

Introduction to Nutrition in Tropical Aquaculture

OSENI M. MILLAMENA

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Introduction

Fish is a vital component of food security especially in developing countries of the world. As the world population grows, the need for more food and more fish has correspondingly increased. Aquaculture, the farming and husbandry of fish and other aquatic organisms, is now a well-established industry worldwide and is the fastest growing food production sector. However, as aquaculture operations expand, the risk to the environment grows.

Fish nutrition and feeding play important roles in the sustainable development of aquaculture. The efficient conversion of feed to fish is important to fish farmers because feed is the largest component of the total cost of production. Improved feed composition and better feed efficiency will result in higher fish production, lower feed cost, and low waste production hence, decreased nutrient load from fish farming.

Feeds in Aquaculture

Aquatic animals, like any other living organisms, need essential nutrients or substances for growth, tissue repair and maintenance, regulation of body functions, and to maintain health. As fish culture becomes more intensive, it also becomes less dependent on natural food and more on prepared feeds. A nutritionally-balanced feed and adequate feeding are important factors that help maximize fish production and profitability. Inappropriate feeds could result in disease outbreaks, poor growth, and high mortality of fishes in the farm. Good quality feed coupled with appropriate feeding management has been shown to result in improved feed conversion efficiency, lower costs of production, and reduced levels of environmental degradation.

An effective feeding program should consider the basic principles of fish nutrition and feeding. This requires an understanding of the nutrient requirements of cultured



Figure 1.1

Fish nutrition, feeds, and feeding management play important roles in increasing the productivity of aquaculture farms.

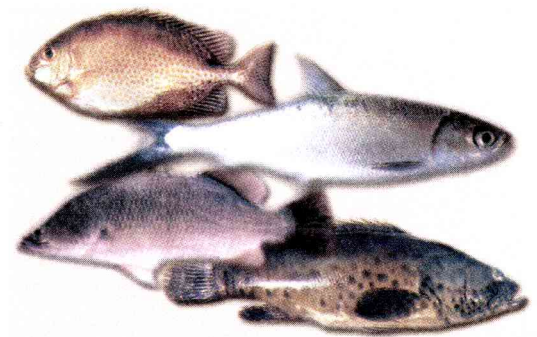


Figure 1.2

A nutritionally-balanced feed and adequate feeding are important factors that maximize fish production and profitability.

species, their feeding habits and behavior, and the ability of fish to digest and utilize essential nutrients.

Aquafeeds must satisfy the nutrient requirements of the cultured species in terms of protein and essential amino acids, lipid and essential fatty acids, energy, vitamins, and minerals. The quality of the feed will ultimately depend on the level of available nutrients for fish. Because fish eat to satisfy their energy requirement, the energy value of the feed will affect its efficiency.

The nutrient requirements should be known for a specific fish species intended for culture. For example, the protein requirements of an omnivore like milkfish and a herbivore like tilapia are generally lower than those of carnivores like grouper, sea bass, and snapper. Fish species also differ in their requirements for essential amino acids. Milkfish requires *n*-3 fatty acids while Asian sea bass and tiger shrimp need both *n*-3 and *n*-6 fatty acids. In contrast, tilapia requires *n*-6 fatty acids. Thus, feed formulations should be based on the requirement and levels of essential nutrients that are optimal for the cultured species.

In feed development, there should be a continuous investigation on methods to improve the quality of raw materials, reduce feed cost, and improve feeding management in the farm. The nutrients in feeds have to be efficiently utilized by the fish. There are numerous new products in the market such as feed attractants, binders, and growth promoters. However, new feed additives are constantly being introduced without proper evaluation of their efficiency, thus caution must be exercised in using them in aquafeeds. Feed manufacturing should ensure that the nutrient composition is maintained and anti-nutrient factors are eliminated. Feed quality control must start from ingredient selection and continue through feed processing, storage, and use in fish farms.

A good quality and nutritionally-adequate feed can be ineffective unless proper feeding practices are used. Emphasis must also be given to good feeding management and improved feed performance. An effective feeding management requires answers to questions of what, how much, when, how often, and where, to feed the fish. The feeding regime used should match the feeding behavior and digestive cycle of the fish in order to maximize feed utilization. Any reduction in food wastage will have a significant impact on fish production costs and the quality of the culture environment.

Feeds and the Environment

The rapid development of aquaculture from extensive to intensive systems has posed some problems about its sustainability. Aquafeeds provide nutrients for fish, but can be major sources of pollutants in aquaculture production systems. Nitrogen, phosphorus, organic substances, and hydrogen sulfide are the main factors affecting environmental pollution of fish farms. As fish stocking density is increased, a proportionate amount of metabolic wastes is produced. Wastes that accumulate in the pond can slow down fish growth and are toxic to fish.



Figure 1.3

Production of high quality feeds starts with good quality ingredients and proper quality control throughout processing until use in fish farms.

Fish farm wastes consist of: a) solid matter, mainly a mixture of uneaten food, feces, and colonising bacteria; b) dissolved matter, such as ammonia, urea, carbon dioxide, phosphorus and hydrogen sulfides. The wastes include amino acids, proteins, fats, carbohydrates, fiber, minerals and bacteria (Boyd 1989). Since the amount of waste increases with poor feed conversion, the less efficient fish and shrimp producers are at greatest risk. The amount of feed should be adjusted to minimize unconsumed feed and prevent pollution of the pond, the surrounding areas, and the coastal zone. Poor feeding management can bring diseases, slow growth, low survival, environmental degradation, poor harvest, and large financial losses.

Aquafeeds have to be environment-friendly. Feed development should take into account new knowledge regarding nutrient requirements and digestibility, improved techniques to make more water stable feeds and greater utilization of alternative sources of protein. The major considerations in formulation of feeds for sustainable aquaculture are:

- ❑ Feeds should have a well-balanced nutrient profile; i.e., more precise amino acid profile, increased energy and balanced protein to energy ratio, so that more nitrogen will be assimilated and less nitrogenous wastes will be excreted by fish;
- ❑ Total phosphorus levels in feeds should be based on the requirement of cultured species and feed ingredients with highly available forms of phosphorus should be used. Phosphorus discharge in pond effluent is influenced by the level and bioavailability of phosphorus in the feed. A better understanding of factors involved in the partitioning of phosphorus in the various fractions of the pond effluent will result in better pond management;
- ❑ Digestible feed ingredients should be used to reduce organic wastes from feeds. Greater assimilation of feed nutrients by fish improves feed efficiency and reduces aquaculture wastes;
- ❑ Pellet water stability should be improved by using efficient diet binders and proper techniques for pelleting feeds. Uneaten feeds collect at the bottom of the pond and contribute to rapid water quality degradation;
- ❑ Greater use of alternative protein sources for fish meal in aquafeeds should be encouraged through continuous and improved research;
- ❑ Exotic feed ingredients which may contain unknown growth inhibitors should be avoided unless methods are available to minimize or eliminate these factors in the finished feed.

Sustainable Approaches to Aquaculture

In making aquaculture sustainable for future generations, the key issues relating to feed development and feeding are:

1. the need to reduce feed cost.

Feed is the most costly single item in fish farming and the availability of a cost-effective feed remains as the bottleneck to aquaculture development. Feed formulas should be refined and feeds made cheaper. Readily available rather than expensive imported ingredients should

be used as feed ingredients. These alternative raw materials may differ from one country to another and their availability may be localized. Thus, feed surveys should be conducted to know the location of these resources and their availability, nutrient composition, and cost. Such an approach is necessary to maximize their utilization and reduce the reliance on imported feed ingredients.

2. the search for alternatives to fish meal and fish biomass for aquaculture.

Traditionally, fish meal has been the major component of fish feeds. Increased global aquaculture production and a reduction in fish meal production increases the need for alternative protein sources. Fish meal has become more expensive and scarce due to increased demand and stiff competition with other food production sectors. Increasing demand for fishery products due to a rapidly growing population, especially from Asian countries, will further decrease the availability of fish meal. Fish should be used to feed people rather than be converted into fish meal or be used to feed carnivorous fish.

Agricultural by-products, such as vegetable and animal meals, have been utilized to produce cheap and cost-effective diets for several aquaculture species. Some of these promising ingredients include high protein, low ash meat meals, poultry offal meals, and legumes such as beans and peas, modified wheat gluten products, oilseeds, and other grains. Biotechnology may also be used to produce novel ingredients with the desired nutritional characteristics.

3. the greater use of supplementary feeds and supplemental feeding systems.

Commercial aquafeeds are usually expensive because they contain nutrients in excess of what the fish needs. They are also formulated as complete diets irrespective of the intended fish stocking density and presence of natural food in the pond. Supplementary feeding practice is partly dependent on natural productivity to supply some nutrients. Feed is only used to supplement the endogenous food supply. Thus, the importance of natural productivity in the overall nutrition of pond-raised fishes should be given emphasis. Since feed is used only as a supplement to natural food, this feeding system is more cost-efficient if the pond ecosystem is well understood. Maximizing the use of natural food organisms will reduce the cost of fish production.

4. integration of feed development and feeding management practices with environmental awareness.

Uneaten feed and metabolic wastes of fish are major sources of pollutants from aquaculture production systems. There is a need to develop feeds that are environment-friendly. The nutrient composition, nutrient balance, digestibility, and water stability of fish feeds have a significant impact on water quality. Improved diets with better feed efficiencies and use of ecologically-sound feeding management will lead to significant reduction of wastes from aquaculture.



Figure 1.4

A good quality feed and appropriate feeding management maximize feed efficiency, lower cost of production, and reduce environmental degradation.

Summary

Fish nutrition, feeds, and feeding management are critical factors in the sustainable development of aquaculture. The choice of a suitable feed is an important task of an aquaculturist. A feeding strategy that utilizes cost-efficient, low fish meal, and low pollution aquafeeds in a supplemental feeding system will help ensure the long-term sustainability of aquaculture. It is also the responsibility of the aquaculturist to implement sound feeding strategies to increase fish production, profitability, and prevent the degradation of the culture environment.

Suggested Readings

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