are stressed due to a variety of physical, chemical and biological factors including poor nutrition [7].

Nutritional diseases are those which the results in due to excess nutrient or nutritional deficiency in fish than the normal requirements. Lipids, carbohydrate, proteins vitamins and mineral salts are some of the important nutrient for proper fish growth [1]. The disease symptom disappears when the existing feed is changed with a new one [4]. Reduced fecundity, slow growth rate, decreased

appetite, increased susceptibility to diseases, morbidity with clinical signs and pathological lesions and mortality are some of the important symptoms of nutritional diseases. Wastes derived from artificial feed affects the fish farming environment directly and also through causing aquatic pollution. Uneaten feeds, fish faeces and other metabolic wastes contribute to particulate nutrient loading of the water which induce stress on the growth of cultured organisms and increase possibility to disease occurrence [9]. Most of the nutritional diseases are very difficult to identify due to their chronic nature but can be avoided through proper feeding management practices [1,4]. A nutritionally balanced and complete live or artificial diet and healthy farming condition are vital requirements for sustainable aquaculture production and good health management of the cultured fish species to prevent nutritional diseases [9]. This review study was conducted to investigate the nutritional requirements of aquaculture fish species, effects of nutritional deficiency and the diseases caused by excess or of fish in aquaculture, causes behind the nutritional diseases and possible treatments to control nutritional diseases of fish.

Materials and Method

Information used in this review paper were collected from different secondary sources such as peer reviewed national or international journals, newsletters, proceedings, reports, related books, browsing internets etc. Information were also collected from different electronic media, visiting websites of different fish disease diagnosis, fish health management and pharmaceutical company websites. All the information collected from the secondary sources have been compiled systematically and chronologically.

Review of Findings

The nutritional diseases of fish may occur as a result of deficiency, excess or imbalance of nutrients. In general, nutritional disease develops gradually because animals can reserve some nutrients in their body up to certain extent to fill up the nutritional deficiency. After full utilization of the reserved nutrients, fish gets sick and affected by several pathogenic microorganisms and disease condition develops. In the fish body [10]. The fish which receives less nutrition than the requirement levels, initially show signs of decreased growth and decreased production [14]. Younger fishes are first affected by disease and then the most productive individuals get affected, even mortality may be increased in the fish population if the malnutrition becomes chronic. Weak fishes are most suscep-

tible to diseases like fin rot disease [14]. Sometimes, the excess feed is converted to fat, deposits different organs of fish and affects the physiological functions of fish severely [10]. Nutritional diseases arising from dietary imbalances, continues to cause problems to fish in cultured condition [11]. 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 [7]. Nutritional deficiency diseases are non-specific in nature [1,4]. Affected fish provides favorable environmental or physiological conditions to be predisposed by the organisms to infection. Over supply of nutrient results in nutrient loss and increase water pollution which can alter the water chemistry and lead to serious health hazards for the entire fish population [9].

Common nutritional diseases in fish

Fish scurvy

Scurvy in fish is a deficiency condition and non-infectious in nature. It rarely occurs naturally when diets are not formulated and prepared based on the species requirement. Deficiency of Ascorbic acid is the preliminary cause of fish scurvy disease. Use of another specie's diets in absence of a suitable formulated diet for species may results in deficiencies [10]. Spinal deformity associated with ascorbic acid deficiency has been reported to occur naturally in *Cromileptes altivelis* post larvae in Indonesia. Fishes in the grow-out stages are usually affected but spinal deformity occurs at post larval stages. It has been reported in *Epinephelus tauvina* and *Epinephelus malabaricus* in Thailand [10]. Anorexia, erosion of fins and opercula, short snout, hemorrhages in eye and fins, exophthalmia, abnormal skull, swollen abdomen, pharyngo-branchial falling, severe emaciation and spinal column abnormality, poor growth are signs of fish suffering from Scurvy disease. High doses of vitamin C intake can provide increased disease resistance against several pathogenic bacterial and virus species in fish [7].

Broken back syndrome

Broken Back Syndrome is a well-known channel catfish disease in super-intensive culture system. This disease arises if fish are fed vitamin C deficient diets for more than eight weeks [1,4]. Vitamin deficiency leads to biochemical dysfunctions and consequent organ dysfunction. Other morphological and functional changes have been also reported in fish deprived of vitamin C [7,9,10].

Lipidosis

It is one of the most common non-infectious nutritional disease among cultured fish species. Presence of disease affected fish in a farm does not affect the healthy individuals [6]. Various degrees of this disease have been observed in cage-cultured grouper fish including *Epinephelus malabaricus*, *Epinephelus coioides* and *Cromileptes altivelis* in Indonesia, Thailand and the Philippines [10]. Feeding of rancid formulated feeds and fatty or poorly stored trash fish can cause lipidosis. Fish in the grow-out stage are most susceptible to lipidosis. Affected fish shows poor growth but low mortality rate, lethargic movement, opaque eyes, slight distention of the abdomen and pale appearance of liver [14].

EFA deficiency

It is associated with low levels of essential fatty acids in live food. Fatty acids are essential components of bio membranes and precursors of some physiological modulators [6]. Marine fish larvae require EFA for normal growth and development. Essential fatty acids such as DHA and EPA are usually found in live food such as copepods, microalgae, rotifers and *Artemia* [12]. Fatty acid deficiency results in larval mortality known as "Shock Syndrome". This disease has been reported from *Epinephelus malabaricus* in Thailand and from *Epinephelus tauvina* and *Epinephelus fuscoguttatus* in Singapore [10]. Body weakness and mortality is observed after 21 day of starting feeding for *E. malabaricus*. This disease is not transmitted to other healthy individuals by affected fish.

Obesity

It is a most common health concern in both pond and aquarium environment. The common goldfishes are especially prone to obesity disease. Obesity in fish may result in health problems. Fatty infiltration of liver is correlated with a high-fat diet. A fatty liver can be the direct result of a high-fat diet or due to the deficiency of biotin or choline in the diet [14].

Nutritional myopathy

Nutritional Myopathy is associated with rancid fat or PUFA containing diets and low vitamin E contents. When cellular integrity is compromised in the cell membrane, this disease can occur [4]. It is a non-infectious and non-transmissible disease. *Cromileptes altivelis* fingerlings and bloodstock are severely affected by this disease [10]. Affected fish shows body color darkening, emaciation, petechial at operculum and occasional spinal cord deformity. The disease can cause continuous low mortality in *Cromileptes altivelis*

fingerlings and mass mortality in *Cromileptes altivelis* bloodstock [4].

Steatitis and white fat disease

These diseases are caused by Vitamin E Deficiency. Vitamin E has antioxidant properties which to play important role in cellular membranes to maintain the integrity in the oxidative processes at the storage of fish. Steatitis was induced experimentally in phocid seals and to measure the relationships between vitamin E deficiency and hyponatremia. Vitamin E is commonly supplied to the Piscivores at a rate of 100 mg/kg of feed to maintain high level of vitamin in blood serum [12].

Hyponatremia

Hyponatremia is a disease of marine fish which is related to salt deficiency. It is most common in freshwater pinnipeds, saltwater animals, otarids, phocid seals, and other marine mammals. Clinical signs are periodic weakness, tremor, lethargy, incoordination, and anorexia. Severely affected animals may collapse in an Addisonian crisis, which can be fatal [12]. Sodium chloride infusion therapy can provide effective protection. Animals should be provided with continuous freshwater flow.

Thiamin deficiencies

Thiamin is a co-enzyme in carbohydrate metabolism and essential for normal nerve functions, digestion and reproduction. Deficiency of thiamine is caused by thiaminase activity. Thiamine is also destroyed by the activity of antithiamine substances in feed. These active enzymes can also destroy thiamine if the fish sits for long periods before feeding [12]. Fish species from sardine and anchovy families contain enzymes which results in degradation of thiamin in the trash fish. Deficiency signs appear when single species trash fish are fed for extended periods but not when mixed species [10]. Clinical signs of thiamine deficiency are Nervous System disturbances, whitish body color, anorexia, regurgitation, erratic swimming and mechanical injuries and hemorrhages on the body surface which can lead to death.

Avitaminosis

Absence of a particular vitamin leads to serious metabolic disorders referred to as Avitaminosis that is frequently fatal. High deficiency of vitamin can lead to non-specific growth retardation and susceptibility to diseases [9]. Vitamin deficiency disease does not usually occur in ponds which can result in depressed immune

function and chronic disease. Optimum level of vitamin is required for the development of immunity in the early stages of their life cycle [7].

Hypervitaminosis

Under different conditions, accumulated water soluble vitamins can produce a toxic condition which is called Hypervitaminosis. Usually, these types of conditions do not occur under practical farming conditions. Hypervitaminosis has been successfully induced in experimental units in fish and the reported toxicity signs [16].

Histamine poisoning

Tuna, Mackerel and other dark-fleshed fish have a short life span. Formation of histamine complex due to bacterial decarboxylation of histidine has been found in the flesh of marine fish species. This toxicity can also occur in non-scombroid fishes, anchovies, herrings or pilchards where it is mostly common in pinnipeds. Clinical signs are lethargy, anorexia and throat inflammation. Antihistamines can provide temporary relief and the animal start ingesting feed within 2-3 days. Epinephrine is effective in severe or acute cases of histamine reaction. Cortisone and diphenhydramine hydrochloride can also be effective [12].

Toxicosis

Toxins may be present in fish feeds such as mycotoxins, pesticides, polychlorinated biphenyl residues, herbicides and other agro-industrial chemicals [17]. Molds produce Mycotoxins on plant products like oil seed by-products and grain by-products. In addition, aflatoxin in the diet can produce liver cancer in rainbow trout. 8-20 ppb of toxin can induce clearly visible hepatomas within 4 - 6 months [1]. Other toxins are protease inhibitors, goitrogens, hemagglutinins, saponins, gossypol and others. Toxins produced by microorganisms associated with feed contamination can cause bacterial Toxicosis [17].

Blindness-melanism syndrome

The disease was firstly described as a "Loss of Scales Syndrome" by Raymond in indigenous fishes of the West Indies, especially *Ocyurus chrysurus* and *Lutjanus analis*. Fish show a loss of appetite, melanism, and an important decrease of weight. Some of them can hardly catch the pellets which also suggest blindness. Ulcerative skin lesion is often seen on the head, latero-dorsal body part, and fins. Ocular lesions such as keratitis and aphaky are sometimes detected.

Granulomatous hypertyrosinemia

Tixerant., *et al.* (1984) were the first to link a so called Granulomatous Syndrome observed on farmed turbot (*Scophthalmus maximus*) to a disorder in tyrosine metabolism. Clinical signs of the disease are essentially 1 White yellowish or orange nodules, mostly on kidney but also on the other viscera and muscle. Subcutaneous white deposits, around the articulations or under the cornea, possibly hiding the pupil. It is also possible to remark cutaneous melanism, loss of weight, hepato-splenomegaly, abdominal dropsy and presence of urinary calculus. At microscopic examination, the white deposits show bushes of needle-shaped crystal, 30 - 40 μm long, located around the melano macrophage centres or around the nodules. These crystals cannot be seen on histological sections (after paraffin embedding).

Nutritional deficiency symptoms

Protein deficiencies

In general, protein and amino acid deficiency disease is not recognized as a problem in ponds. Growth suppression, skeletal deformities, appetite depression and exophthalmia are evidenced in earlier studies [7]. Essential amino acid deficiency can lead to poor utilization of dietary protein and may result in growth retardation, less weight gain and low feed efficiency [9]. Amino acid deficiency can lower the disease resistance of fish and impairs the effectiveness of the immune system in severe cases [7].

Lipids deficiencies

Poor food efficiency, susceptibility to caudal fin erosion, elevated muscle water content, shock syndrome, swollen pale fatty liver, decreased hemoglobin and blood cell volume, degeneration of gill epithelium etc. are some of deficiency syndrome [7,9]. EPA and DHA are very important for larvae and Broodstock development. EPA and DHA deficiency in Broodstock lead to reduced egg quality, poor hatchability and reduced survival of larvae. Auto-oxidation of UFAs lead to morbid changes in the liver. Fin erosion, loss of pigmentation, fatty infiltration of liver, cardiac myopathy and shock syndrome are some of the deficiency signs of Linolenic acid. Slightly affected fish are capable to recover whereas in severe case, fish are not capable to recover to an acceptable limit [7].

Carbohydrate deficiencies

Generally, the deficiency of carbohydrates results in growth retardation due to gluconeogenesis. Sekoke disease is one of the common diseases related to Carbohydrate. It is also called Spontaneous Diabetes in carp which are fed with extremely high-starch

diets. It was reported in Japan. So, elimination of the excess amount of starch from the diets can prevent this disease [9].

Vitamin deficiencies

Usually, nutritional deficiency signs develop slowly, and it is very difficult to detect clear signs at the early stages. However [17]. Poor appetite, poor feed efficiency and reduced weight gain are some of the vitamin deficiency signs. The farmers may obtain indirect clues of vitamin deficiency from this sign.

Mineral deficiency

In fish, minerals provide important roles in osmoregulation, scale and skeleton formation and intermediary metabolism. Difficult to study the mineral requirements of fish are because some minerals are required very minute amounts. Some other minerals are absorbed from water in significant quantities through the gills as well as from the diet [17]. Mineral deficiencies appear due to dietary imbalances and interaction of dietary components. Skeletal

Vitamin	Deficiency Signs
Thiamine	Anorexia, poor appetite, muscle atrophy, loss of equilibrium, poor growth, congestion of fins and skin, fading of body color, lethargy.
Riboflavin	Eye and skin hemorrhage, photophobia, pigmentation of iris, striated constrictions of abdominal wall, dark coloration, appetite, anemia, poor growth, in skin and fins.
Pyridoxine	Nervous disorders, hyper-irritability, anemia, loss of appetite, rapid rigor mortis, peritoneal edema cavity, colorless serous fluid, rapid breathing, exophthalmia.
Pantothenic acid	Clubbed gills, necrosis, cellular atrophy of gills, gill exudate, loss of appetite, lethargy, poor growth, skin hemorrhage, skin lesions and deformities.
Niacin	Poor growth, anorexia, lethargy and mortality.
Inositol	Distended stomach, increased gastric emptying time, skin lesions, de-pigmentation and poor growth.
Biotin	Loss of appetite, lesions in colon, altered coloration, muscle atrophy, spastic convulsions and fragmentation of erythrocytes, skin lesions and poor growth.
Folic acid	Lethargy, fragility of caudal fin, dark coloration, macrocytic anemia, poor growth.
Choline	Poor food conversion, hemorrhagic kidney and intestine, poor growth, accumulation of neutral fat in hepatopancreas, enlarged liver.
Nicotinic acid	Loss of appetite, lesions in colon, jerky motion, weakness, edema, muscle spasms while resting, sensitivity to sunlight, poor growth, skin hemorrhage, lethargy and anemia.
Vitamin B	Poor appetite, low hemoglobin, fragmentation of erythrocytes, macrocytic anemia, reduced growth.
Vitamin C	Impaired collagen formation, eye lesions, anorexia, hemorrhagic skin, liver, kidney and muscle, reduced growth, dark coloration, loss of balance, fin necrosis, high mortality.
Vitamin A	Ascites, ceroid in liver, spleen and kidney, anemia, fragility of red blood cells, poor growth, exophthalmia, kidney hemorrhages, depigmentation and soft exoskeleton.
Vitamin D	Poor feed utilization, raised blood counts, slow growth rate, decreased ash levels, calcium and phosphorous, poor growth, soft exoskeleton, lethargy.
Vitamin E	Muscular dystrophy, pathological condition in reproductive organs, increased permeability of capillaries, hemorrhages and edema in various parts of the body.
Vitamin K	Anemia, prolonged coagulation time.

Table 1. Different vitamins and their deficiency signs in fishes.

deformities, reduced resistance to diseases and anemia are some of mineral deficiency signs [7,9].

Micronutrient deficiency

Zinc, copper, iron and selenium are required at trace amount for metallo-enzymes which are vital to maintain cellular functions

in the immune system [7,9]. Very little is known about the effects of trace elements on immune function of finfish species. Iron is very important nutrient for fish as well as for microorganisms also, even the ability of pathogens to enter to a host depends on the availability of iron. Microcytic Anemia is one of the deficiency signs of iron which can be occurred in several fish species [5,7]. Iron deficiency makes the host fish more susceptible to infectious agents.

Minerals	Functions	Deficiency symptoms
Calcium and Phosphorous	Bone formation, blood clotting, supply high energy phosphorus compounds	Slow growth rate and increased mortalities, scoliosis, lordosis and skull deformities.
Magnesium	Acta as Enzyme cofactor; involved in the Loss of appetite, poor fat metabolism	Lordosis, poor growth and protein growth, tetany.
Iron	Essential constituent of haeme, Cytochromes and peroxidases.	Microcytic Homochronic anemia
Manganese	Bone formation, arginase cofactor and involved in erythrocyte regeneration	Sluggish movement, loss of equilibrium, poor appetite, weight loss and mortality
Iodine	Regulate total oxygen use	Thyroid, Hyperplasia (goiter)

Table 2: Major minerals, their functions and deficiency symptoms in fish and shellfish.

Diagnosis of nutritional disease

Healthy fishes have sufficient ability to be adapted with considerable changes in environmental condition and also to resist fish diseases [1]. A quick and effective system is required to identify the cause of disease for appropriate treatment and control of fish disease. If possible, diseases specialist should ask the farm owners to provide information signs and symptoms of affected fishes [4]. However, the clinical signs of excess nutrition or nutrient deficiency are not specific [1]. Beside this, infectious pathogen is another underlying cause of many clinical signs and symptoms. Skeletal disorders, ophthalmologic conditions and generalized conditions are the most common signs of malnutrition in fish. Investigation approaches to diagnose a nutritional disorder in a fish is very different. A regular routine check on fish stocks is ver important for early detection of possible disease causing agent [1,4,9]. Sacrifice one or two fish in order to determine an underlying disease problem within the environment and get accurate diagnostic test results as quickly as possible. Even though histologic examination cannot guarantee successful diagnosis of a nutritional disorder, it is a very important tool in the disease investigation. An increase in mortality in the fish population may be observed as the malnutrition becomes more chronic. Weak fish are more susceptible to the secondary bacterial diseases [4]. The first response of fish to disease is abnormal behavior. Diagnosis procedure of some fish diseases are given below:

- I. Starvation appears due to nutrient deprivation resulting from inadequate intake or assimilation of feed. Typically, starved fish appears to have a large head and slender body and will be dark in coloration [7,9].
- II. Lipodosis can be diagnosed through histopathology of liver and proximate analysis of artificial feeds. Since

histopathology is required, this may have contributed to lack of reports [10].

- III. Scurvy of fish can be confirmed by the curvature of the body with the hemorrhagic lesion at the broken vertebral column, histopathology of gills and liver. The feed formulation can also be examined as to the form and level of inclusion of ascorbic acid and further by analysis of tissue and feed samples for ascorbic acid content [10].
- IV. EFA deficiency is based on the visual observation of larval behavior (weak movement) is confirmed by fatty acid analysis of live food.
- V. Nutritional Myopathy can be diagnosed Histopathologic ally, myofibril degeneration including extensive myolysis and macrophage invasion in degenerated fibers are observed in the skeletal muscles. Ceroid deposits, a kind of lipo-pigment which stains pink with PAS reaction in the hepatocytes, is typical.
- VI. Histopathological lesions are mainly found in the brain where hemorrhages and degeneration of the nuclei of nervous cells occur and Thiamin deficiency is diagnosed.

Effects of nutritional disease in fish

Sustainable development of Aquaculture sector depends on the successful management of diseases. Among the diseases, nutritional disease is a critical threat to the public health safety. Some of the negative impacts of nutritional diseases of fish are listed below;

- I. Fish disease severely affects the socio-economic condition of farmers including losses in production, employment opportunities, income, investment loss, reduced consumer confidence, food shortage, industry failure etc. [1].
- II. Fish diseases affect fish survival and growth rates which results in poor yield qualitatively, the livelihood of people involved in the culture production and the community

in which they occur through reduced food availability, loss of earnings and recreation, apprehension of healthy environment, consumption and handling of sick fish.

- III. World Bank (2006) reported that, global US \$3billion loss occurs per year due to aquaculture production loss due to disease in the form of investment loss, disease control and health management programs.
- IV. Pathogen identification and use of unapproved drugs in aquaculture raises the issues to reject the products, law enforcement against involved trade parties, trade disruption and heavy financial losses.
- V. Feed-derived "wastes impact the culture environment through direct pollution, which in turn affects the culture organisms. Extra feeds, faeces and metabolic wastes contribute to environmental pollution. These factors induce stress, depress the growth of cultured organisms and increase their vulnerability to diseases.
- VI. A chronic over supplementation of protein results in increased protein excretion by the fish and an increased level of ammonia in the environment. Alteration in water chemistry lead to serious health problems for the farmed populations.

Prevention and control measures

Aquaculture Health management means the management approaches to prevent and control the outbreak of emerging and re-emerging diseases which begins with prevention of disease.

- I. Proper management of water quality and nutrition is the first step in fish disease Prevention. It is impossible to prevent diseases outbreaks without this. Poor water quality, nutrition or immune system are associated with stress which allows the pathogens to cause a disease [3].
- II. Nutritional diseases are not contagious and rarely happen but cannot be cured by medications. Best way to prevent and control through provision of good water quality and good management.
- III. Timely observation of fish behavior and feeding helps in primary detection of disease. It provides easy diagnosis odd disease before the majority of the population becomes sick [4].
- IV. A balanced diet can provide high nutrients to recover from deficiency diseases and high yields. Diets may also have negative effects inducing nutrient deficiencies, toxin production or induction of pathogens into the fish [7,9].

Disease	Treatment
Scurvy	Use adequate amounts of ascorbic acid in diet and provide the minimum requirement for the species.
Lipodosis	Handle feeds properly and observe good storage practices, stop feeding, replace diets with new one if lipodosis is confirmed, avoid feeding fish with spoiled and poorly stored trash fish
EFA Deficiency	Feed 15 day-old larvae with brine shrimps enriched with fish oil
	Maintain clean environment and water management and avoid unnecessary mechanical stress to the larvae
	Enrich feed with rotifers with n-3 HUFA or Nannochloropsis and Bring the EFA levels of the live food to around 12% by enrichment. DHA Supplement is reported to slow down mortality in grouper.
Ceroidosis	Proper food management can prevent this disease, food should be kept in -30°C to prevent rancidity of PUFAs,
	Vitamin E are effective against this disease to prevent oxidative cell damage and enrichment of food with vitamin complex can stamp out mass mortality
Thiamin Deficiency	Alter prolonged single species feeding by Mixed trash fish feed and regular vitamin supply with diets should be adopted. Provide excess vitamin B1 supplement if fish become deficient in thiamin

Table 3: Some nutritional diseases of fish and their treatments.

Conclusion

Fish health management has become one of the basic requirements for sustainable aquaculture development. But, most of the farmer involved in aquaculture practice do not have sufficient knowledge on aquaculture health management practices [1,2]. So, it is very essential to focus the efforts on disease prevalence and fish pathogens. Farmers should be provided with essential knowledge on good aquaculture management practice. Disease preven-

tion can be achieved through proper nutrition supply, good quality water supply and healthy sanitation condition [4]. Poor water quality, proper nutritional diets or weak immune system allow these potential microorganisms to cause disease [1,9]. In order to ensure disease resistance, optimum level of nutrients should be supplied in diets because nutrient requirement level varies from species to species. The following steps can make new windows in nutritional disease control in aquaculture.

- I. Maintaining a suitable stocking density is necessary as overcrowding predispose fish to infections.
- II. Store the feed properly in dry, cool and covered place as *Aspergillus flavus* can grow on mouldy feedstuff and produce aflatoxins.
- III. Increase the shelf life of fish food adding stabilized vitamin C (l-ascorbyl-2-polyphosphate) during manufacturing process. Avoid feeding food greater than 90 days old.
- IV. Clinical signs of hypovitaminosis C include scoliosis and lordosis. Adding vitamin C directly to the water can provide necessary supplementation.
- V. Vitamin B deficiencies are common nutritional problems. The requirements for certain B vitamins are significant increased after prolonged antibiotic treatment and supplements should be considered for these patients.
- VI. When fish flakes come into contact with water, up to 90% of water-soluble vitamins are lost within 30 seconds. Owners should feed smaller amounts of food at more frequencies get the greatest benefit of vitamins.
- VII. Live food can have several benefits, including color enhancement. Live foods should always originate from controlled artificial cultures and wild-caught live food should be avoided.
- VIII. Feeding of higher vitamin is often reported to provide some protection against disease and to improve tissue regeneration following injury or tissue damage due to low temperatures. The prophylactic use of vitamins in animal nutrition is widely recognized and practiced.
- IX. Use of high quality feed ingredients free from contaminants, proper nutrient balance in feed formulation, prevention of micronutrients loss during feed processing, better handling, storage and feed management also have good potential to improve health of aquatic animals.
- X. Feeds formulation based on blood and fish meal should be closely monitored because they supply high amounts of iron which may predispose fish to common bacterial pathogens.
- XI. Deficiencies due to presence of anti-vitamin factors in feed can be overcome by heat processing, cooking or heat treatments etc.
- XII. Avoid feeding the stock with trash fish that cannot provide balanced nutrition. This type of feed lessens the natural resistance of fish and makes them more vulnerable to pathogenic infection.
- XIII. Use dry pellet feed which is hygienic, nutritious and low in bacteria. Dry pellet feed added with vitamins and minerals can further strengthen fish immunity.

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