Fish Feed Technology

PhD. student

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Diet formulation

Diet Formulation

Diet formulation is a complicated process, feed formulators select dietary ingredients establishing upper and lower limits for each, to create a mixture that is

1- pelletable,
2- palatable,
3- nutritious,
4- inexpensive,
5- easy to store, ship, and use.

Ingredients are chosen on the basis of

1- cost,
2- availability,
3- chemical composition,
4- nutritional value

The process of diet formulation involves a difficult choice between two approaches that can be represented on the spectrum of feed cost. At one end of the spectrum is the approach of basing the formulation solely on nutritional value, thereby producing a more expensive feed that is more productive. The other end of the spectrum is the approach of basing the formulation solely on the total feed cost and attempting to minimize that cost. The vast majority of feed formulations falls somewhere in the middle of the spectrum, but the type of feed being formulated will dictate which determinant, nutritional value or feed cost, is more important.

Diet Formulation

Larval or starter feeds are very important to the long-term health of fish and account for a very small proportion of the total feed cost to raise a fish for market or release. Thus, selecting a formulation based more on nutritional value than feed cost is warranted for starter or larval feeds. In contrast, grow-out feeds account for nearly 90% of the total feed used in a production cycle. Small differences in feed costs can have a profound effect on the cost of production and, thus, profit and loss of a fish farm. Obviously, feed formulations for grow-out feeds are developed with feed cost as an important determinant.

Feed formulation involves selecting a combination of ingredients which will produce a mixture containing levels of essential nutrients at or above the minimum requirements of the fish. To do this, one has to know the nutritional requirements of the fish and the available nutrient content of the ingredients. The gross nutrient content is determined by chemical analysis. Data on the nutrient content of all common fish feed ingredients are readily available in feed composition tables.

It is difficult to formulate a feed that contains the exact amount of each critical nutrient at the desired level. To prevent possible problems of this nature, feeds are usually formulated to contain slightly higher levels of protein, energy, and individual nutrients than actual required or recommended levels.

Diet Formulation

The availability of nutrients in feed ingredients is another aspect that must be considered in feed formulation. Incorporating information on nutrient availability into the feed formulation process is easy, but obtaining such information is a much more difficult process. Factors such as the procedures used to manufacture the ingredient and interactions with other dietary ingredients can reduce the availability of a nutrient to a fish, even though the results of chemical analysis show that adequate dietary levels are present. An example of a reduction in nutrient availability as a result of processing is the reduction that occurs when protein supplements are dried in the presence of reducing sugars. Amino acid analysis will detect a certain level of lysine, but the level of available lysine will be much lower. An example of a reduction in nutrient availability due to interaction with other dietary ingredients is that of zinc availability in fish fed diets containing high-ash meals, elevated levels of calcium and phosphorus, or elevated levels of calcium, phosphorus, and phytic acid .

Determining dietary availability involves feeding experimental diets to fish and measuring parameters such as digestibility, enzyme activity, and tissue nutrient saturation. It is essential that nutrient availability values are considered in the feed formulation process. For nutrients for which the availability can vary and for which no reliable availability values exist, levels significantly above the minimum requirements must be used.

Diet Formulation

One assumption commonly made in feed formulation is that a nutrient in one ingredient is interchangeable with the same nutrient in another ingredient. This assumption must be made to allow the feed formula to be manipulated by changing the levels of ingredients and by substituting ingredients as price and availability change. The assumption is not always justified or even recognized. For the most part, however, and despite the potential pitfalls in feed formulation arising from inadequate information on the nutrient availability in ingredients, fish feeds are formulated, manufactured, and used successfully to rear fish every day. Enough information is available to avoid the major problems, and, as mentioned, feeds are normally formuated to contain a slight excess of critical, limiting nutrients.

Practical Considerations in Diet Formulation and Manufacture

.1. Ingredient Limits

In all fish feed formulations, limits are placed on the levels of certain ingredients, irrespective of cost. These limits may be upper limits, lower limits, or fixed limits, meaning that the level of an ingredient is set at a fixed percentage. Upper limits are often placed on ingredients which may contain antinutritional factors or toxicants or on ingredients which affect the palatability or pelletability. Lower limits are placed on ingredients which are desirable in the formulation despite their cost. For example, fish meal may be an expensive source of protein in feed formulations, and replacing fish meal in the formulations with rendered animal proteins may reduce the feed costs. Nevertheless, a lower limit of fish meal is generally made in trout feed formulations to guarantee performance. Fixed levels in fish feed formulations are used for vitamin and trace element premixes and for carotenoid pigments and binders. In practical fish feed manufacture, feed mills sometimes have ingredients in inventory that they wish to remove because they need space or because the ingredient is getting old. This would call for a lower limit to be placed on the level of the ingredient to force it into the formulation, even though the ingredient might not be the least expensive or best choice at that level.

Practical Considerations in Diet Formulation and Manufacture

.2. Type of Diet

The type of feed particle being produced determines to a large extent the limits placed on the levels of many ingredients in a feeds formulation. Dry, compressed pellets, for example, must contain adequate levels of wheat by-products to allow the exterior surface of the pellet to gelatinize during pelleting. If pellets are to be crumbled and screened, additional considerations must be given during feed formulation to ensure pellet hardness In moist pellet or semimoist pellet formulations, the ingredients must be chosen with the water content of the pellet in mind. Ingredients that act as pellet binders, such as pregelatinized potato starch, must be included at levels that provide a sufficient binding capacity to produce a high-quality pellet. In formulations containing moisture levels higher than 30–35%, such as those containing liquefied fish products or ground fishery waste, additional binders must be used.

In extruded, dry pellet formulations, ingredients that can expand and thus produce low-density pellets must be included. Finally, in semipurified diets, highly refined ingredients must be used to produce diets suitable for experimental use.

- Try to keep rations simple. The rule of thumb is that simple nutrient needs can be met by simple feed formulae. Complex formulae do not necessarily guarantee better performance.
- Feed composition data may be given either on dry matter or on an as-fed basis depending on the publication from which the information is taken. Therefore, some recalculation may be required before ration formulation commences.
- Rations should be formulated on dry basis, especially if wet ingredients such as silage, molasses, etc. are included.
- Formulation can be done on the basis of daily needs (i.e. amounts of nutrients rather than concentration), although this is done rarely in practice. Use of percentage units is the simplest means as the final values can easily be converted to any weight unit.
- Every animal has physical and physiological limits beyond which the dry matter intake cannot go. The dry matter intake of animals fluctuates within these limits depending on several factors: species, body size and physiological state of the animal (e.g. pregnancy); and palatability, texture and bulkiness of the diet.
- Select the same units of measure for nutrient requirement and feed composition. For protein, either Crude Protein (CP) or Digestible Protein (DP); for energy, Total Digestible Nutrients (TDN), Metabolisable Energy (ME) or Net Energy (NE). The important thing is that the units of measure of requirement and feed composition of the nutrient to be supplied have to be in the same units to balance a ration.

Practical Considerations in Diet Formulation and Manufacture

.3. Pellet Stability

In practical fish farming, pellet hardness and the absence of fines are qualities that are highly valued. Any fish farmer who has tossed a scoop of feed into the wind and gotten a faceful of dust understands this and will base his next feed purchase on this experience. Fish feed manufacturers usually screen pellets to remove fines before the pellets are sacked, but pellet disintegration can occur in bagged feeds during shipping and handling at the hatchery or fish farm. Pellet durability can be improved by including certain ingredients in the formulation, such as blood meal in compressed pellet formulations, that might not otherwise be included if least-cost formulation procedures are followed.

Pellets produced for slow-eating fish and crustacea must remain in water for hours without disintegrating. This requires special formulations and/or manufacturing processes. In eel diets, for example, pregelatinized potato starch is included in the formulation to enhance the water stability of the dough-like feed. Pregelatinized potato starch would not be included in these diets based on price and nutrient content alone.

Fish Feeds Formulation Calculator

Target Percentage Crude Protein

%CP | Crude Protein (10-44)

Total Feeds Quantity in KG

KG | Feeds Quantity

Ingredient 1:

1 | Select Ingredient

Ingredient 2:

2 | Select Ingredient

Ingredient 3:

3 | Select Ingredient 1 first

Ingredient 4:

4 | Select Ingredient 2 first

✔ Calculate

NOTE: The above Fish Feed Formulation Calculator is based on the Pearson's Square Method.