

Role of Fish Nutrition in Aquaculture Production

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Aquaculture is the main food producing sector in the world. It produces protein at low cost which is an important nutrition factor required by the human beings for the growth and development. Aquaculture is the only alternative resource for renaissance of the ecosystem. To meet the aquaculture demand raised in the world, we are modernizing the techniques to produce the fish, and we are also making the efficient feeds for the optimum growth and development of fishes. Before manufacturing the feed, we must understand the importance of nutritional factors responsible for the fish growth and development. Nutrients plays major role in the growth and condition of the fish. The development of nutritionally balanced commercial diets can have positive impact on the growth performances and survival of aquatic organisms (Tom and Van-Nostrand, 1989). The advancement in the nutritional factors supports the aquaculture industry to become sustainable, cost effective and nutrition rich finfish and shellfish production (Robinson *et al.*, 1998). Fish behaviour and physiological condition depends on the nutrition provided in the feed.

Nutrition is the science that deals with the interaction of a nutrient with living organism, including feed composition, ingestion, energy liberation, wastes elimination and synthesis for maintenance, growth, and reproduction. Dietary nutrients are particularly important for the development of living tissues. They act as energy sources for metabolism, reproduction, and other life processes. Complete diets supply all the ingredients (protein, carbohydrates, fats, vitamins, and minerals) necessary for the optimal growth and health of the fish. Most of the commercial diets containing the essential nutrients including protein, lipid, carbohydrate, ash, phosphorous, water, minerals, and vitamins in the range of 18-50%, 10-25%, 15-20, <8.5%, <1.5%, <10%, 0.5 and 0.5 respectively (Prabu *et al.*, 2017). Aquatic organisms being cultivated in enclosed enclosures or indoor systems may not have access to natural foods, so their nutritional needs can be satisfied only with the addition of supplemental feeds that are enhanced nutritionally.

Digestion and Absorption

Digestion is the breakdown of large insoluble food compounds into small water-soluble components

so that can be absorbed into the blood. Digestion helps to remove dangerous toxic properties of certain food substances. The digestive system of fish includes the mouth, pharynx, oesophagus, stomach, pylorus, intestine, liver, and gall bladder. Absorption means the passage of food through the lining of the digestive tract into the blood.

Structure	Function
Teeth	Grasping, holding, crushing, depending on species
Pharynx	Opening to the gills
Oesophagus	Simple passage to stomach, lined with mucus secreting cells
Stomach	Secretes HCl helps in protein digestion
Pyloric cecum	Increase surface area for absorption of nutrients
Intestine	Absorption of organic and inorganic compounds
Gall bladder	Stores and releases bile for digestion and absorption of fats
Liver	Production of bile, removal of waste products from blood

(Prabu *et al.*, 2017)

Nutritional Requirements of Fishes

i. Proteins

Proteins are composed of long chains of amino acids linked by bonds called peptide bonds. When it comes to fish feed, protein is the priciest, yet essential component that affects the growth of the fish species.

Functions

- Sources of energy
- Helps to form hormones and enzymes.
- Serves as substrate for CHO and FA synthesis.

ii. Fats

It is the second most abundant organic compound. Each gram of fat contains 2.5 times the energy in a gram of carbohydrates or proteins. Highly unsaturated fats can rapidly digest by fish but there is chance of oxidation of the fats, resulting in feed spoilage. Antioxidants are routinely added to most fish diets to prevent fats from becoming rancid in storage. Animals store energy in the form of fats.

Functions

- It acts as biological carriers for the absorption of the fat-soluble vitamins A, D, E and K
- Acts as lubricants and increases feed palatability.
- Sources of essential fatty acids

iii. Carbohydrates

Carbohydrates are the most economical and inexpensive sources of energy for fish diets. In fish diets, carbohydrates are added for their binding activity during feed manufacturing and to lower feed costs.

Functions

- Utilization of carbohydrates as an energy source
- Increases feed binding and palatability.

iv. Vitamins

Vitamins are organic compounds required in the diet for normal growth, reproduction, and health. Vitamins are divided into two categories, water soluble and fat soluble. Fat soluble vitamins are absorbed in the intestine along with fats in the diet. Unlike water soluble vitamins, fat soluble vitamins can be stored in body tissues.

Functions

- Vitamin C is involved in the formation of connective tissue, bone matrix and wound repair.
- Vitamin A is necessary for sight, proper growth, reproduction, resistance to infection and maintenance of body coverings.
- Vitamin K is required for the normal blood clotting process.

v. Minerals

Fish can absorb several minerals directly from the water like calcium (Ca), magnesium (Mg), sodium (Na), iron (Fe), zinc (Zn), copper (Cu) and selenium (Se). This reduces the mineral requirement in the diet. Minerals are divided into two groups such as macro minerals and microminerals. Macrominerals are present in the body in relatively large quantities. The macro minerals include Calcium (Ca), Chlorine (Cl), Magnesium (Mg), Phosphorous (P), Potassium (K), Sodium (Na). Microminerals are present in very small amounts in the bodies of fish, but they are still important to fish health. The microminerals include Copper (Cu), Iodine (I), Iron (Fe), Manganese (Mn), Selenium (Se), Zinc (Zn).

Functions

- Calcium and phosphorous are essential for the development and growth of the skeleton.

- Magnesium functions with many enzymes as a cofactor.
- Iron is necessary for the formation of heme compounds. These compounds carry oxygen.
- Selenium protects cells and membranes against peroxide danger.

vi. Other dietary components

These are the compounds which are added to the diets which have positive effects on the growth and development of the fishes. These includes Fiber, hormones, antibiotics, antioxidants, pigments and feeding stimulants.

a. Fiber

Fiber refers to plant material such as cellulose, hemicellulose, lignin, and other complex carbohydrates. It improves binding of feed and moderates the passage of food through intestine.

b. Hormones

We are adding various natural and synthetic hormones in feed stuff to improve spawning and growth. These hormones include growth hormone, thyroid hormones, gonadotropin, prolactin, insulin and various steroids like androgens and estrogens. Sex steroids reverse the sex of salmonids, carps, and tilapia, producing a monosex culture of sterile fish.

c. Antioxidants

These prevent lipid rancidity and vitamin loss. It is used in high fat fish feeds. Vitamin C and E are natural antioxidant. BHT and BHA are commonly used synthetic antioxidants.

d. Antibiotics

These are added to feed stuff to control diseases in fishes. Only FDA approved drugs can be used in aquaculture diets. When antibiotics are used in the feed, the feeding rate and the withdrawal time must be strictly controlled. FDA approved drugs are sulfadimethoxine / ormetoprim and oxytetracyclin.

e. Pigments

Carotenoids are responsible for the pigmentation of the skin and flesh. In salmonids, the carotenoids astaxanthin and canthaxanthin are responsible for the red to orange color of their flesh. In the wild, these carotenoids come from zooplankton. Good pigmentation increases the price of the fishes.

f. Feeding stimulants

It helps fish to recognize, ingest and grasp the feed. It improves feeding behaviour and feed intake. In general, carnivorous fish respond to alkaline and neutral substances. Herbivorous fishes respond to acid

substances. Inosine and Inosine mono phosphate commonly used as feeding stimulants.

Conclusion

Fish's growth, reproduction, and ability to respond to pathogen, physiological and environmental stressors are all influenced by their diet and feeding habits. So, nutrition is considered as heart of aquaculture. So, nutrition is one of the important areas to be concentrated by aquaculture industry. The fish farmers are struggling hard to reduce the cost of fish feed since fish feed accounts for over 50% of the total cost of fish production. Much research is currently going through concerning the development of cost-efficient feed for enhancing the fish and shrimp production. Replacement of fish meal with plant-based ingredients become emerging area in fish feed preparation. Usage of natural immunostimulant in fish feeds to improve health of the fishes are also

increasing and application of prebiotics, probiotics and symbiotic improves gut health and feeding efficiency in fishes, seeking interest of aqua farmers to use it in now a day. Formulation of natural ingredient-based diets helps to reduce harmful effect on environment and helps to attain sustainability in aquaculture.

References

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