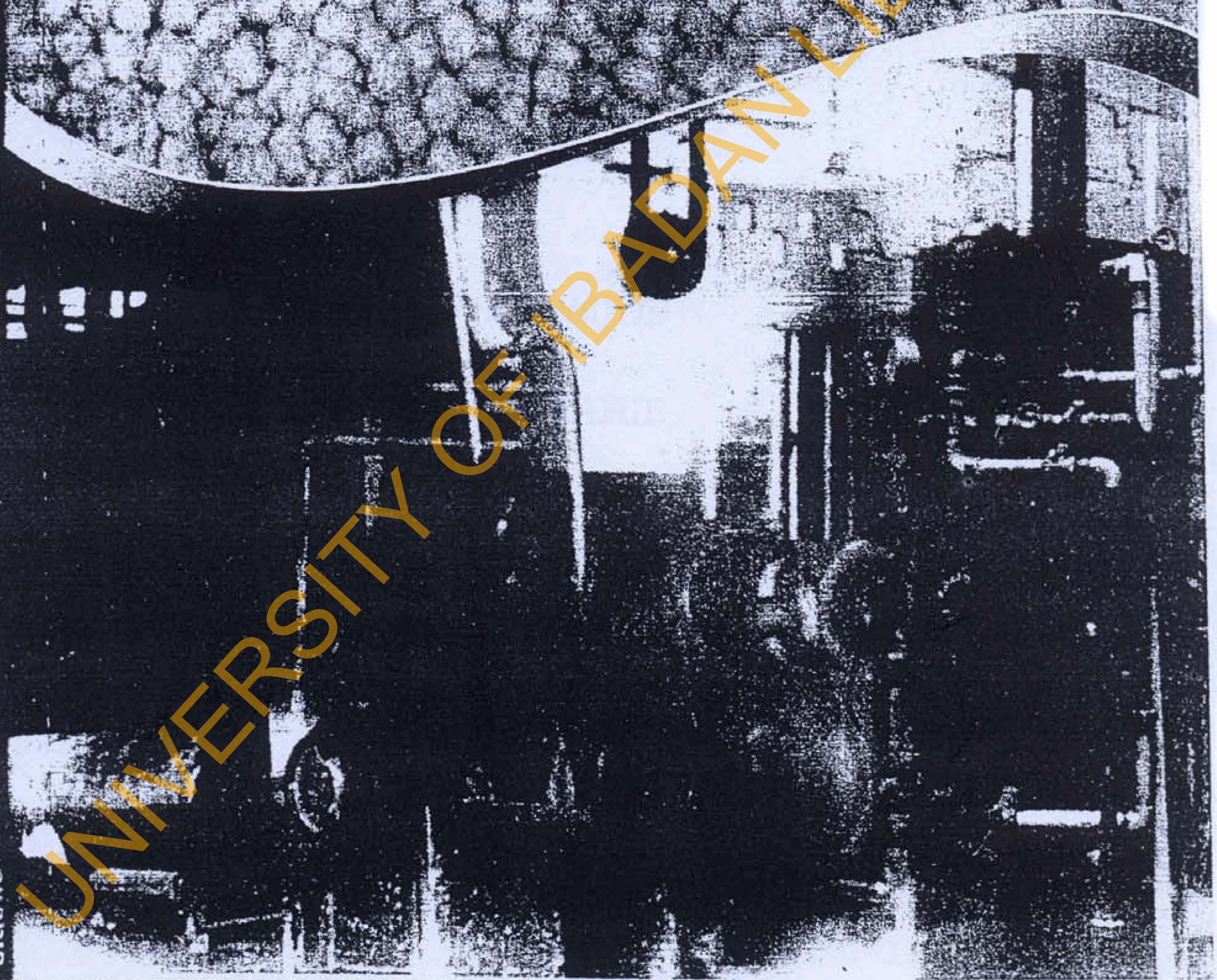
# FISH NUTRITION & The Economic Way To Feeding Fish



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Fish Nutrition & The Economic Way To Feeding Fish Akintomide, Ahmed, Obhahie & Olaifa

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## & THE ECONOMIC WAY TO FEEDING FISH

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And To

- Those who love Nigeria and seek her glory.

# Table of Contents

# The Book

"Fish Nutrition & The Economic Way To Feeding Fish" is a book written by the authors for OAK Ventures. It is the 4th book in the series, and the 2nd of its kind (after 'Advanced Commercial Catfish Farming') on fish production. The book is written as a compendium to enhance the farming of fish for national growth.

Being aware of the fact that over 60% of the gross input (cost of production) is expended on feeding fish that are intensively produced, this piece is fashioned towards exploring other economic means of feeding fish without compromising the standard. Included herein are detailed highlights of what it takes to produce zooplankton and quality (formulated) fish diets, feed assessment, how to feed fish and how to tackle possible nutrient oriented problems. However more emphasis is placed on catfish nutrition within the text.

Please enjoy and reap the fruit of this work as you discover the 'golden eggs' herein.

***Oakman.***

# 1

## Introduction

All living organisms feed to survive. They maintain their normal body physiology and derive strength to move and grow from food. Well-fed animals are normally energetic and vibrant. They have good rate of development and excellent body features such as bright appearance and shiny skin. On the contrary, those poorly fed have poor development, look dull and are usually more susceptible to disease conditions. Fish, like other animals, are fed on adequate quantity of good quality diets to improve their growth rate and general production performance.

Standard quality feeds have been developed to meet the nutritional needs of some fish species, although they are expensive. The recent introduction of some canned natural fish feeds is commendable, but is much more expensive and unaffordable to low income earners who are eager to start fish farming.

The cost of feeding adequate quantity of good quality diet to fish that are intensively farmed, often forms the larger percentage (often greater than 60%) of the total cost of production. This implies that the cost of feeding will greatly influence the productivity and economics of aquaculture. So, if the cost of feed input is considerably reduced without compromising the final feed quality, the business of farming fish will become more rewarding and less capital intensive, thus being more encouraging to farmers.

The focus of this book is thus channelled towards giving a better understanding of what it takes to feed fish in an economic way, incorporating some useful, cheap agricultural/industrial products, by-products and or wastes as feed materials.

# 2

# Fish Feeds and Types

There are two possible ways of grouping fish feeds, and these are:

- Natural or Artificial feeds
- Conventional or Unconventional feeds

## Natural and Artificial Fish Feeds

### Natural Fish Food

As the name implies, this can be any food material produced by nature as live fish food. Plankton, a collective term used for small natural live fish food, consists of tiny plants (phytoplankton) and animals (zooplankton) that live in water. Some edible, small water food plants produced by nature for fish are algae, floating duckweeds, leaves of young reeds, lupin and yeast. Some natural live fish food animals living in water include moina, artemia, daphnia, rotifers, copepods, krill, water insects and worms. Other aquatic food animals are water snails, tadpoles of frogs / toads and small-sized fish.

A group of plankton may be carefully selected from the wild, cultured in separate tank(s) and scooped to feed cultured fish. The type and size of plankton to be selected depend on the feeding habit and mouth-size of fish to be fed. The propagated zooplankton may be maintained on micro-algae, smaller water animals, organic matters and or micro-capsulated feeds. In this way, baby fish are adequately managed on a variety of cultured zooplankton.

Interestingly, some zooplankton such as artemia and rotifer are being cultured, packaged and sold across the globe as canned fish diets. This type of packaged food, although expensive, makes hatchery management easy and convenient. However, the use of such canned products needs be monitored by a regulatory body to forestall possible disease transfer or health risk.

## Artificial / Formulated Fish Feeds

Artificial fish feeds are produced as concentrates (often termed '*Aqua feeds*') that come in diverse forms and sizes, depending on the species, size, age group, feeding pattern and environment of the fish in question. Aquafeed is produced from a calculated selection of natural food materials, synthetic products, their by-products and or wastes. The concentrate ingredients may be a combination of meal / gluten of grains (mainly wheat & corn), fish meal, poultry by-products, oilseed by-products (such as full-fat soy, soybean meal, groundnut cake, cottonseed cake & sunflower meal), di-calcium phosphate, salt and premixes. Standard fish feeds are often packaged and sold as dry or semi-solid granulated, flaked or capsulated feeds, which may float or sink in water.

# Conventional and Unconventional Feeds

## Conventional Fish Feeds

These are possible fish food materials that are generally accepted for use as fish food or in feed production. Such materials include some natural fish food and feedstuffs used in artificial feed production. These foods include artemia, rotifer and daphnia. Some widely accepted feed items for aquafeed production are cornmeal, fish meal and soybean meal.

## Unconventional Fish Feeds

These are feedstuffs that may be incorporated as constituents of fish concentrate or directly used as fish food, but are generally unacceptable as standard fish food, and their use is often restricted to few localities. Feed items that are presently being utilized in concentrate formulation were at one time or the other unconventional. The need to source for cheaper (unconventional) feeds of high dietary values arose from the expensive nature of commercial fish diets and conventional feed ingredients that are used in the formulation.

Depending on the locality, some feed materials may be sourced cheaply or cultured as substitutes to some expensive conventional feed items. Such relatively cheap unconventional feedstuff(s) should be analyzed in a standard laboratory to determine its nutrient value and anti-nutritional factors (if any), processed and included as an ingredient in fish concentrate production.

## Sources & Examples of Unconventional Feedstuffs

Unconventional feedstuffs may be sourced as edible by-products or wastes derived from human food materials, untapped or poorly utilized resources, or are specially produced as fish feed materials. The availability, acceptability to fish, nutrient content, anti-nutritional factor(s), quality and cost implication of such feedstuffs (in each locality) should be carefully considered and compared with available conventional feed ingredients to determine their worth as substitutes. Some identified feed items that may be considered for use in feed production are discussed below.

## Poultry

By-products / wastes obtainable from poultry source as fish feed materials, are relatively common and generally high in protein content. They need to be well processed before being fed to fish to forestall disease transfer / outbreak, and also to increase the palatability and nutrient availability.

Some poultry by-products that may be gainfully processed and utilized in the production of fish feed are runts, very weak birds of low survivability; carcasses of dead birds; by-products / wastes of processed birds such as intestines and other visceral organs, feathers, heads and legs; faecal product with or without cultured maggot, and cracked eggs.

## Hatchery

Hatchery by-products & wastes may also serve as useful feed materials, especially as good protein sources, in formulated feed. These wastes, like poultry wastes, **must** be adequately processed to prevent the spread of any communicable disease.

Some notable examples of hatchery wastes are infertile or unhatched eggs; dead-in-shell embryo; very weak or dead chicks, and egg shell (as calcium source).

## Abattoir

Animal by-products and wastes such as blood meal, offal, rumen content and 'fairly' unwholesome meat, may be processed and recycled in a hygienic way as fish feed items.

## Plants and Animals

Some cheap, common plants and highly productive animals of good nutrient values may be produced or harvested, processed, milled and stored for future use as concentrate ingredient(s), after the nutrient values must have been analyzed.

Plants that may be considered for use as feed ingredients include aquatic plants (duckweed, water velvet and water hyacinth), mushroom, sunflower and breadfruit. Tomatoes, vegetables, melon seed, albizia seed, and leaves of potatoes, pawpaw, cassava and banana / plantain may also be considered for use. They may be processed and stored as meals, cakes or puree (tomatoes) prior to their use in formulated diets.

Animals that may be captured or cultured, processed and utilized as feed ingredients include some aquatic animals (water crustaceans, water insects & trash fish), microworms, earthworms, insect larvae (maggots), insects (flying reproductive termites and farm-flies), tadpoles, snails and rodents (mice, rats and guinea-pigs). Selected animals should be well managed and processed to prevent their serving as secondary host / carriers of infectious agents.

## Food Processing Industries

By-products, wastes or residues obtained from industrial food plants and food vendors may be re-cycled into valuable feed materials for use in fish concentrate production. Some of these items may serve as good energy substitutes in place of grains (corn and wheat), some as protein sources, while some others may serve as vitamin / mineral supplements. They may or may not require much processing, depending on how and where they were sourced.

Some useful wastes that may be obtained from food processing industries are broken rice, biscuit dust/waste, baby cereal waste, corn flakes waste, wheat flour dust, bakery waste and cassava flour / flakes waste. A number of these wastes may also serve as good feed binders. Other useful materials include milk dust / waste, fragmented peanut, industrial puree wastes (e.g. tomato puree waste), fruit residues obtained from fruit juice industries and some eatery residues.

Some examples of both conventional and probable unconventional feedstuffs are given in table 1 below. Also included in the table is a comparison between their prices, where available.

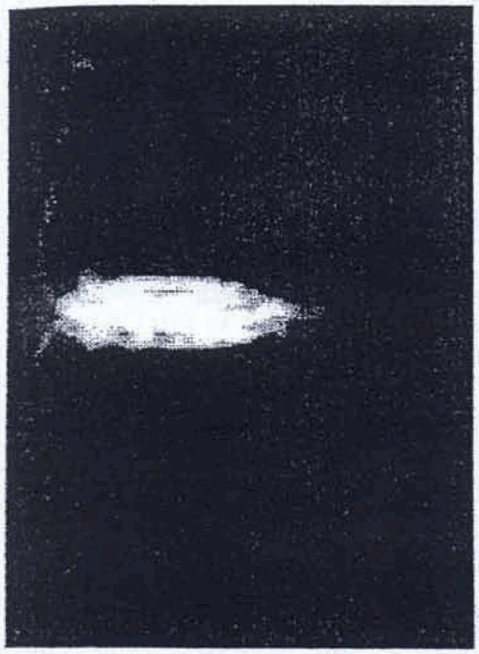
**Table 1:**
**Conventional & Unconventional Feedstuffs with Their Prices**

| | Conventional Feedstuffs | Price ₦/kg | Unconventional Feedstuffs | Price ₦/kg |
|---|---|---|---|---|
| Energy source | | | Rice (waste) meal | N/A |
| | | | Rice bran | 15.0 |
| | Corn meal | 58.0 | Potato meal | N/A |
| | | | Breadfruit meal | N/A |
| | | | (Hulled) guinea corn | 15.0 |
| | | | Barley dust | 14.0 |
| | | | Sorghum offal | N/A |
| | | | Biscuit waste | 20.0 |
| | Wheat Meal | 47.0 | Bakery by-product | N/A |
| | | | Wheat dust | N/A |
| | | | Noodle waste | N/A |
| | | | Baby cereal waste | N/A |
| | | | Cassava by-product | 28.0 |

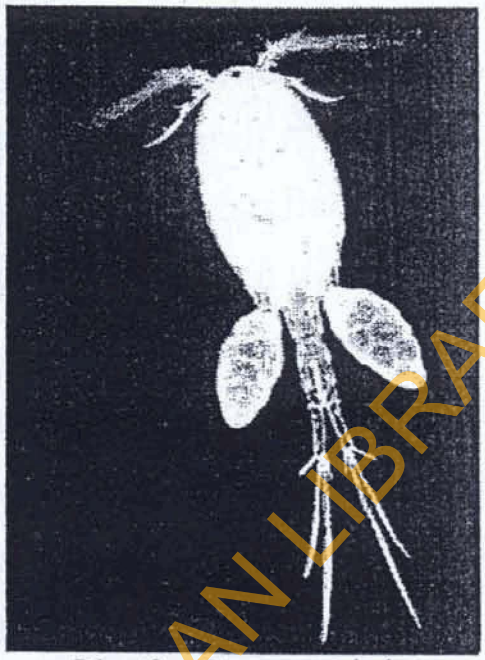
| | | | | |
|---|---|---|---|---|
| *(High Protein)* | | | | |
| Protein source | | | Catfish offal meal | N/A |
| | | | Earthworm meal | N/A |
| | Fishmeal (72%) | 330.0 | Snail (offal) meal | N/A |
| | | | Hatchery by-products | N/A |
| | | | Poultry by-products | N/A |
| | | | Feather meal | N/A |
| | Blood meal | 50.0 | Maggot meal | N/A |
| | | | Liver meal | N/A |
| | | | Insect meal | N/A |
| | | | Tadpole meal | N/A |
| | *(Fairly High CP)* | | | |
| | Groundnut cake | 42.0 | Sunflower meal | N/A |
| | | | Cotton seed cake | N/A |
| | Full-fat soy | 85.5 | Brewery's yeast | N/A |
| | | | Powdered milk waste | N/A |
| | Soybean meal | 70.0 | Albizia seed cake | N/A |
| | | | Tomato puree waste | N/A |
| | | | Duckweed meal | N/A |

***Price source:****Feedmills in Ibadan metropolis, Nigeria (Feb, 2008).*

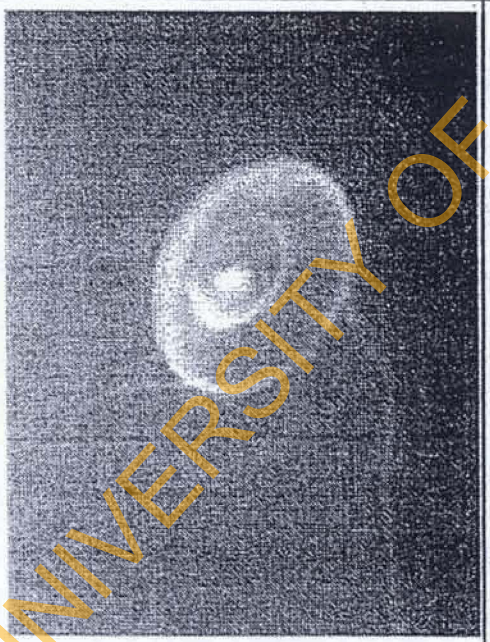
***N/A:*** *Unavailable, suggested, common unconventional materials that may be converted into good use, depending on location.*



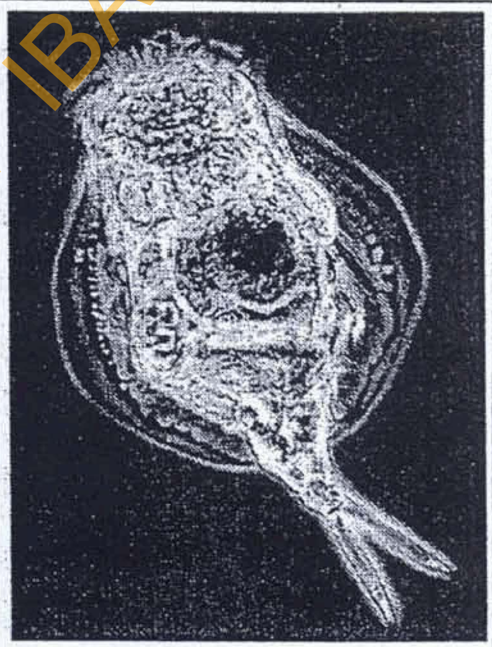
Pix 5: Copepod (*Calanoida* sp.)



Pix 6: Copepod (a cyclop with 2 eggs)



Pix 7: Jellyfish (*Chrysaora quinquecirrha*)



Pix 8: Rotifer *Lecane*

## Production and Application of Zooplankton

Plankton species are naturally occurring in low densities in water bodies. Sufficient quantities of plankton may however be raised in enclosures such as plastic tanks, wooden tanks, fiberglass / fiberglass coated tanks, tarpaulin / tarpaulin coated tanks, stainless steel, concrete tanks and earthen ponds. However, the use of tanks is preferred to earthen ponds for easier managemental manipulations. Corrosive metallic tanks (e.g. uncoated iron tanks) should be avoided. Although the size of each of these water holding receptacles varies, small sized tanks are better and easier to manage than large tanks. A tank dimension of about 2m x 2m x 1.5m may be adopted for use. Where concrete tanks are intended to be used, such tanks should first be 'cured' to reduce the chemical effect of cement.

The two widely accepted methods of zooplankton propagation are the "Trawl to Inoculate" and the "Spreading" methods.

## The Trawl to Inoculate Method

1.) Acquire and fill the water holding receptacle with water from a good water source such as borehole, to a depth of about 1metre.

2.) Using inorganic or well managed organic fertilizer (or a combination), fertilize the tank and leave for about 3 to 5 days for bacterial and phytoplankton growth.

3.) With the aid of a microscope or magnifier, examine water samples obtained from existing water body(-ies) for choice zooplankton, early in the morning or late in the evening.

4.) Trawl for the choice zooplankton from the sited zooplankton-rich water body to seed and inoculate the culture tank.

## The Spreading Method

1.) Acquire a viable culture tank.

2.) Separate and spread the resting eggs of choice zooplankton or simply spread earthen sediments containing zooplankton cyst/resting-egg/

ephippia on the bottom of the tank.

3.) Let in water from a good water source and keep the water level at about 1metre depth. If the available water is turbid, allow it to get settled before being used.

4.) Fertilize the culture unit and watch-out for bacterial growth, followed by phytoplankton growth and climaxed by zooplankton production within 3 days to a week.

*Note: Resting eggs can be obtained from the tank sediment of an established zooplankton culture system (usually from about a week old or more culture system), and stored in a refrigerator at 4$^0$C for about a year or more, for future propagation.*

Once the culture system is established, there is the need to maintain a good micro-algae level for a continuous optimal zooplankton production, through the careful use of fertilizers. Alternatively, other zooplankton feeds such as micro-encapsulated feed and organic matters may optionally be considered or combined with algae feeding in maintaining the culture.

A periodic examination of the cultured zooplankton for viability and culture progression is important. To do this, a scoop of the organism is harvested into a clean transparent glass container, and examined with the naked eye or with the aid of a hand lens. Zooplankton appears whitish and could be observed to be darting around in the container when held against a light source.

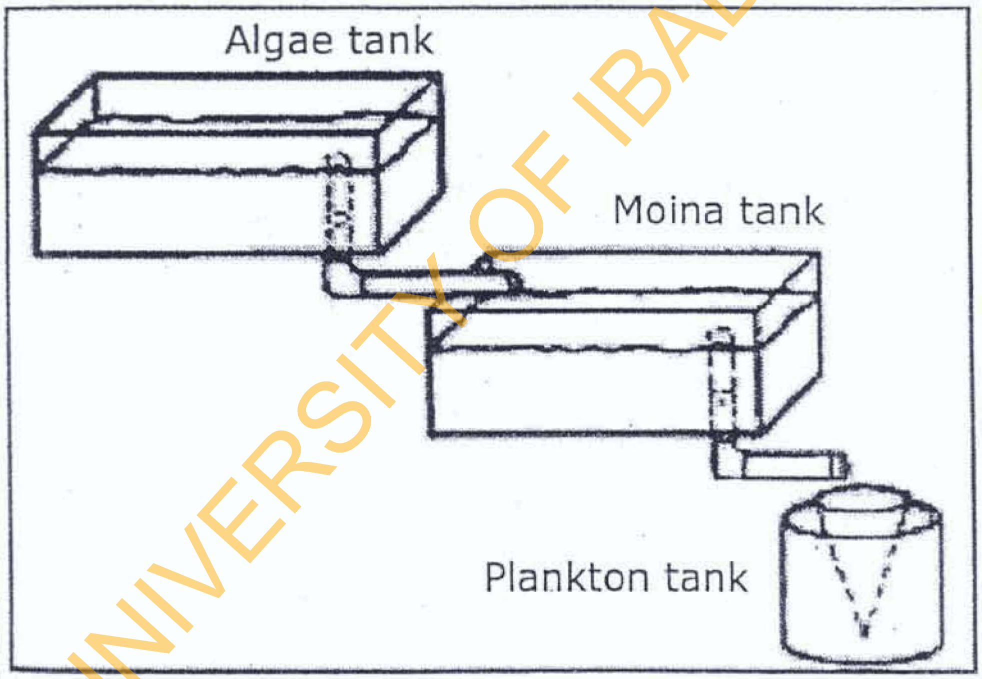



**Figure 1:** Tank arrangement for the separate culture & harvest of *Moina* and its food (Rottmann *et al*, 2003).

## Fertilizer Application in Zooplankton Production

Fertilization of culture medium can be carried out using inorganic or manure/organic fertilizer. Inorganic fertilizers are artificial or synthetic fertilizers, examples of which are Nitrogen, Phosphorus & Potassium (NPK), Ammonia, Urea and Super-phosphate fertilizers. Organic fertilizers that may be used include animal manure (chicken droppings) and wastes (blood, fish fins & gills), crop residues and compost. However, great care should be taken when using organic fertilizers (especially animal droppings) to avoid disease contamination.

The common method used for inorganic fertilizer application is the broadcast method, while the 'sac' and 'fermentation' methods are usually applied for manure/organic fertilization.

## Harvesting of Zooplankton

Standard nets for zooplankton harvest are available, though they are imported and expensive. However, suitable local fabrics can be substituted for standard zooplankton harvest nets.

Harvesting is initiated by dipping and towing a zooplankton harvest net within the culture from one side of the tank to the other. The harvest of each of the several trawls is emptied into a bucket of fresh water to obtain a good concentrated zooplankton harvest and to keep them alive. The harvest is then processed by sifting it through a sieve (coffee sieve and mosquito netting sieve may be improvised) to remove mosquito larvae, aquatic insects and other debris. The filtrate could then be used in feeding the fry in fry holding tanks.

**Fish Fry Diets**

Formulated diets should be rich in simple protein and energy, essential vitamins and minerals. Special microbound, microcoated and microencapsulated diets with fortified enzymes (e.g. protein hydrolysate) and other additives are being produced for fish fry as concentrates. Optimal particulate size, quality and quantity of feed are essential.

## Other Baby Fish Food Preparations

Some other feed materials are occasionally used in feeding fish seedlings with some recorded success level, apart from using the conventional zooplankton and formulated diets. Sometimes these unconventional feeds are fed along with zooplankton, formulated diets or other unconventional baby fish feeds. They are often served in their moistened or powdered form. Some of these other feed items are listed below.

- Steamed, mashed egg-yolk
- Egg custard
- Fish meal
- Dried/fresh yeast e.g. baker's yeast & torula yeast
- Milled or smashed worm e.g. red worm
- Shrimp head flakes

*Note: it is often preferred to use special formulated fish seedling diets and not self-formulated feeds because of the sensitive nature of the fish.*

4

# Formulation of Fish Feed

## Dietary Composition of Fish Feed

Aquafeed production is directed at satisfying the nutrient requirement of farmed fish either in part (supplemental diet) or totality (complete diet). The dietary requirement (carbohydrate, protein, lipids, vitamins and minerals) of some fish is known while others' are extrapolated from data obtained from related fish.

## Carbohydrates

Carbohydrates provide the cheapest energy source for animals. Dietary carbohydrates, such as dextrin and starch, are better utilized by fresh- and warm-water fishes than cold-water and marine fishes. The digestibility and utilization of carbohydrates may be improved when extruded under high temperature and pressure to reduce the molecular complexity. They are important in feed gelatinization for proper binding (feed stability in water) and floating feed production. They are often included at less than 25% of the feed weight. Examples of such feed items are ricemeal, cornmeal, wheatmeal & oatmeal.

## Proteins

Proteins are complex aggregation of amino acids, which are utilized in body building and immune development. It is a major component and the most expensive part of fish feed. Most aquafeeds produced contain about 25 to 35% dietary protein for maintenance ration, and about 35 to 60% (or more) protein for complete diet. Protein requirements for herbivorous and omnivorous fishes are often lower than they are for carnivorous fishes, just as fish raised under intensive (high density) systems usually require more protein than those in low density systems. Fish fry are normally fed with the richest diets, while adult fish receives relatively low protein diets (table 2).

There are 10 essential amino acids required by fish for healthy growth — lysine, methionine, leucine, isoleucine, phenylalanine, arginine, threonine, tryptophan, histidine and valine, and these are normally included in fish premix. Some feed ingredients with high protein content ( 50 % CP) include fishmeal, bloodmeal, poultry by-product meal and meatmeal, while those of moderate protein content (20 – 49 % CP) include groundnut cake, full-fat soy, soybean cake, soybean meal, cottonseed cake and sunflower meal.

## Lipids

Lipids are good energy source and fat-soluble vitamins conveyance. They are easily digestible with less metabolic stress. Simple lipids include fatty acids and triacylglycerols. Generally, unsaturated, long chain fatty acids of the Omega 3 and 6 groups are important to fish. These essential fatty acids are available in fish meal / oil and most other aquatic products / by-products, but not in terrestrial plants or animal tissues. Linolenic acid is another unsaturated, essential fatty acid of vegetable oils, which is important for normal fish growth.

The lipid requirement of a fish is a function of its ecological base. Marine fishes require the long chain n-3 highly unsaturated fatty acids (HUFA) for optimal growth and health. Unlike marine fishes, most freshwater fishes can produce the n-3 HUFA, eicosapentaenoic acid (EPA:20:5n-3) and docosahexaenoic acid (DHA:22:6n-3) from linolenic acid. Fish species such as tilapia, require the n-6 fatty acids, while others such as carps and eels, require both n-3 and n-6 fatty acids.

These essential fatty acids are often added in the form of oils to or sprayed as a coating on finished feeds (usually 0.5 – 2% of dry diet). They are often added to the feed to increase the metabolizable energy to a desired level, and to provide the essential fatty acids required for healthy growth. However, a maximum feed content of less than 15% should be maintained. Feeds high in dietary lipid content often encourage feed rancidity, poor binding property and fat deposition in body organs such as the liver.

**Table 2:** Energy & Protein Content of Common Catfish Diets

| Age Group | Crude Protein (%) | M. E. (KCalkg$^{-1}$) |
|---|---|---|
| Fry | ≥ 50 (50 – 70) | 3,000 - 3,500 |
| Advanced Fry | ≥ 50 (50 – 60) | 3,000 - 3,500 |
| Fingerling | 45 – ~~40~~ 55 | 3,000 - 3,500 |
| Juvenile | 40 – 50 | 2,800 - 3,200 |
| Grower | 40 – 50 | 2,800 - 3,000 |
| Adult | 35 – 45 | 3,000 - 3,500 |

## Vitamins

Vitamins are essential for normal body function, growth and health. They are not synthesized, so are required to be included (in small quantities) as feed additives. There are 15 essential vitamins for most fish, which may be grouped into two water-soluble and fat-soluble vitamins.

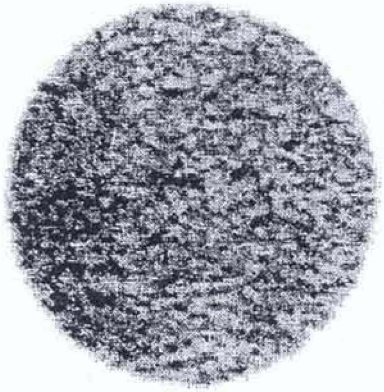
Water-soluble vitamins include thiamine, riboflavin, folic acid, niacin, pantothenic acid, pyridoxine, nicotinic acid, biotin, cyanocobalamin, inositol, choline and ascorbic acid (vitamin C), while vitamins A, D, E and K are fat-soluble vitamins. Of these vitamins, vitamins C and E seem to be the most important, being antioxidants. They (vitamins C & E) are important in stress management.

## Minerals

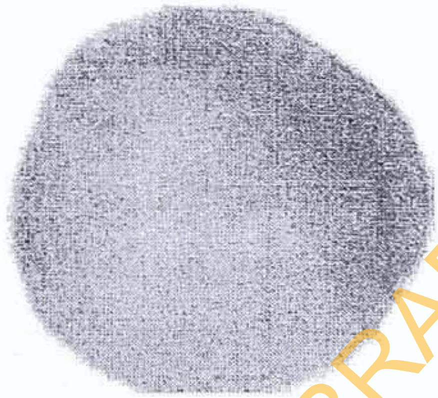
These are inorganic substances that are required for normal body function and osmotic balance. They influence each other's function, and are influenced by factors such as water parameters — temperature and acidity. Minerals may be grouped as macro-minerals that are required in relatively large quantities when compared to micro-minerals that are required in traces.

Examples of macro-minerals are calcium, sodium, potassium, phosphorus, and chloride, while magnesium, copper, zinc, selenium, iron, iodine, chromium, cobalt and manganese are regarded as micro-minerals or trace elements.

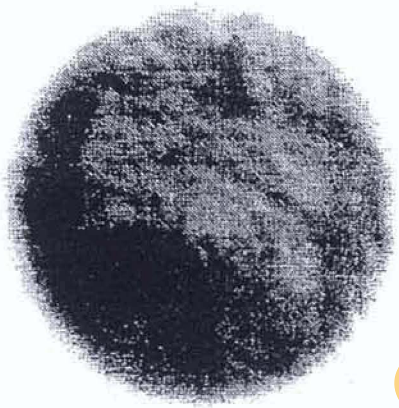
Pix 10: Some Feed Ingredients



Soyabean meal

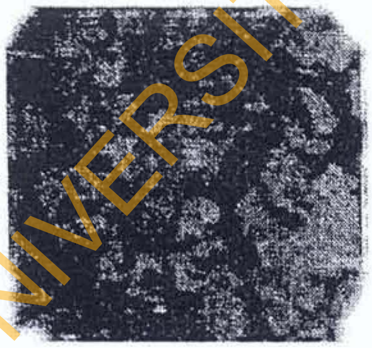


Powdery corn gluten meal

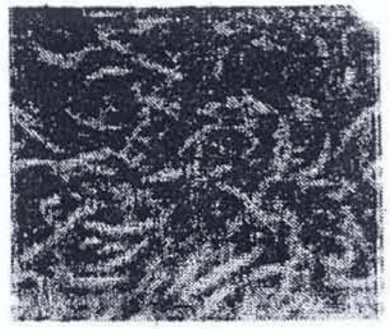


White Fishmeal

Cotton seed oil cake



Corn seed cake



Dried mealworm

## Formulating your Fish Diet

Fish concentrates may be formulated using both conventional and unconventional feed materials. Conventional feedstuffs such as corn meal, wheat meal, soybean meal, fish meal, di-calcium phosphate, salt and premixes are mostly used in concentrate formulation. However, the inclusion of cheap, processed unconventional feed items into fish concentrates will make the practice a more rewarding business and a means to waste management.

In formulating fish feeds, the nutrient values (crude protein, energy, fat / oil, fibre ... and mineral contents) of each feed item to be used should be known. The selected feedstuffs are then mixed according to the predetermined percentage of feed formulation. Various software programming and methods are available in determining the mixing ratio.

- **Computer Software (Linear Programming)**

This is an easy process to use in determining the proportion of mixture, once the basic operational mode is understood. It is timesaving, requires no calculation, and gives the least possible cost of concentrate formulation / production.

## Algebraic Method

### Harder Measuration

This may be employed to determine the unknown proportion of mixture of 3 feedstuffs that will solve for 3 feed variables (e.g. Crude Protein, Metabolizable Energy and Fat / Oil content).

In the absence of system software, this method may be preferred, although it involves a lengthy calculation and requires some skill.

## Quadratic Equation

It may be used in determining the proportion of mixture of 2 items that will solve for 2 feed variables (e.g. crude protein and metabolizable energy). The calculation involved is not as tedious as that of harder measuration and requires just some basic understanding of algebra.

## Pearson's Square

This method may be employed in determining the proportion of mixture of 2 feed items in such a way as to solve for 1 feed variable (e.g. crude protein). The limiting factor to the use of this method is in its solving for just 1 feed variable, since the protein and energy content of any feed is important, as other feed variables may be augmented with additives.

## Trial and Error Method

This is a crude way to determine the proportion of mixture of feed items.

To have an understanding of the calculations involved in feed formulation, three examples will be attempted using Pearson's square and quadratic equation, and an example using harder measuration. The concentrates will be formulated using both conventional and non-conventional feedstuffs of assumed feed values. Although 5 to 7 feed items (excluding vitamins/minerals supplements) are commonly combined by most commercial feed producers in aquafeed production, for proper understanding, 2 to 5 items will be work on in the examples that follow, starting with the easiest (2 feedsuffs).

## Assumptions

| Feedstuffs | CP (%) | ME (KCal $kg^{-1}$) |
|---|---|---|
| Corn meal (CM) | 10 | 3400 |
| Rice meal (RM) | 12 | 3200 |
| Biscuit waste (BW) | 14 | 3400 |
| Soybean meal (SM) | 44 | 2700 |
| Duckweed (DW) | 39 | 2450 |
| Hatchery egg meal (HEM) | 70 | 3500 |
| Insect meal (IM) | 70 | 2900 |
| Fish meal (FM) | 70 | 2800 |

*Please note that the figures quoted are mere hypothetical values*

## Question 1

A farmer wishes to formulate some quantity of feed for his 3 months old fish (growers). What proportion of the ingrĕdients has to be combined in order to produce a concentrate of 45% CP and 2900 kCal $kg^{-1}$ from rice meal and fish meal.

## Given Data

Concentrate, C = 45% CP and 2900kCal $kg^{-1}$

Feedstuffs = Rice waste meal (RM) and fish meal (FM)

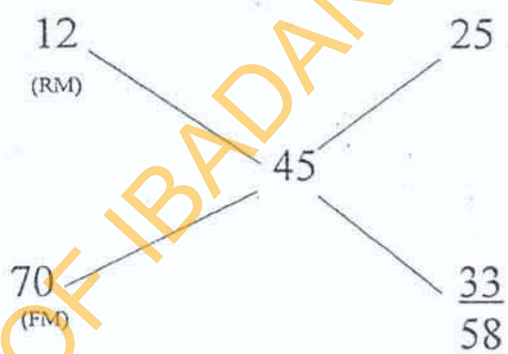
RM = 12%CP & 3200kCal $kg^{-1}$

FM = 70%CP & 2800kCal $kg^{-1}$

## Answers

### Pearson's Square

$CP_{RM}$ = 12%, $CP_{FM}$ = 70%, $Cp_c$ = 45%




%RM = $^{25}/_{58}$ x 100% (of feed)

RM = 43.10345% ≈ 43.1%

%FM = $^{33}/_{58}$ x 100% (of feed)

FM = 56.89655% ≈ 56.9%

So, For 100kg of feed, 43.1kg of RM and 56.9kg of FM are required.