

Nutritional pathology of fish

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Introduction

- Formulation of well-balanced diets and their adequate feeding are two of the most important requirements for successful aquaculture.
- Nutritional status is one of the most important factor that determine the ability of fish to resist diseases
- Nutritional diseases of fish can be developed as a result of deficiency, excess or improper balance of components present in the food available
- Diseases sign develop only when supply of any diet component falls below critical level
- When there is too much food the excess that is converted to fat and deposited in fish tissue and organ may affect several physiological function of the fish

The deficiency and imbalance diseases

- Deficiency disease are two types – deficiency or imbalance of the macronutrient in the diets- the protein; carbohydrate; lipid

And deficiency of the micronutrient- vitamins and minerals

- In terms of macronutrient usually lipid component of the macronutrient that the most serious problem arises in terms of practical diets – deficiency; oxidation; imbalance

Protein deficiency:

- All the fish required high level of protein as a source of amino acids for protein synthesis and for glycolysis
- Fish diet must be contain high level of high quality protein since protein is one of the most expensive component of the diet
- The growth and the maintenance of health of fish depend on the content and quality of protein in the feed.
- Also protein is importance for the growth of fish and ensures the formation and activity of essential enzymes and hormones.
- The principle feature determining protein quality for fish nutrition in the level and avability of the essential amino acid
- Deficiency of one or more of these leads to deficiency diseases

The most common signs of protein and/or amino acid deficiency in fish are:

- Reduction of growth rate.
- Mortality
- Scoliosis and Lordosis.
- Anemia (Reduction of RBCs)

Essential amino acid deficiency signs in fish

EAA	Fish Species	Deficiency sign
Lysine	Oncorhynchus mykiss Cyprinus carpio	Dorsal/caudal fin erosion ; Increased mortality
Methionine	Oncorhynchus mykiss Salmo salar	Increased mortality
Tryptophan	Oncorhynchus mykiss Oncorhynchus nerka	Scoliosis, lordosis, cataract; caudal fin erosion ; decreased carcass lipid

Toxic amino acids

- Nutritional pathologies may arise from the consumption of feed proteins containing toxic amino acids or their derivatives. Feed proteins containing toxic amino acids which have been reported to have a negative effect on fish growth and feed efficiency (including eventual fish death) include the plant legumes Leucaena leucocephala (toxic nonprotein amino acid – mimosine)
- In addition to the non-essential amino acids, certain EAA (ie. leucine) have also been reported to exert a toxic effect in fish when present in dietary excesses
- For example, the reported toxicity signs for a dietary excess of leucine (13.4% of diet) in rainbow trout (O. mykiss) included scoliosis, deformed opercula, scale deformities, scale loss, and spongiosis of epidermal cells

Lipids deficiency

- Pathological conditions occur in fish from excess dietary fats, deficiency of fatty acids and the toxic effect of unsaturated dietary fats.
 - Reduced growth of the fish.
 - Skin de-pigmentation.
 - Fins erosion.
 - Rapid swimming is followed by immobility and loss of reflex.
 - Fish may float or sink to the bottom and then recover or die.

Essential fatty acid deficiency signs in fish

Fish species	Deficiency sign
Oncorhynchus mykiss	Increased mortality; increased susceptibility to caudal fin erosion; decreased haemoglobin and RBC; shock syndrome; swollen pale liver; reduced spawning efficiency
Oncorhynchus kisutch	swollen pale liver; increased hepatosomatic index (fatty liver); high mortality
Cyprinus carpio	Increased mortality; fatty liver
<u>Lates calcarifer</u>	Reduced growth and feed efficiency, reddening of fins
<u>Ctenopharyngodon idella</u>	Reduced growth and feed efficiency, swollen pale liver, increased mortality, lordosis, shock syndrome

Trace elements and mineral deficiencies and imbalances

- Fish can also absorb minerals from water
- Minerals required only in small quantities
- Some trace elements are required as coenzymes and for vital maintenance of cellular function in the immune system

Essential mineral deficiency sign in fish

Elements	Deficiency sign
Phosphorus(P)	
C. Carpio	Reduced growth; poor feed efficiency; bone demineralization; soft ray of pectoral fin; cranial deformity; increased visceral fat
O. Mykiss	Reduced growth; poor feed efficiency; bone demineralization;
Calcium (Ca)	
Ictalurus punctatus	Reduced growth; low carcass ash;
O. Mykiss	Poor growth; anorexia(loss of appetite); poor feed efficiency
Potassium(K)	Reduced growth; reduced feed efficiency; anorexia; death
Magnesium (Mg)	
C. Carpio	reduced growth; anorexia; reduced bone magnesium content; cataract
O. Mykiss	Reduced growth; anorexia; calcinosis of kidney; degeneration of muscle fiber; degeneration of gill filaments

Iron (Fe)	Hyper chromic microcytic anaemia
Zinc (Zn)	
C. Carpio	Reduced growth; cataract; loss of appetite; high mortality; erosion of fin and skin;
O. Mykiss	Reduced growth; increased mortality; short body dwarfism; fin erosion
Manganese (Mn)	
C. Carpio	Reduced growth; short body dwarfism; cataract
O. Mykiss	Cataract; reduced growth; short body dwarfism; abnormal tail growth
Copper (Cu)	
C. Carpio	Reduced growth; cataracts
Selenium (Se)	
S. salar	Increased mortality; muscular dystrophy; reduced growth
C. Carpio	Reduced growth; cataracts; anaemia
Iodine	
Salmonids	Thyroid hyperplasia

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)

Vitamins deficiency sign in fish

Riboflavin (vitamin B12)	
Salmonids	Anorexia; poor growth; cloudy lens; fin erosion; rapid Opercular movement; light or dark pigmentation; anaemia; photophobia
C. Carpio	Anorexia; poor growth; high mortality rate; haemorrhage of skin and fin photophobia
Pantothenic acid	
Salmonids	Anorexia; reduced growth; gill necrosis;/clubbing; anaemia; mucous covered gill; sluggish activity
C. Carpio	Anorexia; reduced growth; skin haemorrhage; exophthalmia
Niacin (Nicotinic acid)	
Salmonids	Anorexia; poor growth; reduced feed efficiency; dark colouration; erratic swimming;
C. Carpio	skin haemorrhage; high mortality

Biotin	
Salmonids	Anorexia; reduced growth; increased mortality; poor feed efficiency; blue slim diseases; thick gill lamellae
C. Carpio	reduced growth and activity
Thiamine (Vitamin B1)	
Salmonids	Anorexia; Poor growth; nervous disorder;
C. Carpio	fin haemorrhage; nervousness; anorexia; poor growth
Folic acid	
Salmonids	Macrocytosis anaemia; poor growth; anorexia; dark colouration; exophthalmia;
Ictalurus punctatus	Anorexia; poor growth; nervous disorder
Pyridoxine (Vitamin B6)	
Salmonids	nervous disorder; anorexia; greenish-bluish colouration of skin; anaemia
C. Carpio	nervous disorder; anorexia; poor growth

Ascorbic acid (Vitamin C)	
salmonids	Nervous disorder; scoliosis; lordosis; internal haemorrhage; dark colouration
Ictalurus punctatus	Reduced growth; scoliosis; lordosis; external haemorrhage; erratic swimming behaviour
Cyanocobalamin (Vitamin B12)	
salmonids	Reduced growth; poor feed efficiency; dark pigmentation
Ictalurus punctatus	Reduced growth; Low haematocrit value
Vitamin A	
Salmonids	Reduced growth; exophthalmia; degeneration of retina
C. Carpio	Anorexia; faded body colour; fin and skin haemorrhage
Vitamin D3 (Cholecalciferol)	Reduced growth; tetany; reduced feed efficiency

Vitamin E (Tocopherol)	
Salmonids	Reduced growth; exophthalmia; anaemia; clubbed gill diseases; reduced egg hatching; pale gill colour
c. carpio	Muscular dystrophy; mortality; exophthalmia
Vitamin K3	
salmonids	Increased blood clotting time; anaemia
i. punctatus	Skin haemorrhage

Reported vitamin toxicity signs in fish

Vitamin A	
Salmonids	Reduced growth; scoliosis; lordosis; increased mortality; pale yellow liver
Vitamin D	
Salmonids	Reduced growth; dark colouration
<i>I. punctatus</i>	Reduced growth; poor feed efficiency
Vitamin E	
Salmonids	Reduced blood erythrocyte concentration

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.

- **Vitamins deficiency**

Vitamin	Symptoms of deficiency
Ascorbic acid	Skeletal deformities poor wound healing.
Thiamine	Poor growth and nervous symptoms.
Riboflavin	Cataract and corneal opacity. Pigmentation abnormalities. Poor growth. Fin erosion.
Pantothenic acid	Clubbing of gills filaments loss of appetite, poor growth, exudates on gills.
Folic acid	Poor growth, lethargy, dark coloration, anemia.
Pyridoxine	Nervous disorders, anemia loss of appetite, rapid and gasping breathing.
Vitamin A	Blindness, poor growth.
Vitamin E	Muscular dystrophy anemia, poor growth.
Vitamin K	Reduced blood clotting time.

Mycotoxin

- Mycotoxin is metabolic product of fungal contaminants of feed component
- The most significant of these toxic metabolites in terms of fish diets are the- Aflatoxins
- Toxic produced by – blue green mould *Aspergillus flavus* which is common contaminant of oil seed feed ingredients
- Aflatoxins are carcinogenic
- Caused – hepatocarcinoma in cultured fish

Algal toxic

- Algal bloom in water kill fish by removing oxygen from the water
- Many of the fresh water algae – *Myrocystis aeruginosa* and nontoxic anabaena have been shown to be toxic to human or animal

Sekoke diseases

- Sekoke diseases in carp has been described in japan in association with the incorporation of significant levels of silk worm pupae in the diet
 - lipid infiltration of Parenchymatous organs, bilateral cataract and degenerative changes in extrinsic eye muscle, retina

Starvation

- Starvation can occur due to number of reasons other than obvious under feeding:
- Incorrect assessment of the weight of receiving the food.
- Presentation of a feed of inappropriate physical characteristics, usually when size of individual particle is too large for size of fish or sinks too quickly through the water.
- Signs of starvation are easy to spot and include loss of condition, loss of weight and failure to reproduce. These may be an increase in cannibalism, ranging from fin nipping to attempts to swallow whole fish particularly very young ones.

Diagnosis of nutritional deficiency:

- Presumptive diagnosis of nutritional deficiency is based on clinical signs and combined with evidence of an inadequate diet. Definitive diagnosis requires identification of a specific nutritional deficiency in diet.

Treatment and control:

Treatment of disease due to nutritional imbalance depends on:

- Provision of fish with right kind of food with sufficient quantity according to diagnosis of the types of deficiency of nutritive components.
- Mathematical formulation of a complete ration must be followed by ration preparation, analysis and actual feeding of fish to be assured that all nutrients are available.
- Physical preparation of the ration must also be considered to allow for presentation of the nutritionally balanced diet to the fish in such a way that it can be ingested and digested. Taste or palatability of the ration for each fish species must be considered. Fish have a highly sensitive sense of taste, so the ration must pass the palatability test. When presented to the fishes in order for it to be completely and continuously ingested.
- The ration must be fed to the fish at prescribed time intervals because of a more or less limited stomach capacity.
- The amount of ration fed to confined fish daily to maintain nutritional depends on fish species, fish size, ration quality, water temperature and type of ration.