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PAPER-III FISH NUTRITION AND FEED TECHNOLOGY

UNIT-I

NUTRTIONAL REQUIREMENTS OF FISH

Introduction:

Fish farming, nutrition is Critical because feed represents fish farming, nutrition is critical because feed represents 40 to 50% of the production costs.

• Fish nutrition has advanced dramatically in recent years with development of new, balanced Commercial diets that Promote optimal fish growth and health.

• The development of new species -specific diet formulations supports the aquaculture industry as it expands to satist increasing demand for affordable, Safe, and high quality fish and sea food products.

• Prepare or artificial diets may be either complete or supplemental.

• Complete diets supply all the ingredients (protein, carbohydrates, fats, vitamins and minerals) necessary for the optimal growth and health of the fish

• Most fish farmers use complete diets those Containing all the required protein (18-50%), lipid (10-25%), carbohydrates (15-20%), ash(<8.5), Phosphorus (<1.5), water(<10%), and track amount of vitamis, and minerals.

Protein:

• Because protein is the most expensive Part of fish feed, it is important to accurately determine the Protein requirements for each Species and size of Cultured fish.

• Of these, 10 are essential (indispensable) amino acids that cannot be synthesized by fish. The 10 essential amino acids that must be Supplies by the diet are: "methionine, orginine, threonine, tryptophan, histidine, Isoleucine, lysine, leucine, valine and phenylalanine" Of these, lysine and methionine are often the first limiting amino acids.

• Protein levels in aquaculture feeds generally average 18 -20% marine shrimp, 28 -32 % for cat fish, 32 -38% for Tilapia, 38 -42% for hybrid striped bass.

• Protein requirements usually are lower for herbivorous (plant eating) Omnivorous (plant-animal eaters) that they are for carnivorous (fresh eating) fish, and are higer for fish reared in high density (recirculating aquaculture) than low density (Pond aquaculture) System.

• Protein requirements generally are higer for smaller fish. As fish grow larger, their protein requirements usually decrease.

• Protein requirements also vary with quality as well as the genetic composition and feeding rates of the fish.

• Proteins are composed of Carbon (50%), nitrogen (16%), Oxygen (21.5%) and hydrogen (6.5%). Fish are captain of using a high protein diet, but as much as 65% of the protein may be lost to the environment. Most nitrogen is excreted as ammonia by the gills of fish, and only 10% is lost as Solid wastes.

Lipids (fats) :

• Lipids (fats) are high -energy nutrients that can be utilized to Partially Spare (Substitute for) protein in aquaculture feeds.

• Lipid supply about twict the energy as protein and carbohydrates.

• Lipids typically Comprise about 15% of fish diets, supply essential fatty acids [EFA] and serve as transporters for fatsoulble vitamins.

• Although increasing dietary lipids can help reduce the high costs of diets by Partially sparing

Protein in the feed, problems such as excessive fat deposition in the liver can decrease the health and market quality of fish.

• Simple lipids include fatty acids and Triacylglycerols. Fish typically require fatty acids of the Omega 3 and 6(n-3 and n-6) families. Fatty acids can be: (a) saturated fatty acids (SFA, no double bonds)

(b) Poly unsaturated fatty acids (PUFA > 2 double bonds)

(c) Highly unsaturated fatty acids (HUFA >4 double bonds)

Carbohydrates:

• In carbohydrates (starches and Sugars) are the most economical and inexpensive sources of energy for diets.

• Although not essential, carbohydrates are included in aquaculture diets to reduce feed costs and for their binding activity during feed manufacturing.

• Dietary starches are useful in the extrusion manufacturers of floating feeds cooking starch during extrusion process make it more biologically available to fish.

• Fish can only extract about 1.6 k cal from the same amount of carbohydrate up to about 20% of dietary carbohydrates can be used by the fish.

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.

• The two groups of vitamins are watrt soulble and fat soulble. Water soulble vitamins include. The B vitamins Choline, Inositol, Folic acid, Panthothenic acid, biotin and ascorbic acid

(vitamin C) vitamins of these vitamins C probably is the most important because it is a powerful antioxidant and helps the Immune system in fish.

• The fat soulble vitamins include A vitamin, retinols (responsible for vision). The D vitamins, Cholecalciferols (bone integrity) E vitamins, the Tocopherols (anti oxidants) and K vitamins such as Menadione.

• Deficiency of each vitamins has certain specific symptoms, but reduce growth is the most common symptom of any vitamin deficiency.

Minerals:

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

• They can be divided in to two groups (macro - mineral and micro minerals) based on the quantity required in the diet and the amount present in fish.

• Common macro - minerals are Sodium, Chloride, Potasst and Phosphorus.

• These minerals regulate osmatic balance and aid bone formation and integrity.

• Macro - minerals (trace minerals) are required in small amounts as Components in enzymes and hormone System. Common trace minerals are Copper, Chromium, Iodine, Zinc and selenium.

• Fish can absorb many minerals directly from the water through their gills and skin, allowing them to compensate to some extent for mineral deficiencies in their diet.

NUTRIENT REQUIREMENTS OF PRAWN

The Prawn are capable of digesting a wide range of foods of both plant and animal origin.

- Characterization of the activities of the digestive enzymes in the alimentary tract indicate the presence of enzymes like trypsin, aminopeptidase ,proteases, amylases , chitinase, cellulose, lipases.

Proteins and amino acids:

- Diets with about 35 to 40% protein and grass energy level about 3.2 k.cal/kg diet protein energy ratio of about 125_130 mg protein 1 k.cal are suitable for growth.
- Prawn of m.rosenbergii clear water system the do not have any supply of natural foods.
- Broodstockrare in ponds having natural food(benthic micro and macro fauna require about 30% protein in the diet.
- May commercial feeds for grow out can 10242 32% crude protein ratio of 1:1 is known to be effective for feed efficiency and growth rate.
- The prawn requires the same ten essential amino acids as other crustacean and fish species.

Carbohydrates:

- The comparatively high specific activity of amylase found of m.rosenbergii suppose the fat that the species effeciently utilizes carbohydrates as a source of energy.
- During fasting energy metabolism in the prawn is dominated by carbohydrates, followed by lipids and proteins.
- Complex polysaccharides including starch and dextrin are more effectively utilised than simple sugars.

Lipids and fatty acids:

- The dietary lipids level in prawn diets can be as low as 5% provided the lipid source contains sufficient levels of essential fatty acids.
- There is adietary requirement for highly unsaturated fatty acid(HUFA) although in very small qualities.
- M.rosenbergiiplay kadar crustaceans is unable to synthesise cholesterol. Due to the absence of enzyme 3 e hydroxy 3 methyl gluturgeyco A reductase the dietary requirement for cholesterol is approximately 0.3 to 0.6 % in diet.
- Low level of dietary cholesterol in broodstock diet is known to adversely affect egg quality resulting in inferior quality of seed production.

Vitamins;

- The Prawn requires 60_150mg c/kg diet.levels of 60mg ascorbic acid and 300 mg d_ to cholesterol per kg diet are considered sufficient for proper reproduction and offspring viability in prawn brood stock.
- Fat soluble and water soluble vitamins are required by prawn.
- Diet deficient in ascorbic acid, biotin, folic acid, niacin, thiamine resulted in poor appetite poor FCE.
-

- Lack of specificvitamins can be histopathological changes in shrimp digestive gland cells and poor appetite and poor FCR.
- Vitamin C is important for plant growth and survival.

Minerals:

- General function of minerals include constitutes of the exoskeleton balance ofosmometic pressure, structural constituents of tissues and transmission of nerve impulse and muscle contractions.
- Minerals are two types micro elements and macro elements.
- They are essential components for enzymes vitamins and hormones pigments catalyst and enzymeactivators.
- Prawn can absorb minerals directly from the aquatic environment via gill and body.
- So, dietary requirements of minerals in largely dependent on mineral concentration of aquatic environment.

EFFECT OF RATION ON GROWTH

 Ration size or feeding rate defines the amount of feed given to the organism cultured. An optimum ration is one which gives the best growth and FCR.

 Such a ration if properly dispensed will result in minimum wastage and minimum deterioration of the water quality.

 Over feeding result in wastage and water quality deterioration. Under feeding or a lower ration result in poor growth and production.

 The later may in turn influence growth, however good the feed.

 Ration size is variable. A juvenile requires more energy for metabolism per unit weight and has the potential to grow faster than an adult fish. Therefore, juvenile fish require high ration than adult fish.

 Ration size has to be, modified according the size and age of the cultured organism.

 Water quality and temperature also effect the feeding rate and ration size.

 The ration size is normally calculated as a percentage of the biomass present. This percentage to be fed is not fixed with the percentage decreasing as the organism grows, but the absolute fed increases by virtue of the fact that stock has grown and the total biomass increased.

 Applying a feeding rate accurately depends on the accurate estimation of the biomass in the system (Average weight X Number).

 The average weight can be obtained by regular sampling. Accurate records will not only help the culturist to maintain the correct feeding schedules but will also given an excellent guide to the performance of the system.

 Excess feeding does not result in higher growth. Beyond a certain level excessive feeding has no influence on the growth. However, it would result in the poor FCR.

 There is a feeding level at which an organism grows best and the FCR is minimal. Feeding practices should strive to attain such a level which can be considered as the optimal feeding range.

FACTORS EFFECTING ENERGY PARTITIONING

Energy is defined as the capacity to do work, is required by all organisms to sustain life. Work done in a biological system rives the
chemical reactions required to build new tissues, maintains salt and water balance, moves food through the digestive tract, respires and reproduces.
Animals obtain the energy they require from their food or in the periods when they are deprived of food from body stores.
The partitioning of energy is affected by a variety of environmental and metabolic processes.

A. **Body size** – Small fish produce more heat per unit weight than do large animals. Small fish should be fed a higher percentage of body weight than large fish. Generally oxygen consumption and metabolic rate should increase directly with increasing body size ,but its nit so. The energy demand of a piece of tissue depends on the size of the animal of which it is a part.

B. **Water flow**- energy which is used for physical activity is not available for growth, Fish which are forced to swim against water current are expending energy which would otherwise be used for growth.

C. **Temperature** - Since fishes s are poikilotherms water temperature plays an important role in energy partitioning. Two effects of temperature can be observed in aquatic animals. When an ani al is acclimatised to a certain temperature and then introduced to an environment where the temperature is greater, its metabolic rate will increase. If the animal is soon returned to original temperature its metabolic rate will return to the original rate. If the animal is kept for a higher temperature for lot of time metabolic rate will decrease till it get acclimatised.

D. **Oxygen availability** – Aquatic animals consume oxygen at a rate directly dependent upon ambient oxygen (Conformers) tension or at a rate independent of ambient oxygen tensions (Non-conformers). In case of conformers the metabolic rate is greater at higher oxygen tension and so the energetic cost of maintenance is also greater at higher oxygen tensions.

E. **Stress**- stress results in increased basal metabolic rate and can be induced by a variety of factors, including accumulation of waste products in water, low oxygen, crowding, handling, poor quality feed etc., the energetic cost involved in dealing with these stressors will reduce growth rates.

ESSENTAIL AMINOACIDS AND FATTY ACIDS REQUIRED FOR CULTIVABLE FISH

For cultivating fish, providing a diet that includes all essential amino acids and fatty acids is crucial for optimal growth, health, and reproduction. Here's a detailed overview of the essential amino acids and fatty acids required for cultivable fish:

Essential Amino Acids for Fish

Fish require a similar set of essential amino acids as other animals. These amino acids cannot be synthesized by the fish in sufficient amounts and must be supplied through their diet:

1. **Arginine** - Important for growth and immune function.
2. **Histidine** - Vital for enzyme activity and hemoglobin structure.
3. **Isoleucine** - Plays a role in muscle development and repair.
4. **Leucine** - Essential for protein synthesis and metabolic function.
5. **Lysine** - Critical for protein synthesis and enzyme function.
6. **Methionine** - Important for growth, methylation reactions, and as a precursor for cysteine.
7. **Phenylalanine** - Necessary for protein synthesis and neurotransmitter production.
8. **Threonine** - Involved in protein synthesis, enzyme activity, and maintaining digestive health.
9. **Tryptophan** - Precursor for serotonin and essential for protein synthesis.
10. **Valine** - Important for muscle metabolism and coordination.

Essential Fatty Acids for Fish

Essential fatty acids (EFAs) are crucial for maintaining cell membrane structure, function, and overall health. Fish require two main types of polyunsaturated fatty acids (PUFAs):

1. **Omega-3 Fatty Acids:**
    - **Eicosapentaenoic acid (EPA; 20:5n-3)**
    - **Docosahexaenoic acid (DHA; 22:6n-3)**

    These are critical for neurological development, immune function, and reducing inflammation.

2. **Omega-6 Fatty Acids:**
    - **Linoleic acid (LA; 18:2n-6)**
    - **Arachidonic acid (ARA; 20:4n-6)**

    These are essential for growth, reproduction, and skin health.

Sources of Essential Amino Acids and Fatty Acids in Fish Diets

To meet the nutritional requirements of cultivable fish, their diets should include a variety of ingredients:

- **Fishmeal**: Rich in both essential amino acids and fatty acids.
- **Soybean meal**: A good source of protein and some essential amino acids.
- **Algae**: Rich in DHA and EPA.

- **Plant oils (e.g., flaxseed, canola)**: Contain alpha-linolenic acid (ALA), which can be converted to EPA and DHA in some fish species.
- **Animal fats**: Provide a good source of arachidonic acid (ARA).

Formulated Fish Feeds

Commercial fish feeds are often formulated to ensure they provide all essential nutrients. These feeds are typically designed to match the specific requirements of different fish species and their life stages. For instance:

- **Starter feeds** for larval and juvenile fish are high in protein and essential fatty acids.
- **Grower feeds** are balanced to promote rapid growth.
- **Broodstock feeds** are formulated to enhance reproductive performance and egg quality.

In summary, ensuring that fish receive a balanced diet rich in essential amino acids and fatty acids is crucial for their health and optimal growth. Utilizing a combination of high-quality ingredients and commercial feeds can help meet these nutritional requirements effectively.

DIETARY SOURCES OF ENERGY REQUIRED BY FISH

Fish growth involves the laying down of muscle, fat, epithelial and connective tissue. The proportion of protein or fat laid down in these tissues depend upon the diet taken, in order to protein synthesis to occur correct number of essential amino acids must be provided. Essential amino acids are those that the animal cannot produce and has to be supplemented through the diet. The requirement of amino acids for
aquatic animal varies from species to species.

Protein as energy source

The composition of protein provides a balanced mix of the essential amino acids. Growth of fish and prawn is primarily determined by level of protein and its constituent amino acids. Protein is major as well as most expensive component in fish feed. The diversity in fish feeding habits exhibited in nature reflect in the variation in their protein and essential aminoacids. requiremnts. Protein is the most important component of the diet of fish because protein intake generally determines growth, has a high cost per unit and high levels are required per unit of feed.
Fish meal is a rich protein source but this is expensive, this can be replaced by soyabean meal, cotton seed meal. It is generally been found that most alternative protein sources are able to replace fish meal to some extent.
Since, dietary protein is relatively expensive, to nutritionist aim to formulate

diet in such manner that the energy required by the animal is provided by non-protein sources.protein energy ratio of the diet are correlated with the body composition of the product. Body composition is the amount of moisture ,protein, carbohydrate and fat contained in a fish carcass. Optimising body composition to yield the maximal dressing percentage and sensory quality is important for an aquaculturist as this is directly related to profitability.

Carbohydrate as energy source

Carbohydrates are the cheapest and most abundant source of energy for animals. Most of the plant material are carbohydrates. Carbohydrates in feeding material range from easily digested sugars to most complex cellulose molecules which cannot be digested easily by animals. It is only through their symbiotic relationship with bacteria that ruminant animals can large amount of cellulose. Carbohydrate has limited use as an agent providing energy and so for sparing

protein in the diet of finfish. In the point of fishes carbohydrates are cheap source of dietary energy ,the digestable carbohydrates can be well utilized as an energy source if it is kept in proper balance with other nutrients. The value of carbohydrate in the fish diet depends on the source and type of carbohydrate and the processing to which it has been subjected.

Lipids as energy source

Lipids whether plant or animal origin ,consists of esters between one molecule of glycerol and three molecules of long chain fatty acids. They are highly insoluble in water and as a result are not easily hydrolysed. Lipids contain more energy per unit weight than any other biological product. The inclusion of lipids usually increases palatability. Generally lipids are well digested and utilised by fishes. The protein sparing effect of lipid varies between species but appear to be optimal at about 15-18 % of the diet. The effect is more clearly observed when the amount of dietary protein consumed is low, or the content of protein is less in the diet.

FEED RATION

- Fishes feed intake and metabolism change with fish age& size, temperature in water, pHvalue,etc.
- In order to avoid over or under feeding the fish, By amount of feed must be given each time.
- The amount of feed to be provided to the fish per day, the feeding rate depends on the fishes bodyweight.
- Fish adjust their food consumption rates to meet their metabolic energy requirements.
- Therefore the feed required ration varies with time during the production cycle depending onA)fish sizeB) water quality in pond
- The amount of average fish
  Feed required for ration=size(weight)×feed rate×Total no of fish in pond
- Here food rate is the feeding amount as a percentage of the fish average weight.
- When water temperature is 15% the feed ration is 1%of total fish weight at 20°c daily ration isabout 2% of total fish weight 30°C 4_5%, because fish have a great applite at this time for fastgrowing but over feeding is not allowed,and water quality should be maintained.
- Water temperature in winter has a sharp decline daily ration should be 1_2% of fishes totalweight to keep their fatness.
- An optimum ration is one which gives best growth and FCR such a ration if properly dispensedwill result in minimum wastage and minimal deterioxation of water quality.
- Under feeding or a lower ration results in poor growth and production.
- Over feeding results in wastage and water quality deterioxation.
- Ration size is variable ajuvenile fish requires more energy for metabolism per unit weight and haspotential to grow faster than adult fish.so juvenile fish need a higher ration.

PROTEIN SPARING EFFECT

Protein sparing is the process by which the body derives energy from sources other than protein. Such sources include fatty acids, dietary fats, and carbohydrates.protein sparing conserves muscle tiseue. The balance between DP Digestible protein and DE

Digestable Energy in the diet is a key factor. The amount of protein to be included in fish diet is influenced by protein to energy ratio protein digestibiltity and amount of non - protein energy in the diet. When insufficient non-protein energy is available in the feed dietary protein is deaminated in the body to supply energy rather than being used for tissue growth and proteinsynthesis.

Excess protein results in high levels of ammonia production, which effects voluntary feed intake and growth of fish. Adequate levels
of non-protein energy sources like lipid and carbohydrate in the diet could minimise the use of protein as a source of energy of which carbohydrate is most economic. knowledge of optimal level of proyein and the protein sparing effect of carbohydrates may be useful to reduce fish feed cost.

UNIT-II

ARTIFICIAL FEED

The prepared feed is called artificial feed or supplementary feed.They are also called ascompound feed or complete feed.

- Feeding fishes artificially with prepared feed is called artificial feeding or supplementary feeding.
- When fishes or prawns are reared in intensive culture natural food is not sufficient artificial feedis a must.
- Based upon feed ingredients used artificial feed is a must.
- Based upon feed ingredients used artificial feed is 2 types.
  A) Simple feed **B)** compound feed

A) Simple feed:

Simple feed are made up of single feed ingredient.They do not supply all the essential nutrients required by fishes.They are unbranched feed.They are unbranched feed.They include rice bran, groundnut oil cake,silk worm pupae etc.

B) Compound feed;

Compound feeds are made up of more than four feed ingredients They will supply all the essential nutrients required by fishes.They are also called balanced feed/complete feed.

Based upon nutrient level and size the artificial feed is grouped into *starter feed *Grower feed*Finisherfeed*Brood stock feed

- Based upon physical condition of feed they are of two types.
  *Dry feed*Non dry feed
  A.Dry feed:
  Dry feed will have moisture content of 8-12%.They are grouped into A)Mash or meat B) Pellet feed
- The dry and powdered form is called mash or meat.It is mostly used in hatchery and nurseryponds.
- In pellet feeds the formulated feed ingredients are mixed.cooked and Hy in the form of noodi.
- Pellet feed is two types:
- 1. Floating feed 2.Non floating feed.
- Floating feed will float on surface of water.This feed will be consumed by surface feeding fishes.
- Non floating feed will sink to the bottom of the pond.This feed will be consumed by bottomfeeding fisher.

Non dry feed:
This feed has high content of moisture.It is classified into wet feed moist feed.1.wet feed will have moisture 18_45%
2.Moist feed will have moisture 45_70%
3.Non extruded feeds include balls,cakes and pastes .4.Extruded feed include pellets and flakes.

FEEDING METHODS EMPLOYED IN CULTURE PONDS.

The fish are fed with artificial feed by any one of the following methods

1.manual feeding 2.demand feeding

2. Autometic feeding 4. Computer feeding

1. Manual feeding:

Manual feeding is the hand feeding.The feed are collected from the store room and placed in thefeeding sites manually.

2. Automatic feedings
In autometic feeding the required amount of feed drop into the water automatically at the requiredintervals.It is operated by electric and electronic timing devices.

3. Demand feeding

In demand feeding the fish gets the feed when it operates a device connected to the feeder

The feed is stored in the feeder suspended above the water.An rod or plate hangs from thefeeder into the water when the moving fish touches the rod a small amount of feed is released.

4. Computer feeding

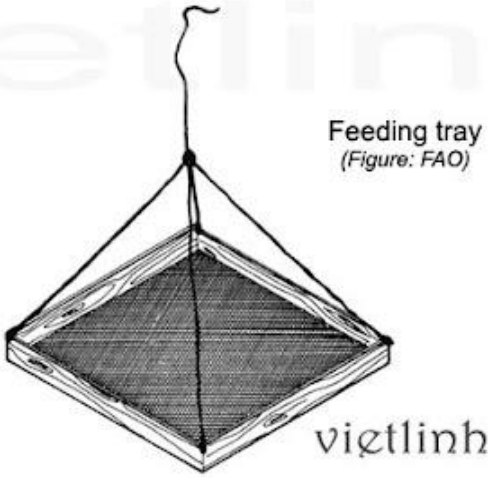
Feeding the fish with the aid of computer programming is called computer feeding.The amount of feed and the time interval are automatically programmed by the computer based on the density offish growth rate age of the fish temperature etc.

- There are mainly two'feeding methods1.Try feeding. 2. Demand feeding
  Try feeding:
  To assess the feeding and save feeding from wastage and further deterioxation andto increase profitability in culture feed trays are kept along the periphery of the ponds.
- Feed trays are generally 2×2 feet nets with frame with a float for identification location.
- A pond of 1 hec size would need 4_6 feeding trays about 1_4% daily ration is kept

in these feeding trays/ check trays.

- Every day after each feeding the feed in the feeding tray is checked to know whether feed is fully consumed.
- Depending on the quantity consumed the adjustment of feed is made
- Since, shrimps are under water and always in dynamic movement it is very difficult to assess the exact number of shrimps available in the pond during stock assessment. Hence survival can be checked based on the actual quantity of feed consumed per day.
- Survival rate= Actual feed consumed/ calculated feed requirement
- Feed requirement is estimated based on the calculated survival rate.
- If pond is well prepared without any predators the calculated quantity of feed should be consumed.
- If calculated feed is not consumed due to decrease or reduction in survival rate feeding ration should be adjusted.
- Average amount of unconsumed feeding remaining in trays adjustment to feeding rate.

- Under certain conditions shrimps found to congregate near the trays and consume feed rapidly This is most likely due to poor bottom condition.
- Under such conditions the following precautions is taken.
- To increase quantity of feed in trays.
- To check the trays faster the compare result with other ponds
- To elevant the tray from the bottom.
- To increase number of trays in ponds and feed only on trays.



Feeding tray
(Figure: FAO)

Demand feeding:

- Demand feeders are widely used in fresh water aquaculture practices.
- Feed is placed in the feeders which has a cone shaped opening at the bottom.
- A rod extends into the water and along the rod inside the cone is a plastic disc slightlysmaller in diameter than the tapered cone
- The disc acts as a plug to prevent feed from falling out the bottom of the feeder
- When fish move around in the water th rod moves shifting the position of the disc.
- Allowing a small quantity of feed to fall into the water.
- The amount of feed delivered with each movement of the rod is adjusted by moving the disc up or down the rod , resulting in a larger or smaller clearance between the edges of the disc and the walls of the cone.
- The use of the demand feeders,offers several benefits.
- First fish feed themselves resulting in low labour costs and Little wasted feed assuming thedevice is adjusted properly.
- When fish want to eat they eat if for some reason they are not hungry they do not feed.
- Second since fish feed all day water quality remains high because there are no low oxygenperiods after feeding.
- Third fish take turns feeding so aggressive fish feed first then move away allowing lessaggressive fish to have access to feed.
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SIGNIFICANCE OF PELLET FEED

charecteristics of pellet feed:

Convenient feeding management and the aquatic feed can be suspended in the water surface for a longtime.It is not required to set up the feeding table when feed fish but a fixed point is necessary.fishes need to float on the surface when they are eating which can directly observe their situation timely adjust of the feeding amount and know the fish growth and health.

Therefore the expansion of aquatic feed is helpful to scientific feeding and management not onlysaves a lot of time,but also can improve the labour productivity.

Farmers can calculate feeding feeding amount according to fish varieties specifications, quality, watertemperature and feeding rate then feed quickly which can both save a lot of time and improve labour productivity.

There are many anti nutrition factors in feed materials,such as gossypol, saponin, trypsin inhibitor, which exist in oilseeds soyabean meal and cotton seed meal.At a certain moisture and temperature,

these anti nutritional factors gradually lose some of the activity in the process of expanding thus decrease the damage to digestive enzymes improve the digestion and absorption rate of feed reduceexcretion.

Through the expansion of equipment, material expand instantaneously at high temperature and pressure to meet the requirement of floating.The high temperature high humidity and high pressure canKil most of the harmful microorganisms.

Effect of pellet feed on water quality:

Pellet feed has a good stability in the water not dissolved within two hours and floating time of highquality floating fish feed can be as long as 12 hours which can avoid the nutritional ingredients loss in water or sink into the mud and waste.The pellet feed will save 10_20% material than sinking fish feed even if some of the feed left can be picked up to dry , which can highly limit to control feed waste.pellet feed is easy to observe and control this can reduce or avoid power material residual Bait o pollute water which are very favorable protection and the growth of fish.

Due to high temperature high pressure expansion and drying treatment, water content is relatively low(usually around 9%) the particles are hard with high stability.Therefore , pellet feed can be stored for a long time and is not stored for a long time and is not easily to damp,not prone to mildew, which can avoid loss of nutrients.

TYPES OF FEED

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DRY FEED

• Dry feeds- Dry feeds are generally made up of dry ingredients or from mixtures of dry andmoist ingredients.
• dry feeds are not completely free from moisture
• moisture content usually about 7-13% depending on the environment
• Dry feed are compacted into a definite shape generally by mechanical means calledpellets
• Depending on the formulation and compacting technique these diets are floating and non-floating or sinking in water

• Dry feeds may be simple mixtures of dry ingredients, in which case they are called 'mashes' ormeals'
. • Pellets can be made in a range of sizes Depending on the processing technique used, pelletsmay float or sink when placed in water.
• The non-floating type are often broken up and then sieved into a range of smaller sizes, calledcrumbles or granules, for small fish or shrimp.

Types of Dry feed:-

• Pellet feed • Flake Feed

• Powdered Feed

• Micro – Encapsulated Feed

• Micro – bound diet

• Micro – Coated diet

(b) Wet feed

Non-dry feeds- are divided into two major categories - Wet and moist.

• Wet feeds- as those which are made entirely or almost entirely from high moisture ingredients, suchas 'trash' fish, waste slaughterhouse products, undried forage, etc.

• Moisture contents of about 45-70% Moist feeds- are made from mixtures of Wet, or moist and dryraw materials, or from dry ingredients to which moisture has been added

• Usually moist feeds range from 18-45% moisture.

• There is no really clear division between 'moist' and 'wet' feeds.

• A third class of products - flaked feed - is designed for aquarium fish, fish fry and early post-larvalshrimp

• Non-dry feeds- 'moist' or 'wet' are either extruded or non-extruded.

• An extruded feed is one which is made into a product like noodles by forcing it through narrow holesin a special piece of equipment.

• Non-extruded moist or wet feeds may simply be non-formed single ingredients (such as 'trash' fish) ormixtures of them, or they may be formed by machinery (but usually by hand) into cakes, balls and pastes.

• Natural binding materials in the feed, or added binders

• Extruded moist pellets can be dried, by machinery or by sun-drying, into dry sinking pellets - thus thelink between the two products.

• During the production of either dry or non-dry feeds heat may or may not be used.

• Non-extruded moist feeds may be cooked or steamed during manufacture to increase their waterstability.

• Dry pellets may be made by a 'cold' process or steam may be used in their manufacture.
• All pelleting generates some heat mechanically.

• All floating pellets receive a considerable amount of heat during processing.

FEED CONVERSATION RATIO:

FCR is the amount of feed required to produce a unit of fish.In more simple words.FCR is theamount (kg) of feed needed to produce 1 kg of fish FCR is a prime indicator of

- Performance of the feed used
- Performance of worker feeding the fish
- Performance of fisher health
- Cost effectiveness of using an existing feed
- FCR=Total amount of feed fed during culture/Total weight gained by fish
- For example if 5000 kg or MT feed fed during culture period and if 3700kg or3.7 Mt fishesobtained from pond .Then the FCR is 1.35.
- First feeds are fed by fishes and after digestion assimilation all these feeds are convertedinto energy and building flesh or muscle of fish body which increases finally fish weight.
- FCR indicates which feed is good which is bad.A good conversion rate can bring

a betterprofit from fish culture

- FCR should not exceed 2 and if it is below 1.2 ,1.1,1 or even 0.9 or 0.8 farmer should thinkwhat type of feed he has used.
- One easy formula is that
  Propet management+ better FCR=Good profit.
  FCR which is used as a description of growth as a function of feed intake, depends mainly onthe feeding rate but also on temperature.
- FCR is a valuable and powerful tool for the fish farmer.It allows for an estimate of the feedthat Wii be required in growing cycle.
- FCR gets smaller as amount of proteins in diet increases.This means that it will takes lessfeed to produce a kilogram of fish
- Feed with higher levels of protein might be more expensive per kg, because it is possible touse less feed,it may actually be the cheapest way to feed fish.
- IT is possible to get FCR of less than one if there is a lot of natural food in the pond
- The fish will eat both supplementary and natural food and grow better than when they eatsupplementary feed.
- Very good feed that have low FCR allow for more fish to grow in pond because waste polluting the water is less with better water b quality the carrying capacity of the pond isincreased.

FEED STRATEGIES:

There are four feeding strategies for grow out.

- No fertilization
- Fertilization
- Supplementary feed and
- Complete diet feeding

No fertilization or feed input:

- Fish are totally dependent for their food on the live food organisms and plants present inthe water.
- Growth of these organisms is in turn dependent on the natural fertility of the water and soil.
- This feeding strategy is practised in extensive culture system with low stocking density.
- **Fertilization:**

Chemical and organic fertilizers are applied to increase production of live foodorganisms and plants.

- Fertilizer use is typical of extensive and semi intensive farming systems.

Supplementary feeding:

- This is added when natural productivity of the water resulting from fertilization cannotadequately maintain maximum growth of the cultured fish at high stocking density.
- Dietary requirements of the fish is supplied by a combination of natural live foodorganisms and supplemental diets.
- Higher stocking density and production are attained with this practice which is typical ofa semi intensive farming system.

Complete diet feeding:

- This involves the external provision of a nutritionally complete,high quality diet.
- Complete diets may consists of a single food item of high nutrient value.(E.g.trash fish)artemia nauplii or a combition if different feed ingredients.
- Dietary requirement of cultured fish is totally supplied by the diet , typical of anintensive culture system.

Pond fertilization:

- The natural productivity of a body of water can be increased by chemical and organicfertilization.

Chemical fertilization:

- Chemical fertilizers directlystimulate phytoplanktonproduction**.**

They also indirectly increase the production of grazing zooplankton and benthic organisms since theseorganisms can ingest primary producers.

UNIT-III

SELECTION OF INGREDIENTS AND THEIR NUTRIENT COMPOSITION FOR PREPARATION OF ARTIFICIAL FEED.

Arttificial feed:

These are otherwise called as non& viable and compound feeds.This type of feed is produced by man made using available raw material and medicine.These feed are produced based on the feed forindividual fish species.

Artificial feeds(non viable feeds)are again classified as practical diets and purified or semi purifieddiets.

Purified or semi purified feeds are mainly used at laboratory level for qualification of nutrient requirement for many cultivable fishes.The ingredients used are purified and refined one .The commonprotein source used in semi purified diet is gelatin casein (90%), carbohydrate source is corn, starch, lipid source is corn oil and binder source is carboxyl methyl cellulose.

Practical diets are mainly used at farming level and the ingredients used are not purified and refined one.practical diets are further classified based on a)stages of the life cycle,b) based on forms or moisturecontent ic) based on their uses in farming practice.

Based on their stage of the life cycle:

- Starter feed , crumble feed or larval feeds . fry feeds(minced diets,micro feeds-MED,MBD&MCD,egg custard,live feeds.
- Fingerlings feeds(Grower)
- Grow out feeds(finisher)
- Brood stock feeds
- Product quality feeds (specific purpose food) pigmented& medicated
- Usually, the fish might change their stage so,feed must provide the nutrition, according to theirlife stage.
- Hence,they are classified as their life stage larval feed Grower(fingerling stage) . some special types of feed called micro feed are also used .these feed supplies the equal dietary compound as micro particulate, microencapsulated , micro bounded and micro coated.

Based on their moisture content or forms:

- According to the percentage of water content,they are differentiated into dry feed and non dryfeed.Both the dry feed and non dry feed has got its own merits and demetrits.Dry feed is used more than wet feed.
- A dry feed (7_13% moisture) has 2 types namely floating and sinking feeds.Floating feed is used for surface and column feeder fish (catla, silver carp,sea bass,grouper,trout, tilapia, ornamental fishes.

- Non dry feeds has 3 types namely,semi moist feeds(15_25% moisture) moist feeds (26_45%moisture) and wet feed (46_70% moisture) based on their uses in farming practice.
- **Artificial feed : advantages:**
- More fish production
- Supply all essential energy requirement to fish.
- Supply gross major nutrient requirements
- Supply minor nutrients(micro)

  Disadvantages:
- Chance for aesthetic appearance since it contains muddy odour,pigments, hormones etc.
- Water quality to be maintained through out culture period with utmost case
- Deputation must be done.

Dry feed	**Non dry feed**
Advantages Moisture (7_13%) • Easy to transport manufacture and storeproduced to suit specific needs • Punit production of specificilalized feedssuch as medicated pigmented feeds. **Disadvantages:** • Less palatable becauseof hard consistency.	**Advantages:** • Semi moist feeds (15_25%). • Moist feed(26_45%) • Wet feed (46_70%) More palatable becoz of softconsistency. **Disadvantages:** • Transportation & storage under refrigeration poseprblm. • Irregular availability ofraw fish in adequate quantities. • Change for pathogen introduction if not cooked properly • Unconsumed feeds mayaffect water quality.

PREPARATION OF PELLET FEED:

The objective of feeding fish is to provide the nutritional requirement for good health, optimum growth, optimum yield and minimum waste within reasonable cost so as to optimise profits .Every farmers should be particular about the quality of feed fed to the fish use it is the feed that determines.

- Nutrient londing and ultimately carrying capacity in the pond, hence water quality withinthe culture system.
- Fish growth rate
- Economic viability of the enterprise 60_70% of variable production costs in a normalproduction cycle is due to feed.
- Health status of the fish.

  Raw material for fish feed pellets:
- Raw material include formed products such as soyabean,rape seed,and wheat, rice by products,husk rice ,Oran rice and brown rice from evergreen mills,the grain the cereal ,orother materials raw material need gried into 60_80% mesh with moisture content (13_18%).

  Processing of pelletizing fish feed:

1. Equipment needed:

- Raw materials harmer mill (to reduce practice size of ingredients to 0.4_0.6mm) Rawmaterial mixer.
- Fish feeder extruder (dry type for floating fish feed wet type for both floating and sinkingfish feed.)
- Extrusion means to cook the mix of ingredients under temperature, moisture& pressure inextruder.
- Fish feed drying system.
- Fish feed packaging machine.

  2. pelleting process:

  Grinding: Variety of raw ingredients requires size reduction particlesize is critical tomechanical and chemical activity.
- In the crushing process, particle size is determined by a combination of screen size,rotor speed,the size & number of hammer blades, hammer blows, collision with the Walls of the grinding chamber and the impact among particles.The major factor that affect particle size is screen which accounts for 70% of what determines the finished particle size and the rotorspeed is also an important factor.Any material that enters the grinding chamber must be reduced to a size below the diameter of the screen holes the pass through the screen that .the mills discharge opening.A main factor in determining finished particle size is the speed of the hammer mill.conversely, hammer at slow rotor speed ,it is hard to grind the material into particles.

  Mixing:

  The process is as important as grinding.If. You grind ingredients but then you should mix then homogeneously powdery feed materials are mixed thoroughly in the mixer to ensure ahigh quality of nutritional feed.

  Every formulation has its mixing time.If you get over the mixing time ingredients start to bedecomposed.

Extruding:

The production process includes an extrusion process creating pellets with sizes ranging from less than a millimetre to several centimetres suitable for different size andspecies of fish.

- This process is followed by the addition of fatty acids such as fish ,oil pellets are fold baggedor in bulk to fish farmers around the world.
- Characteristics of feed are produced by extruder can produce floating sinking slow sinking feeds because the density can be controlled using different sizes,shapes and colours.Theseare commercially produced extruded

Drying: The moist pellets should be dried to a moisture content of 10% or less.Ideally thisshould be at low temperature and with good air flow to dry the pellets as quickly as possible to ensure that heat sensitive micronutrients such as vitamins are not destroyed.

- It is most important when drying pellets to prevent fungal contamination nutrients.Funguscan be toxic to fish and to the humans who handle the feed.

Packing:. When pellets are dry and cool they should be stored in bags or containers that can be sealed against insects,rats or other pets and to keep out moisture avoid using plasticbags because feeds can sweat and this encourages growth of mould.

- Quality nutritional features denaturing of proteins,gelatinization of starch, reduction ofantinutrients, flavour enhancement, balanced protein/lipid complexes, increased digestibility.
- Attractive texturing and shaping, controlled expansion and density,hygenic salmanella freepellets.
- Ingredients flexibility to process a large range of raw material continuous processing,fastchance over time.

Storage:

- During transportation and handling,protect the feed from moisture,heat and direct sunlightheat and sunlight directly destroy feed nutrients like vitamins.
- Store the feed in a cool,shaded,dry and we'll ventilated room .white , wooden buildingswith reflective metal roofs are excellent for storing feed warm moist and stagnant air enhances mould growth and attracts insects.
- Do not stack bags on field directly against on a wall or on a concrete floor stack them on top of pellets off the walls of the building to prevent moisture coming in contact with thebags.
- Protect the feed from rodents bats, chickens and other animals. The feed can be stored incages made of coffee wire mesh to keep off such animals.
- Do not use pesticides or other toxic material near the feeds.

MICROENCAPSULATED AND MICRO BOUND FEEDS

- There are several types of compounds larval diets. They range include from simple eggcustard to complex microparticulate feed.
- Per early weaning, young larvae required feed of smaller size and must be prepared asmicro bound, micro coated are in microencapsulated form.

Micro encapsulated feeds:

- Micro encapsulation is a process in which liquids and partparticulate dietary componentsare enclosed within a carefully engineered wall.
- Capsule consist of a wall under internal nutrients are released at the active sites within thetarget biological systems of fishes shrimp larvae.
- The wall or shell dissolution can be accomplished by rupture, enjumative action pH changeor bacterial action in fish or shrimp larval body system.
- The the wall could be biodegradable polymer I.e, modified gelatin where in the nutrientswithin the capsule could be released by the the enzymative process of the animal or by microbes flora present in gut.
- One major advantage of microencapsulated diet is that specific nutritional requirement canbet met with a higher degree of precision since there will be minimal nutrient loss through water teaching encapsulated food could be thoroughly quality controlled have good shelf life be consistent in nutrient composition and may be developed completely. Free of contaminants.

Micro bound feed:

In microbound feeds, the finely powdered ingredients or bound within the water stablematrix of hydrocolloid binders.

The the binders used may be of starches (insulin, chitin, ketocin ,pectin, gumarabic,agar,carragement) or protein (zein, casein or gelatin)

- The micro boundparticle lack distinct coat , with ingredients haphazardly distributedthroughout matrix.
- This type of binder effects particle characteristics such as water stability palatability anddigestibility.
- The main advantage of micro bond particle feed is quick sinking which makes it unavailableto Larvae and the resulting nutrient leaching.
- This can be overcome by liquid coating

C)Micro coated feeds:

- Micro coated feeds are nothing but microencapsulated feed with an extra coating of anycapsulated like alginic acid gelatin, lipids etc. Is given to enhance its stability bi a simple process by soaking or spraying.
- Even a coating of cholesterol lecthin are modified corn gluten for zein makes them microcoated feeds.
- Unlike microencapsulated particles jise do not causes entire coat.

NUTRIENT COMPOSITION AND NUTRIENT AVILABILITY OF FEED INGREDIENTS

Fish feed formulation is a critical aspect of aquaculture that ensures optimal growth, health, and productivity of fish. The composition and availability of nutrients in feed ingredients play a pivotal role in the effectiveness of the feed. Here's a comprehensive overview:

1. Key Nutrients in Fish Feed

Fish require a balanced diet comprising proteins, lipids, carbohydrates, vitamins, and minerals. Each of these nutrients has specific functions:

- **Proteins**: Essential for growth, tissue repair, and enzyme production. High-quality protein sources include fish meal, soybean meal, and other plant and animal-derived ingredients.
- **Lipids**: Provide energy and essential fatty acids necessary for various physiological functions. Common lipid sources include fish oil, soybean oil, and other vegetable oils.
- **Carbohydrates**: Serve as an energy source, though fish have a limited ability to digest complex carbohydrates. Grains like corn and wheat are typical carbohydrate sources.
- **Vitamins and Minerals**: Crucial for metabolic functions, immune response, and overall health. Vitamin and mineral premixes are often added to ensure the diet meets all nutritional requirements.

2. Common Feed Ingredients

- **Fish Meal**: High in protein and amino acids but can be expensive. It has excellent palatability and digestibility.
- **Soybean Meal**: A plant-based protein source that is more cost-effective than fish meal but may require processing to reduce anti-nutritional factors.
- **Corn Gluten Meal**: Rich in protein and carotenoids, useful for pigmentation.
- **Wheat**: Provides carbohydrates and acts as a binding agent in pelleted feeds.
- **Fish Oil**: Source of omega-3 fatty acids, essential for growth and health.
- **Other Ingredients**: Can include animal by-products, insect meal, algae, and various plant proteins.

3. Nutrient Availability (Bioavailability)

Bioavailability refers to the proportion of nutrients that are digested, absorbed, and utilized by the fish. Factors affecting bioavailability include:

- **Digestibility**: The degree to which feed ingredients can be broken down and absorbed. Digestibility is influenced by the fish species and the feed's physical and chemical properties.
- **Anti-nutritional Factors**: Substances like phytates, tannins, and protease inhibitors in plant ingredients can reduce nutrient availability. Processing methods such as heating and fermentation can mitigate these effects.
- **Processing Methods**: Extrusion, pelleting, and other processing techniques can enhance nutrient availability by improving digestibility and reducing anti-nutritional factors.

4. Assessing Nutrient Composition and Availability

- **Proximate Analysis**: Determines the basic nutritional components such as moisture, crude protein, crude fat, crude fiber, ash, and nitrogen-free extract.

- **Amino Acid Analysis**: Provides detailed information on the profile of essential and non-essential amino acids.
- **Energy Evaluation**: Gross energy (GE), digestible energy (DE), and metabolizable energy (ME) are assessed to ensure the feed meets the energy requirements of the fish.
- **Mineral Analysis**: Determines the levels of essential minerals such as calcium, phosphorus, magnesium, and trace minerals.

5. Improving Nutrient Composition and Availability

- **Ingredient Selection**: Choosing high-quality, highly digestible ingredients.
- **Processing Techniques**: Using methods like extrusion, fermentation, and enzymatic treatment to enhance digestibility and reduce anti-nutritional factors.
- **Formulation Strategies**: Balancing ingredients to meet the nutritional requirements of the specific fish species while considering cost-effectiveness and sustainability.

Conclusion

The nutrient composition and availability of feed ingredients are fundamental to the success of fish feed formulations. By understanding and optimizing these aspects, aquaculture operations can improve fish growth, health, and overall productivity, leading to more sustainable and profitable practices.

PHYSICAL PROPERTIES OF FEED:

Aside from the statement of the major nutrients present in a feed stuff or feed information is also required on the physical characteristics of the product including colour, texture, order particle sizepelletability,bulk density, Water stability and attractability.

Water stability:

One physical property that is necessary in a feed it . it'swaterstability.A water stable diet provides maximum available food to the fish and minimum leaching out of vitaminsand. Othernutrients.poor water stability can also impair water quality crustaceans such as shrimps lobsters and crabs grasp their food with them chelae carry into the mouth and fear it into smaller fragments before swallowing.

They need relatively more stable pellets than do the fin fish.Thus binders andprocessing techniques like and extrusion are done to ensure water stability.

Water stability tests are usually done on pellets intended for slow feeders.
One gross way of determining the stability of the Pellet in the water is bycrumbling it or by just feeding the rough edge of the Pellet.

Particle size:

Pellets with ingredients that are not finely or uniform ground tend to be lessstable than pellets with uniformly ground ingredients.
Hence ingredients should be finely ground and sieved to uniform particle sizeand before in corporation in the diet.
The size and shape of feeds should be designed to accommodate and confirmto the anatomical organs of the crop animal for seizing engulfing or ingesting food, food particle size in the feeding of cultured species whose mouth parts vary greatly.

Texture:

Also an important aspect of diet is texture hard soft , moist,dry,rough orsmooth.
Some species appear to avoid hard pellets.Thosethat tear their food may have to be provided with feed of a texture different form that given to those speciesthat swallow or nibbe off small pieces of the food.

colour:

Various species of aquatic animals are able to see colurs.
Colour contract between the feed and the culture tank may provide greater easy for the fish to capture their food.

Density:

As ground feed ingredients are received in the feed bulk density measurement can be done to check on the amount of adultants present.
Bulk density of the ingredient simple should be determined and compared with the bulk density of pure feedstuffs.
If contaminants or adult Texants present bulk density will change.
It is a good practice to go back to sample for closer look by paying particular attention to adulterants.

In general adulterants are ground extra fine to escape detection.

Pelletability:

Depending on their nature feed ingredients may be of low medium or high pelletability.

Usually the finer the particle size the higher is the pelletability of the ingredient.

REASONS BEHIND SPOILAGE HALF FEED WHEN STORE.

INTRODUCTION:

- Prepared feeds for fish and shrimp perishable products they are also more or less fragile,depending on the type of feed.
- Feed processors attempt to formulate and manufacture aquaculture feeds to extend theirshelf life and improve durability.
- However the degree to which aquaculturists can reduce wasted feed and realized its full purchase value is ultimately dependent on how well the basic principles off feed storageand handling are understood and applied.

Storage:

- For reasons of cost and convenience, dry dates are presently the most widely used feeds inaquaculture, these include extruded feeds, hard pellets, crumbles .
- The general rule for preservation of these feeds is to store them in a dry, well ventilatedarea that affords some protection from rapid changes in temperature.
- A good storage facility should also provide adequate containment for control of pests. **Vitamin potency:**The potential of most vitamins contained in formulated feeds declines during storage. This is because many of these organic compounds highly reactive and unstable under certain conditions they can be easily denatured by heat oxygen, moistureand even ultraviolet light.
- The rate of vitamin activity loss in a given feed formulation is dependent on the particularvitamin its source on the conditions under which feed is stored.
- Typical changes in vitamin activity losses in this feeds revealed that after doubling the recommended storage time only vitamin C activity declined below minimum acceptablelevels.
- Vitamin requirements are actually a function of feed consumption and desired biologicalresponse of the fish other than a specific concentration in the field.

Mold Growth:

All too often feed store in fish hatcheries and forms is destroyed by common molds. The potential for this to occur is always present because of the fact that mold producing fungi and other microorganisms exist naturally throughout the environment.

- They are present in grains after harvest and in animal and earcasses prior to rendering.
- Food processing operations involved in stabilizing these feed stuffs and in manufacturing feeds typically use heat and dehydration steps that are sufficiently destructive to eliminatethe original contaminating microflora. However some fungus Spores can survive Harsh processing conditions.
- Contaminating fungi growth best when the moisture of the feed is 14.5 to 20% and inequilibrium with a relative humidity of 70 to 90%.
- Extruded and pelleted feeds are manufactured at considerably lower moisture levelsallowing a safety margin for variability among individual field particles.
- The most effective mold prevention strategy therefore is to maintain moisture levels instored feed below requirements for fungal growth.

Lipid Rancidity/Chemical spoilage:

Lipids used in aquaculture feeds are usually that type that contain significant levels ofunsaturated fatty acid which are required for good health and growth of most species of fish and shrimp.

- The high degree of unsaturation of these fatty acids causes them to be particularly prone tooxidation rancidity.
- Feed manufacturers attempt to prevent oxidation in lipids sources such as fish oil bystabilizing them with antioxidant.
- However the commonly used antioxidant such as ethoxyguin, mutilated hydroxyanisole andmutilated hydroxytoluene are sacrificial in the way that they protect the oil.
- Once they are used up free radicals that are already present in the oil begin to react withunsaturated fatty acid components and the process of oxidation begins.
- It is often thought that freezing is the best method of long term preservation.
- Rotating the feed inventory as quickly as possible is the only effective strategy to avoidhaving feed go rancid before it is used.

Pest Infection:

The presence of insects and rodents in feed storage areas can often be an overlooked outserious problems in aquaculture.

- This pets not only consume failed but also cause additional and sometimes greater feed losses through packaging damage and the creation of environmental storage conditions that promote mould growth.
- They also have the potential to serve as vectors for transmission of diseases to humans.

Insects:

- Insect infestation can be a very serious problem in Feeds stored over a prolonged period oftime.
- An actively reproducing population of insects can quickly consume significant amounts offood and deteriorate the physical quality of remaining feed.
- Most of these insects thrive on food containing 12 to 14% moisture they are capable of completely developing from an egg to areproductively active adult within 30 days then temperature are between 20 and 30°c.
- However regular inspection of feed and early detection of birds along with good sanitationin storage areas for proactive practices that can greatly reduce the incidence of food contamination with bugs.
-

- Insecticides can be used to eliminated a persistent infestation.
  Rodents: populations of rats and mice that become established in storage areas obviouslyconsume some amount of feed.
- The basis for your rodent control program should always be good housekeeping both insidethe warehouse as well as around the interior perimeter.
- Combining this with maintenance of physical barries that limit entry and an aggressivetrapping effort will noticeably minimise feed losses caused by rodents.
- Use of poisons only be considered as lost resort to control rodent and populations in feedstorage areas

SHORT ANSWER QUESTIONS

UNIT-1

MICRONUTRIENTS ESSENTIAL

FOR FISHINTRODUCTION:

- Vitamins and minerals are micronutrients required for normal growth, reproduction, healthand maintenance of fish metabolism.
- The Requirement of is depend upon the intake of other nutrients age of fish environmentalstresses etc.

Vitamins:

- Four fat soluble and eleven water soluble vitamins are known to be required by fish.
- Fat soluble vitamins vitamin A 3500iu/kg.
- Feed vitD_ 3000iu/kg.vit E 100iu/kg,vit k_10mg/kg.
- Water soluble vitamins ascorbic acid, B12,, biotin, choline, folic acid, Inosilot,niasin,pantothenic acid, pyridoxine, Thamine.
- In spite of addition of excess amount of vitamins to most fish diet. Vitamin deficiencydisorders still occurs in fish culture.
- The reason behind is improper manufacturing handling storage of fish feed.
- Vitamins are also susceptible to destruction by oxidation in the presence of excessivemoisture, heat and trace minerals. Particularly if rancid fat is present.
- Nutritional disorders caused by vitamins deficiencies can impair the utilisation of othernutrients weaker the health of fish and lead to disease.

Minerals:

- In fish minerals perform important roles in osmoregulation intermediary metabolism andinformation of The skeleton and scales.
- Minerals required in the fish diet include calcium zinc manganese Cobalt selenium, iodinefluorine,Phosphorus,magnesium, copper ,iron.
- The potential for toxicity of minerals must also be carefully assesed since fish are verysensitive to excess amount of minerals.
- Mineral requirement of fishes difficult to study because many minerals are required Mount and other observable from water insignificant qualities through the gills as well as from diet.
- Macro minerals are calcium Phosphorus magnesium chloride sodium potassium.
- Micro minerals includes cobalt, chromium, copper, iron, iodine, Manganese, zinc andselenium.

Trace minerals and some of their functions:

Copper_metalloenzym

esCobalt_ vit B12

Chromium_carbohydrate

Metabolism

Iodine_hemoglobin

Manganese_Orange matrix

of

Bone

Selenium_ glutathineperoxidax.

VITAMIN AND MINERAL REQUIREMENTS FOR PRAWN

The Prawn are capable of digesting a wide range of foods of both plant and animal origin.

- Characterization of the activities of the digestive enzymes in the alimentary tract indicatethe presence of enzymes like trypsin, aminopeptidase ,proteases, amylases , chitinase, cellulose, lipases.

Proteins and amino acids:

- Diets with about 35 to 40% protein and grass energy level about 3.2 k.cal/kg diet proteinenergy ratio of about 125_130 mg protein 1 k.cal are suitable for growth.
- Prawn of m.rosenbergii clear water systemthe do not have any supply of natural foods.
- Broodstockrare in ponds having natural food(benthic micro and macro fauna require about30% protein in the diet.
- May commercial feeds for grow out can 10242 32% crude protein ratio of 1:1 is known to beeffective for feed efficiency and growth rate.
- The prawn requires the same ten essential amino acids as other crustacean and fish species.

Carbohydrates:

- The comparatively high specific activity of amylase found of m.rosenbergii suppose the fatthat the species effeciently utilizes carbohydrates as a source of energy.
- During fasting energy metabolism in the prawn is dominated by carbohydrates, followed bylipids and proteins.
- Complex polysaccharides including starch and dextrin are more effectively utilised thansimple sugars.

Lipids and fatty acids:

- The dietary lipids level in prawn diets can be as low as 5% provided the lipid source containssufficient levels of essential fatty acids.
- There is adietary requirement for highly unsaturated fatty acid(HUFA) although in very smallqualities.
- M.rosenbergiiplay kadar crustaceans is unable to synthesise cholesterol. Due to the absenceof enzyme 3 e hydroxy 3 methyl gluturgeyco A reductase the dietary requirement for cholesterol is approximately 0.3 to 0.6 % in diet.
- Low level of dietary cholesterol in broodstock diet is known to adversely affect egg qualityresulting in inferior quality of seed production.

Vitamins;

- The Prawn requires 60_150mg c/kg diet.levels of 60mg ascorbic acid and 300 mg d_ tocholesterol per kg diet are considered sufficient for proper reproduction and offspring viability in prawn brood stock.
- Fat soluble and water soluble vitamins are required by prawn.
- Diet deficient in ascorbic acid, biotin, folic acid, niacin, thiamine resulted in poor appetitepoor FCE.
- Lack of specificvitamins can be histopathological changes in shrimp digestive gland cells andpoor appetite and poor FCR.
- Vitamin C is important for plant growth and survival.

Minerals:

- General function of minerals include constitutes of the exoskeleton balance ofosmometic pressure, structural constituents of tissues and transmission of nerve impulse and musclecontractions.
- Minerals are two types micro elements and macro elements.
- They are essential components for enzymes vitamins and hormones pigments catalyst andenzymeactivators.
- Prawn can absorb minerals directly from the aquatic environment via gill and body.

So, dietary requirements of minerals in largely dependent on mineral concentration of aquaticenvironment.

CHECK TRAYS

To assess the feeding and save feed from wastage and further deterioxation and tk increase profitability in culture feed trays are kept along the periphery of the ponds.

- Feed trays are generally 2×2 feet nets with frame with a float for identification location.
- A pond of 1 hacter size would need 4_6 feeding trays about 1_4% daily ration is kept inthese feeding trays/ check trays.
- Every day after each feeding the feed in the feeding tray is checked to know whether feed isfully consumed.
- Depending on the quantity consumed the adjustment of feed is made.
- Since shrimps are under water and always in dynamic movement,it is very difficult to assess the exact number of shrimps available in the pond during stock assessment.Hence, survival can be checked, based on the actual quantity of feed consumed per day .

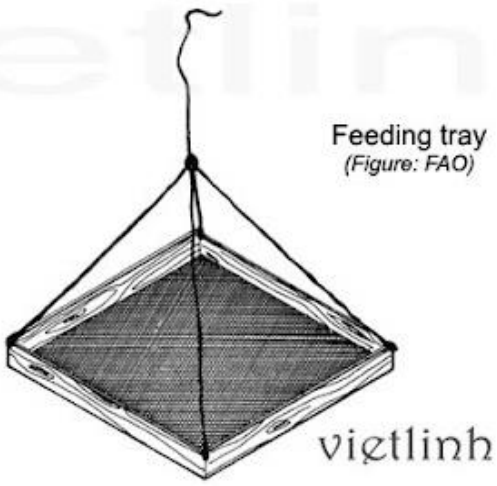
Survival rate=Actual feed consumed/calculated feed requirement

- Feed requirement is estimated based on the calculated survival rate.
- If pond is well prepared without any predators the calculated quantity of feed should beconsumed.
- If calculated feed is not consumed due to decrease or reduction in survival rate feedingration should be adjusted.

- Average amount of unconsumed feeding remaining in trays (1%) adjustment to feedingrate.

O	**Increase 5%**	
Less than 5%5_10% 10_25% More than 25%	No change Decrease5% Decrease10 % Suspend 2 feed ration andreintiate@10%less	

- Under certain conditions shrimps found to congregate near the trays and consume feedrapidly.This is most likely due to poor bottom condition.
- Under such conditions the following precautions is taken
- To increase quantity of feed in trays.
- To check the trays faster the compare result with other ponds.
- To elevate the tray from the bottom.
- To increase number of trays in ponds and feed only on trays.



Feeding tray
(Figure: FAO)

DIETARY SOURCES OF ENERGY REQUIRED BY FISH

Fish growth involves the laying down of muscle, fat, epithelial and connective tissue. The proportion of protein or fat laid down in these tissues depend upon the diet taken, in order to protein synthesis to occur correct number of essential amino acids must be provided. Essential amino acids are those that the animal cannot produce and has to be supplemented through the diet. The requirement of amino acids for
aquatic animal varies from species to species.

Protein as energy source

The composition of protein provides a balanced mix of the essential amino acids. Growth of fish and prawn is primarily determined by level of protein and its constituent amino acids. Protein is major as well as most expensive component in fish feed. The diversity in fish feeding habits exhibited in nature reflect in the variation in their protein and essential aminoacids. requiremnts. Protein is the most important component of the diet of fish because protein intake generally determines growth, has a high cost per unit and high levels are required per unit of feed.

Fish meal is a rich protein source but this is expensive, this can be replaced by soyabean meal, cotton seed meal. It is generally been found that most alternative protein sources are able to replace fish meal to some extent.

Since, dietary protein is relatively expensive, to nutritionist aim to formulate
diet in such manner that the energy required by the animal is provided by non-protein sources.protein energy ratio of the diet are correlated with the body composition of the product. Body composition is the amount of moisture ,protein, carbohydrate and fat contained in a fish carcass. Optimising body composition to yield the maximal dressing percentage and sensory quality is important for an aquaculturist as this is directly related to profitability.

Carbohydrate as energy source

Carbohydrates are the cheapest and most abundant source of energy for animals. Most of the plant material are carbohydrates. Carbohydrates in feeding material range from easily digested sugars to most complex cellulose molecules which cannot be digested easily by animals. It is only through their symbiotic relationship with bacteria that ruminant animals can large amount of cellulose. Carbohydrate has limited use as an agent providing energy and so for sparing protein in the diet of finfish. In the point of fishes carbohydrates are cheap source of dietary energy ,the digestable carbohydrates can be well utilized as an energy source if it is kept in proper balance with other nutrients. The value of carbohydrate in the fish diet
depends on the source and type of carbohydrate and the processing to which it has been subjected.

Lipids as energy source

Lipids whether plant or animal origin ,consists of esters between one molecule of glycerol and three molecules of long chain fatty acids. They are highly insoluble in water and as a result are not easily hydrolysed. Lipids contain more energy per unit weight than any other biological product. The inclusion of lipids usually increases palatability. Generally lipids are well digested and utilised by fishes. The protein sparing effect of lipid varies between species but appear to be optimal at about 15-18 % of the diet. The effect is more clearly observed when the amount of dietary protein consumed is low, or the content of protein is less in the diet.

VITAMIN REQUIREMENT BY FISH

Vitamins:

• Vitamins are organic compounds necessary in the diet for normal fish growth and healththey often are not synthesized by fish and must be supplied in the diet.

• The two groups of vitamins are watrt soulble and fat soulble. Water soulble vitamins include. The B vitamins Choline, Inositol, Folic acid, Panthothenic acid, biotin and ascorbic acid (vitamin C) vitamins of these vitamins C probably is the most important because it is a powerfulantioxidant and helps the Immune system in fish.

• The fat soulble vitamins include A vitamin, retinols (responsible for vision). The D vitamins,Cholecalciferols (bone integrity)E vitamins, the Tocopherols (anti oxidants) and K vitamins such as Menadione.

• Deficiency of each vitamins has certain specific symptoms, but reduce growth is the mostcommon symptom of any vitamin deficiency.

Determination of Feeding rate

Steps to Determine Feeding Rate:

1. **Calculate Biomass:**
   - Estimate the total biomass of the fish stock in the culture system.
     Biomass (kg)=Number of Fish×Average Weight per Fish (kg)\text{Biomass (kg)} = \text{Number of Fish} \times \text{Average Weight per Fish (kg)}Biomass (kg)=Number of Fish×Average Weight per Fish (kg)
2. **Determine Daily Feeding Rate:**
   - Use species-specific feeding charts or guidelines to determine the percentage of biomass to be fed daily.
     Daily Feed Amount (kg)=Biomass (kg)×Feeding Rate (%)\text{Daily Feed Amount (kg)} = \text{Biomass (kg)} \times \text{Feeding Rate (\%)}Daily Feed Amount (kg)=Biomass (kg)×Feeding Rate (%)
3. **Adjust for Temperature:**
   - Adjust the feeding rate based on water temperature using species-specific temperature correction factors.
4. **Account for Feed Quality:**
   - Ensure the feed used meets the nutritional requirements of the species and is of high quality.

Example Calculation:

- **Species:** Tilapia
- **Number of Fish:** 1000
- **Average Weight per Fish:** 0.5 kg
- **Biomass:** 1000×0.5=5001000 \times 0.5 = 5001000×0.5=500 kg
- **Feeding Rate:** 3% of biomass (varies with species and conditions)
- **Daily Feed Amount:** 500×0.03=15500 \times 0.03 = 15500×0.03=15 kg

Thus, you would feed the tilapia 15 kg of feed per day. Adjustments should be made based on continuous monitoring and changes in environmental conditions.

PHYSICAL PROPERTIES OF FEED:

Aside from the statement of the major nutrients present in a feed stuff or feed information is also required on the physical characteristics of the product including colour, texture, order particle sizepelletability,bulk density, Water stability and attractability.

Water stability:

One physical property that is necessary in a feed it . it'swaterstability.A water stable diet provides maximum available food to the fish and minimum leaching out of vitamins and. Othernutrients.poor water stability can also impair water quality crustaceans such as shrimps lobsters and crabs grasp their food with them chelae carry into the mouth and fear it into smaller fragments before swallowing.

They need relatively more stable pellets than do the fin fish.Thus binders and processing techniques like and extrusion are done to ensure water stability.

Water stability tests are usually done on pellets intended for slow feeders.
One gross way of determining the stability of the Pellet in the water is bycrumbling it or by just feeding the rough edge of the Pellet.

Particle size:

Pellets with ingredients that are not finely or uniform ground tend to be lessstable than pellets with uniformly ground ingredients.
Hence ingredients should be finely ground and siened to uniform particle sizeand before in corporation in the diet.
The size and shape of feeds should be designed to accommodate and confirm tothe anatomical organs of the crop animal for seizing engulfing or ingesting food, food particle size in the feeding of cultured species whose mouth parts vary greatly.

Texture:

Also an important aspect of diet is texture hard soft , moist,dry,rough orsmooth.
Some species appear to avoid hard pellets.Thosethat tear their food may have to be provided with feed of a texture different form that given to those speciesthat swallow or nibbe off small pieces of the food.

colour:

Various species of aquatic animals are able to see colurs.
Colour contract between the feed and the culture tank may provide greater easy for the fish to capture their food.

Density:

As ground feed ingredients are received in the feed bulk density measurement can be done to check on the amount of adultants present.
Bulk density of the ingredient simple should be determined and compared withthe bulk density of pure feedstuffs.
If contaminants or adult Texants present bulk density will change.
It is a good practice to go back to sample for closer look by paying particularattention to adulterants.
In general adulterants are ground extra fine to escape detection.

Pelletability:

Depending on their nature feed ingredients may be of low medium or high pelletability.

~~Usually the finer the particle size the higher is the pelletability of the ingredient.~~

REASONS BEHIND SPOILAGE HALF FEED WHEN STORE

INTRODUCTION:

- Prepared feeds for fish and shrimp perishable products they are also more or less fragile, depending on the type of feed.
- Feed processors attempt to formulate and manufacture aquaculture feeds to extend their shelf life and improve durability.
- However the degree to which aquaculturists can reduce wasted feed and realized its full purchase value is ultimately dependent on how well the basic principles off feed storage and handling are understood and applied.

Storage:

- For reasons of cost and convenience, dry dates are presently the most widely used feeds in aquaculture, these include extruded feeds, hard pellets, crumbles .
- The general rule for preservation of these feeds is to store them in a dry, well ventilated area that affords some protection from rapid changes in temperature.
- A good storage facility should also provide adequate containment for control of pests. **Vitamin potency:** The potential of most vitamins contained in formulated feeds declines during storage. This is because many of these organic compounds highly reactive and unstable under certain conditions they can be easily denatured by heat oxygen, moisture and even ultraviolet light.
- The rate of vitamin activity loss in a given feed formulation is dependent on the particular vitamin its source on the conditions under which feed is stored.
- Typical changes in vitamin activity losses in this feeds revealed that after doubling the recommended storage time only vitamin C activity declined below minimum acceptable levels.
- Vitamin requirements are actually a function of feed consumption and desired biological response of the fish other than a specific concentration in the field.

Mold Growth:

All too often feed store in fish hatcheries and forms is destroyed by common molds. The potential for this to occur is always present because of the fact that mold producing fungi and other microorganisms exist naturally throughout the environment.

- They are present in grains after harvest and in animal and earcasses prior to rendering.
- Food processing operations involved in stabilizing these feed stuffs and in manufacturing feeds typically use heat and dehydration steps that are sufficiently destructive to eliminate the original contaminating microflora. However some fungus Spores can survive Harsh processing conditions.
- Contaminating fungi growth best when the moisture of the feed is 14.5 to 20% and in equilibrium with a relative humidity of 70 to 90%.
- Extruded and pelleted feeds are manufactured at considerably lower moisture levels allowing a safety margin for variability among individual field particles.
- The most effective mold prevention strategy therefore is to maintain moisture levels in stored feed below requirements for fungal growth.

Lipid Rancidity/Chemical spoilage:

Lipids used in aquaculture feeds are usually that type that contain significant levels of unsaturated fatty acid which are required for good health and growth of most species of fish and shrimp.

- The high degree of unsaturation of these fatty acids causes them to be particularly

prone tooxidation rancidity.

- Feed manufacturers attempt to prevent oxidation in lipids sources such as fish oil bystabilizing them with antioxidant.
- However the commonly used antioxidant such as ethoxyguin, mutilated hydroxyanisole andmutilated hydroxytoluene are sacrificial in the way that they protect the oil.
- Once they are used up free radicals that are already present in the oil begin to react withunsaturated fatty acid components and the process of oxidation begins.
- It is often thought that freezing is the best method of long term preservation.
- Rotating the feed inventory as quickly as possible is the only effective strategy to avoidhaving feed go rancid before it is used.

Pest Infection:

The presence of insects and rodents in feed storage areas can often be an overlooked out serious problems in aquaculture.

- This pets not only consume failed but also cause additional and sometimes greater feed losses through packaging damage and the creation of environmental storage conditions thatpromote mould growth.
- They also have the potential to serve as vectors for transmission of diseases to humans.

Insects:

- Insect infestation can be a very serious problem in Feeds stored over a prolonged period oftime.
- An actively reproducing population of insects can quickly consume significant amounts offood and deteriorate the physical quality of remaining feed.
- Most of these insects thrive on food containing 12 to 14% moisture they are capable of completely developing from an egg to areproductively active adult within 30 days then temperature are between 20 and 30°c.
- However regular inspection of feed and early detection of birds along with good sanitationin storage areas for proactive practices that can greatly reduce the incidence of food contamination with bugs.
- Insecticides can be used to eliminated a persistent infestation.

Rodents: populations of rats and mice that become established in storage areas obviously consume some amount of feed.

- The basis for your rodent control program should always be good housekeeping both insidethe warehouse as well as around the interior perimeter.
- Combining this with maintenance of physical barries that limit entry and an aggressivetrapping effort will noticeably minimise feed losses caused by rodents.
- Use of poisons only be considered as lost resort to control rodent and populations in feedstorage areas