

Unit-XI

FISH NUTRITION AND FEED MANAGEMENT

- **The nutritional requirements of fish are similar to those of land animals for growth, reproduction and other normal physiological functions**
- **Good nutrition in animal production systems is essential to economically produce a healthy, high quality product.**
- **In fish farming, nutrition is critical because feed represents 40-50% of the production costs.**
- **Fish nutrition has advanced dramatically in recent years with the development of new, balanced commercial diets that promote optimal fish growth and health.**

Natural fish food organism or Live food organisms

- A variety of natural fish food organisms are found in a waterbody
- The natural food provides the constituents of a complete and balanced diet
- Natural feeds have high protein and fat contents, which promote the growth of the fish

Classification of food and feeding habits of fishes

As per Schaprcas, 1933

- Main food : It is the most preferred food on which the fish will thrive best
- Occasional food : It has relatively high nutritive values and is liked and consumed by fish whenever the opportunity presents
- Emergency food : It is fed upon/ accepted when other food material is not available.

As per Nikolsky, 1963

- Basic food : It is normally eaten by the fish and comprises most of the gut contents.
- Secondary food : It is frequently consumed in smaller quantities.
- Incidental food : It is consumed rarely.
- Obligatory food : The fish consumes this food in the absence of basic food.

As per Das and Moitra, 1963

Herbivorous fishes : They feed on plant material, which forms more than 75% of gut contents.

Omnivorous fishes : They consume both plant and animal food.

Carnivorous fishes : They feed on animal food, which comprises of more than 80% of the diet.

Herbivores are divided into 2 sub-groups.

Planktophagous fishes : They consume only phyto- and zooplankton

Detritophagous fishes : They feed on detritus.

Plankton

- Fish production in a waterbody is directly or indirectly dependant on the abundance of plankton.
- Planktons are free floating organisms found in water

Phytoplankton

- Phytoplankton gives green colour to the water due to the presence of chlorophyll.
- Phytoplankton occupy the base of the food chain and produce
- phytoplankton consist of three major classes

a.Chlorophyceae

b.Cyanophyceae

c.Bacillariophyceae.

a. Chlorophyceae

- These are called green algae due to the presence of chlorophyll.
- Many chlorophyceae members are useful as food to fishes.

- *Chlamydomonas*.
- *Volvox*,
- *Chlorella*.

Filamentous algae like

- *Ulothrix*,
- *Spirogyra*
- *Scenedesmus*
- *Cosmarium*. etc.

Cyanophyceae

- These are also called as myxophyceae
- commonly known as blue green algae
- This colour is due chlorophyll a, carotenoids and biliproteins

Nostoc

Oscillatoria

Anabaena

Microcystis,

Bacillariophyceae

- These are called diatoms
- They are unicellular organisms with different shapes and sizes.
- These may be yellow or golden brown or olive green in colour
- The diatoms consumed by fish are

Diatom

Navicula

Nitzschia

Rhizosolenia

Cyclotella

Zooplankton

Plankton consisting of animals is called zooplankton

The zooplankton forms an important group as it occupies an intermediate position in the food web

a. Protozoans

b. Crustaceans

c. Rotifers

Protozoans

- Protozoans are most primitive, unicellular and microscopic animals.
- The protozoans with flagella are included under the class flagellata
- Euglena* is the most common fish food organism under flagellate

Ceratium

Chilomonas and

Phacus are also used as fish food

- The protozoans with cilia are included in the class Ciliata
- Here the cilia persist throughout life

Paramecium

Metopus

Euplotes.

The ciliates are the dominating organisms among the zooplankton

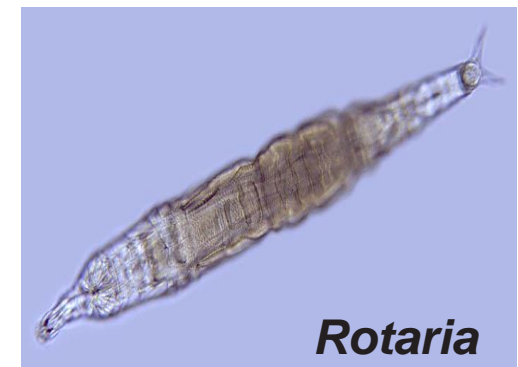
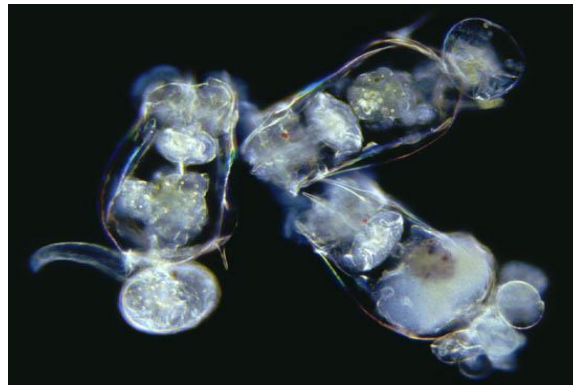
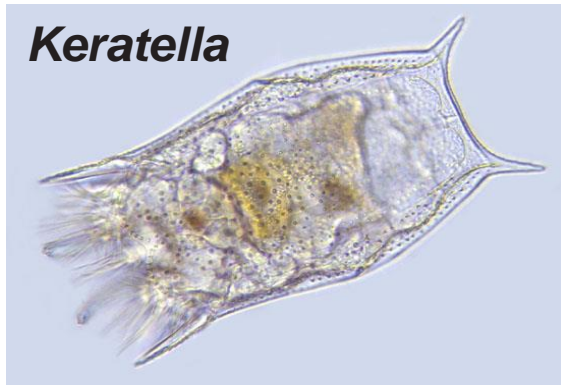
Crustaceans

- The aquatic animals with 19 pairs of appendages and branchial respiration
- The important microcrustaceans are copepodes and cladocerans
- The crustacean nauplii temporary planktons
- Copepods are *Cyclops*, *Mesocyclops*, *Diaptomus*
- The cladocerans are *Daphnia*, *Ceriodaphnia*, *Moina*,

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Rotifers

- Anterior ciliated wheel-like structure called corona and hence they are called wheel animalcules
- Usually rotifers like, *Keratella*, *Rotaria*, *Brachionus*, *Testudinella* etc
- Rotifers offer several advantages as fish feed organisms.
 - They reproduce quickly
 - Rotifers are small and therefore are accepted as food by most fishes and shell fishes (40 microns to 2.5 mm)
 - They are nutritious and their actual nutritional value can be improved



Bioenriched feeds

Process involved in improving the nutritional status of live feed

By feeding or incorporating within them various kinds of materials such as

Microdiets

Microencapsulated diets

Genetically engineered baker's yeast

Emulsified lipids rich in ω 3HUFA (Highly Unsaturated Fatty Acid) together with fat soluble vitamins.

Prepared (artificial) Diets

Artificial diets may be either complete or supplemental

Complete diets supply all the ingredients

- Protein
- Carbohydrates
- Fats
- Vitamins
- minerals

Protein

- Protein is the most expensive part of fish feed
- It is important to accurately determine the protein requirements of the cultured fish
- Proteins are formed by linkages of individual amino acids
- Over 200 amino acids occur in nature, only about 20 amino acids are common
- Of these, 10 are essential amino acids that cannot be synthesized by fish
- Essential amino acids
 - methionine, arginine, threonine, tryptophan, histidine, isoleucine, lysine, leucine, valine and phenylalanine

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Protein levels in aquaculture feeds generally average

| | |
|--------|-------------------|
| 18-20% | for marine shrimp |
| 28-32% | for catfish |
| 32-38% | for tilapia |
| 38-42% | for sea bass |
| 30-40% | for carp fishes |

Protein requirements

- lower for herbivorous fish and omnivorous fish
- higher for carnivorous fish
- higher for fish reared in high density than low density systems
- higher for smaller fish
- protein requirement is less for large fish.

Protein is used for fish growth if adequate levels of fats and carbohydrates are present in the diet

Lipids (fats)

- Fats are the principal form of energy storage in plants and in animals
- Fat contains more energy per unit weight than any other biological product
- Lipids supply about twice the energy as proteins and carbohydrates
- Supply essential fatty acids (EFA) and serve as transporters for fat-soluble vitamins

The two major EFA of this group are

Eicosapentaenoic acid

Docosahexaenoic acid

Simple lipids include fatty acids and triacylglycerols

- a) Saturated fatty acids (SFA, no double bonds)
- b) Polyunsaturated fatty acids (PUFA, >2 double bonds)
- c) Highly unsaturated fatty acids (HUFA; > 4 double bonds)

Marine fish typically require n-3 HUFA for optimal growth and health ranging from 0.5-2.0% of dry diet

Freshwater fish do not require the long chain HUFA, but often require an omega -3 fatty acid ranging from 0.5 to 1.5% of dry diet.

In high lipid feed is used then the excessive fat deposition in the liver can decrease the health and market quality of fish.

Carbohydrates

- **Carbohydrates (starches and sugars) are the most economical and inexpensive sources of energy for fish diets**
- **Carbohydrates are included in aquaculture diets to reduce feed costs and for their binding activity during feed manufacturing**
- **Carbohydrates are the a major energy source for mammals, but are not used efficiently by fish**
- **Mammals can extract about 4 kcal of energy from 1 gram of carbohydrate, whereas fish can only extract about 1.6 kcal from the same amount of carbohydrate.**

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Vitamins

- Vitamins are organic compounds necessary in the diet for normal fish growth and health.
- They often are not synthesized by fish, and must be supplied in the diet
- Two groups of vitamins are water-soluble and fat-soluble.
- Water-soluble vitamins include
 - B vitamins, choline, inositol, folic acid, pantothenic acid, biotin and ascorbic acid (vitamin C).
- Fat-soluble vitamins include
 - A vitamins (responsible for vision)
 - D vitamins (bone integrity)
 - E vitamins (antioxidants)
 - K vitamins (blood clotting, skin integrity).
- Deficiency of each vitamin has certain specific symptoms, but reduced growth is the most common symptom of any vitamin deficiency.
- Other common symptoms are abnormal color, lack of coordination, nervousness, hemorrhage, fatty livers and increased susceptibility to bacterial infections.

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Minerals

Minerals are inorganic elements necessary in the diet for normal body functions.

They can be divided into two groups

Macro-minerals

Micro-minerals

Based on the quantity required in the diet

Common macro-minerals are

Sodium

Chloride

Potassium

Phosphorous.

- *These minerals regulate osmotic balance and aid in bone formation and integrity*
- *Micro-minerals (trace minerals) are required in small amounts as components in enzyme and hormone systems*
- **Common trace minerals are copper, chromium, iodine, zinc and selenium.**
- **Fish can absorb many minerals directly from the water through their gills and skin**

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Feed Types

Commercial fish diets are

Extruded (floating or buoyant)

- Extruded feeds are more expensive due to the higher manufacturing costs
- The farmer can directly observe the feeding intensity of his fish and adjust feeding rates accordingly

Pressure-pelleted (sinking) feeds

Shrimp, for example, will not accept a floating feed they feed on pellet feed

- Feed is available in a variety of sizes ranging from fine crumbles for small fish to large (1/2 inch or larger) pellets.
- The pellet size should be approximately 20-30% of the size of the fish species mouth gape.
- Feeding too small a pellet results in inefficient feeding because more energy is used in finding and eating more pellets.
- Conversely, pellets that are too large will depress feeding and, in the extreme, cause choking.
- Select the largest sized feed the fish will actively eat.

Types of feeds

Feeds can be classified based on the stage of the life-cycle at which they are used

- Starter feeds
- Grower feeds and
- Finisher feeds

Feeds can be classified based on the stage of the life-cycle

- Started feeds
- Fry feeds
- Fingerling feeds
- Grow-out feeds and
- Broodstock feeds

Feed Formulations

A complete diet must be

- Nutritionally balanced
- Palatable
- Water stable
- Proper size
- Texture

The basic information required for feed formulation are

- Nutrient requirements of the species cultivated
- The feeding habits of the species
- Local availability cost and nutrient composition of ingredients
- Ability of the cultured organism to utilize nutrients from various ingredients as well as the prepared diet
- Expected feed consumption
- Feed additives needed and
- Type of feed processing desired

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FEED INGREDIENTS

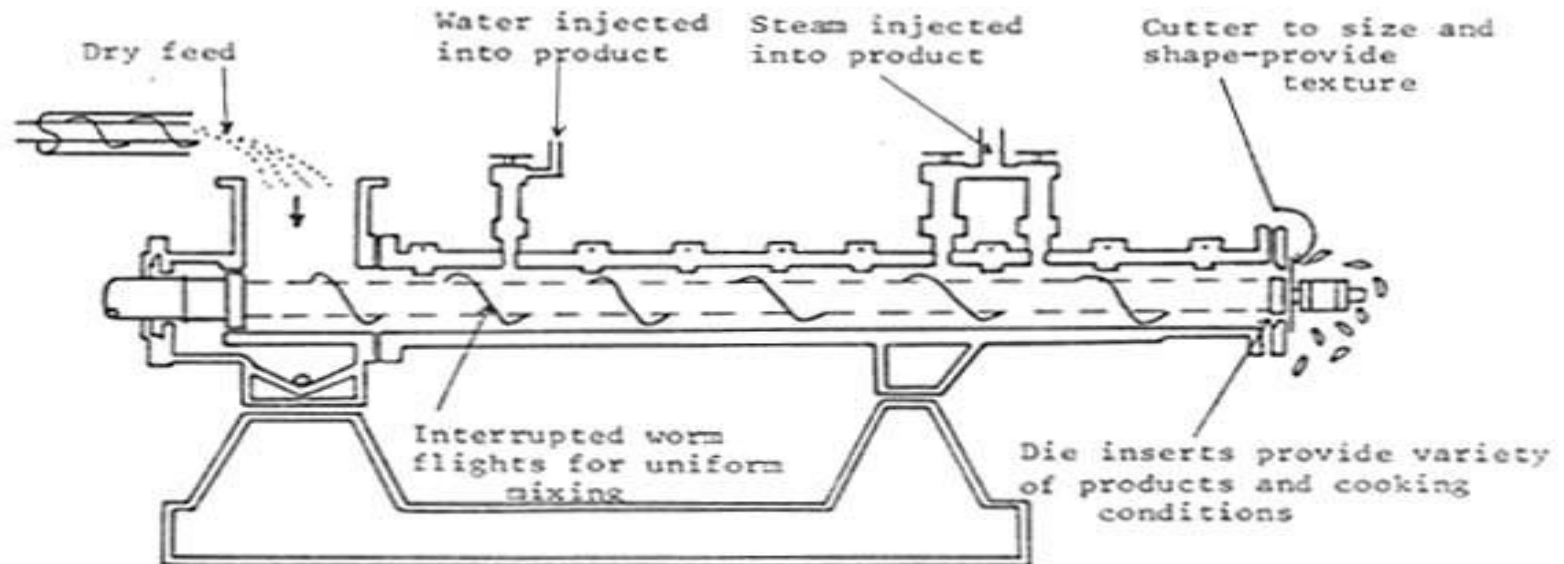
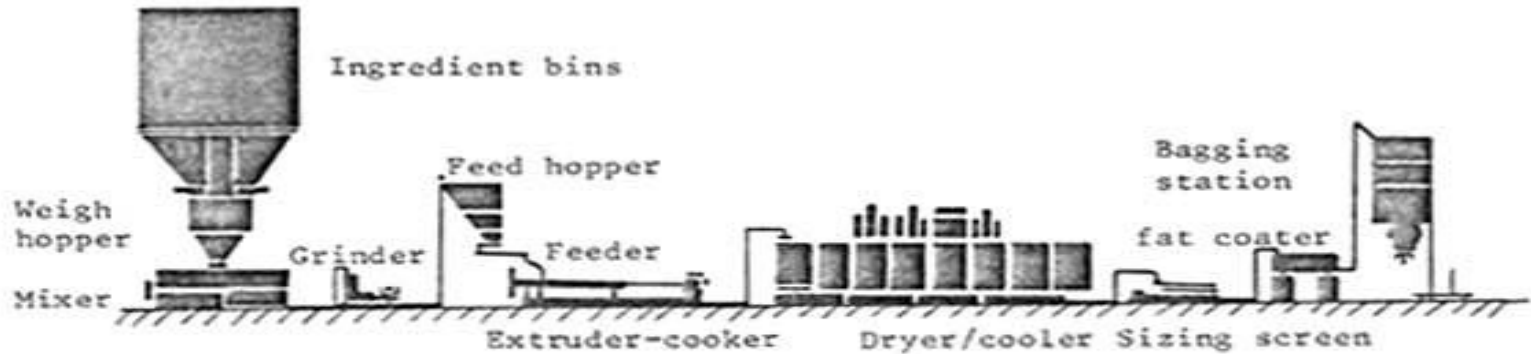
| Ingredients | % |
|--|-----|
| Soybean meal | 15 |
| Rice bran | 9.9 |
| Fish meal | 20 |
| Meat meal (local) | 20 |
| Cotton seed meal | 15 |
| Maize | 20 |
| Vitamin and mineral mixture | 0.1 |
| <u>Calculated chemical composition</u> | |
| Protein, % | 40 |
| Lysine | 2.3 |
| Methionine + cystine | 0.8 |
| Digestible energy, kcal/g | 1.7 |
| Cost/kg | 27 |

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Processing recommendations for preparing fish diets

| Procedure | Specification |
|----------------------------------|--|
| Mixing | Mix all dry ingredients together except vitamin mix. |
| Grinding | Grind the mixture in a stud or grist mill so that 90% passes through a 60-mesh sieve and 67% passes through an 80-mesh sieve. |
| Wet mixing | Add hot water and mix the grinded ingredients to a semi powder and wet condition |
| Steam cooking | The wet mixed powder is steam cooked for 30 minutes and allowed to cool for 15 minutes |
| Addition of vitamin and minerals | After steam cooking the feed mixture is allowed to cool after which the pre-weighed vitamin and mineral mixture is added and mixed well |
| Extruder | In this process the prepared feed mix is allowed to pass through the extruder for preparing the feed pellets. The size of the extrude can made as per the requirement |
| Drying | In normal sunny days the extruded feed can be dried in direct sunlight or the extruded feed can be dried in plate driers for 6 – 10 hrs at 50 centigrade to avoide charring of the feed. |
| Packaging | After drying the final feed product can be packed and marketed |

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THE ANDERSON EXPANDER-EXTRUDER-COOKER

Feed storage

- A manufactured diet requires storage at least at the place of manufacture and on the farm.
- Feeds are composed of perishable biological material which deteriorates with storage.

Deteriorative effects during storage are caused by

- Oxidative damage
- Microbial damage
- Insect and or rodent damage / infestation and
- Other chemical changes during storage.

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Feeding Rate, Frequency and Timing

- **Depends on stocking density**
- **Type of farming**
- **Type of species farmed**

Feeding Methods

- **Bundh feeding**
- **Boat feeding**
- **Automatic machine feeding**

Mass culture of microalgae

Mass production of phytoplankton or “green water” for rotifers

Chlorella sp.,

Isochrysis galbana

Pavlova lutheri

Nannochloropsis oculata and *N. gaditana*

Dunaliella tertiolecta

Tetraselmis suecica.

Mass production systems

For aquaculture purposes, microalgae are mass produced in three main ways:

- Batch (or discontinuous or multistep back-up system) culture
- Semi-continuous culture and
- Continuous culture