# FISH FEED FORMULATION

## 1. Introduction

Feed formulation is the process by which the appropriate feed ingredients are selected and blended to produce a diet with the required quantities of essential nutrients. No single ingredient can be expected to meet all nutrient requirements of the cultured organisms. By selecting various ingredients in correct amounts, a compounded ration which is nutritionally balanced, pelletable, palatable and easy to store can be prepared. Supplying adequate nutrition for various aquaculture species involves the formulation of diets containing all essential nutrients and the proper management of diets containing all essential nutrients and the proper management of multitude factors relating to diet quality and intake. Therefore, lots of information is required for formulating an ideal diet. Proper nutrition increases the ability of cultured organisms to attain its potential growth, reproduction and survivability. In the formulation of the diet, Protein: Energy is the most important parameter and it is to be balanced for the preparation of a better quality feed that is economical and eco-friendly.

The terms that one needs to understand to formulate practical fish diets are crude protein level, energy level- either expressed as metabolizable energy (ME) or as digestible energy (DE), specific amino acid levels, crude fibre level and ash level. Nutritional requirements, composition of ingredients, digestibility, nutrient availability and additives are the major factors considered in feed formulation.

- Required quantity of oil cake should be soaked in double the quantity of water at least 20 – 24 hours prior to usage and the oily water from the surface of the mixture should be discarded.
- Rice bran and fish meal should be sieved properly.
- Broken rice should be boiled, if used.
- All the ingredients should be mixed thoroughly in a container
- Flour should be boiled in the required quantity of water to make it sticky (Oil Cake soaked in water) Ingredients should be mixed with this sticky batter to form a paste and finally small feed balls should be prepared.


OIL CAKE SOAKED IN WATER

## 8. Feed application

Normally most of the fish feeds during the day. For that reason, the daily ration should be divided into two portions. One portion should be applied in the morning at around 10 – 11 am and second portion in the afternoon at 3 – 4 pm. Feed should be provided to the fish in feed trays to avoid feed loss and to maintain good water quality. To feed carps, the feed trays should be placed 1 foot below the water surface. If feed tray is not possible for any reason, feed should be applied daily in a few particular locations in the pond.

### Simplified system of feeding strategy for the farmer

| Body weight of fish | Amount of feed | Feeding frequency |
|---|---|---|
| Upto – 50 gm | 3.0 gm | 3 times / day |
| 50 – 100 gm | 4.5 gm | 2-3 |
| 100 – 250 gm | 5.0 gm | 2 |
| 250 – 500 gm | 6.5 gm | 2 |
| 500 – 750 gm | 8.0 gm | 2 |
| 750 – 1000 gm | 10 gm | 2 |
| > 1000 gm | 12 gm | 2 |

## 9. Conclusion

The technical knowledge on the methodology for feed preparation needs some experience on mechanical aspects of feed manufacturing which is considered to be an art rather than science. Knowledge on both theoretical and practical aspects of feed formulation is a must for the production of an ideal feed.

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*November, 2015*

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## Example 2: More than two ingredients:

Using fish meal (C.P. 60%), GNOC (48%) De-oiled bran (C.P. 15%) and tapioca (C.P. 4%) a prawn diet with 32 % crude protein can be prepared as follows:
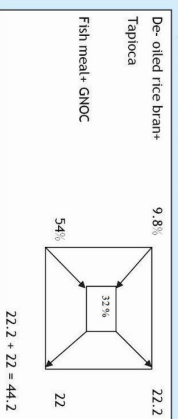
Group the ingredients with less than 20% crude protein and average their protein content,

De-oiled rice bran (15.6) + Tapioca (4) = 19.6%
Average = 9.8%

Group the ingredients with more than 20% crude protein and average their protein content.

Fish meal (60%) + GNOC (48%) = 108%
Average = 54%

Now the average protein contents are put on the two left corners of the square, and the rest is same.

Now add the figures on the right hand side corners of the square.

$$\text{Deoiled rice bran + Tapioca} = \left(\frac{22.2}{44.2}\right) \times 100 = 50.22\%$$

$$\text{Fish meal + GNOC} = \left(\frac{22}{44.2}\right) \times 100 = 49.77\%$$

De-oiled rice bran = 50.22/2 = 25.11%
Tapioca = 50.22/2 = 25.11%
Fish meal = 49.77/2 = 24.885%
GNOC = 49.77/2 = 24.885%

The composition of the feed is
De-oiled rice bran = 25.11%
Tapioca = 25.11%
Fish meal = 24.885%
GNOC = 24.885%
Total = 100.0

## 7. Feed preparation

Fish feed can easily be prepared using different ingredients. Fish farmers can also prepare feed by themselves. If possible feed should be prepared by using feed pelleting machine. The preparation techniques of mixed fish feed is described briefly here.

Fish meal (58% protein)

Rice bran (10% protein)

20 × 100 = 41.7
30%
28 × 100 = 58.3
Sum = 48

De-oiled rice bran+
Tapioca 9.8%
Fish meal+ GNOC 54%

32%
22.2
22.2 + 22 = 44.2
22

**2. Pre-requisite for fish feed formulation**

Attributes to be noted prior to the feed formulation of fishes are given below

i. Food and feeding habit of targeted fish species.
ii. Nutritional requirement of targeted fish at different life stages.
iii. Local availability of feed ingredients.
iv. Cost of locally available feed ingredients.
v. Chemical composition of feed ingredients.
vi. Digestibility of the nutrients in the targeted feed ingredients.
vii. Anti nutritional factors present in the ingredients.
viii. The processing or pre-treatment techniques for the removal of anti nutritional factors from these ingredients
ix. Inclusion level of feed ingredients.
x. Type of feed to be prepared (Type of processing of feed is needed).
xi. Information about the additives.
xii. Season and environmental conditions (temperature)
xiii. Pellet stability.

The above mentioned information should be critically considered before making pellets which may otherwise affect the quality and economics of the feed.

**3. Criteria for selection of feed**

The fish farmers in our country mainly use oil cake and rice bran as supplementary feed for fish. Other than these two, farmers use those types of feed materials that are not economically profitable and even a few ingredients are detrimental for pond ecosystem. The main objective of the application of supplementary feeding is generating higher weight gain in fishes. Therefore, while selecting feeds for aquaculture, the following important aspects should be considered.

- Easy availability of ingredients
- Financial ability of fish farmers
- Cost of ingredients
- Preferred feed for fish
- Nutrient demand of fish
- High feed conversion ratio

**4. Nutritional requirement of fish**

For having a healthy fish with rapid growth, a balanced diet is essential. However, among all the nutrients, protein is required in large quantity. For that reason, the nutrient demand of fish is generally known as protein demand. All other nutrients like carbohydrate, lipid and minerals are mostly present in the other ingredients that are used in the preparation of fish feed. Accordingly if protein demand is fulfilled, there is no much deficiency of other nutrients. The nutritional demand of fish depends on age and species. Studies have shown that the nutrient (protein) demand of carps is 35 – 40 %. Therefore, to obtain maximum yield, 35 – 40 % protein should be present in the supplied feed. However, fish receive only 5 – 15 % of total protein requirement from the natural feeds. Based on all the above mentioned facts, prepared feed with 25 – 30 % protein could be considered as a balanced feed.

**Nutritional requirements of cultivable carps**

| SI.No | Nutrients% | Fry and fingerlings | Juveniles and growers | Brood fish |
|---|---|---|---|---|
| 1 | Protein | 40-45 | 35-40 | 30-35 |
| 2 | Carbohydrate | 22-26 | 30-35 | 35-40 |
| 3 | Fats | 6.8 | 5 | 5 |
| 4 | Vitamins | 1 | 1 | 1 |
| 5 | Minerals | 1 | 1 | 1 |
| 6 | Digestible energy(Kcal/100gm) | 310 | 280 | 280 |

**5. Calculating nutritional composition of feeds**

The studies on commonly used fish feed ingredients available in our country shows that the ingredients contain high nutrient content. The nutrient analysis of some of the ingredients are given below

| Name of the ingredients | Nutrient content (%) | | |
|---|---|---|---|
| | Protein | Carbohydrate | Lipid |
| Rice bran | 12.6 | 37.5 | 11.3 |
| Wheat bran | 15.5 | 37 | 5.5 |
| Groundnut cake | 48 | 30 | 13.8 |
| Mustard oil cake | 30.33 | 34.38 | 13.44 |
| Coconut cake | 17 | 47 | 5.6 |
| Tapioca flour | 4 | 86 | 1.3 |
| Broken rice | 13 | 70 | 4.5 |
| Fish meal | 60 | 11.6 | 3.7 |
| Duck weed | 14.02 | 60.88 | 1.92 |

While calculating nutrient content of fish feed in general, protein is the only nutrient that is estimated. The nutrient content of feed prepared from more than one ingredient can easily be determined using general unitary method. The technique for calculating protein content in feed is shown below. Suppose, 1 kg of feed is to be prepared by using fish meal, groundnut oil cake (GNOC), rice bran and flour as binder. The ratio of the ingredients to be used are fish meal - 10%, GNOC – 40%, rice bran – 40%, flour – 7%, Vitamin and min premix 3%. Here the protein content of the feed prepared from these ingredients can be calculated as:

**6. Methods of feed formulation**

*Pearson's Square Method*

This method may be used in case of two or more feed ingredients and is preferable in a trial and error method. Examples of feed formulations with two and more ingredients are shown below.

*Example 1:- Two Ingredients.*

Find the proportions of rice bran and fish meal (Tilapia) required for making a feed containing 30% crude protein.

1. Draw a square.
2. Place the desired protein level at the center of the square. In this case, 30%.
3. Place the two ingredients on the two left corners of each square along with the protein content of each.
4. Calculate the difference in crude protein content of the two ingredients (58 and 10) and record this number (48) near the lower left corner of the square.
5. Subtract the desired protein level (30%) of the feed from the protein content of each ingredient. Ignore positive or negative signs. The difference between percentages of protein in rice bran and in the feed (20) represents the amount of fish meal needed. The difference between fish meal and the feed (28) represents the amount of rice bran needed.
6. Add the differences obtained at the right corners of the square (20 and 28) and record their sum (48) near the bottom right corner. The sum in the right corner should equal the difference in protein content recorded near the lower left corner of the square.
7. Divide the differences obtained in step 5, which were 20 and 28 by the sum obtained in step 6, which was 48 and then multiply each by 100 to obtain the percentage of each ingredient needed for the feed. Thus, 42 Kg of fish meal and 58 Kg of rice bran are combined to make 100 Kg of fish feed containing 30% crude protein. The feed can also be described as being composed of 42% fish meal and 58% rice bran.

| Ingredients | Protein content (%) | Dose used (%) | Required quantity (g) | Protein available in feed (%) |
|---|---|---|---|---|
| Fishmeal | 60 | 10 | 100 g | 6 |
| GNOC | 48 | 40 | 400 g | 19.2 |
| Rice bran | 12 | 40 | 400 g | 4.8 |
| Flour | 4.5 | 7 | 70 g | 0.315 |
| Vit & min premix | - | 3 | 30g | - |
| Total | | 100 | 1000 g | 30.315 |