

Fish Feed Technology

PhD. student

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3- Feed Categories 6

Wheat mill run is described as wheat, *Triticum aestivum*, flour by-product, less than 9.5% fiber, International Feed Number 4-05-205. The last five numbers in the International Feed Number are assigned to each ingredient name, the first number being a code for the feed class. Over **18,000** feed ingredients have been assigned numbers using this system

Classes of Feed Ingredients

1. Dry forages and roughages
 2. Pasture, range plants, and forages fed green
 3. Silages (ensiled forages only)
 4. Energy feeds
 - Less than 20% protein (dry basis)
 - Less than 18% crude fiber (dry basis)
 5. Protein supplements: more than 20% protein (dry basis)
 6. Mineral supplements
 7. Vitamin supplements
 8. Additives: antibiotics, coloring materials, flavors, hormones, and medications
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Aims and Strategy of Fish Feed Production

Protein Supplements

As indicated protein supplements are feed ingredients having a **protein content above 20%**, on an **as-fed** or wet weight basis. There are three general groups. The **first** group is made up of ingredients having a protein content of **20–30%** which contain materials of **plant origin** that are by-products of the brewing and distilling industries, wheat germ meal and corn gluten feed. The **second** group is composed of ingredients having a protein content of **30–50%** and includes the **oilseed meals, crab meal, and dried milk** products. The **third** group contains ingredients of **over 50%** protein and includes **fish meals, blood meal, feather meal, meat and bone meal, yeast products, shrimp meal, poultry by-product meal, soy protein concentrate, wheat gluten, corn gluten meal, and casein.**

Quality Standards for Fish Meal Required for Salmonid Diets^a

Component	Level
Crude protein (N × 6.25)	>68%
Lipid	<10%
Ash	<13%
Salt (NaCl)	<3%
Moisture	<10%
Ammonia–nitrogen	<0.2%
Antioxidant	<200 μg/g

Quality Standards for Fish Oil Required for Salmonid Diets^a

Component	Level
Iodine value	Report value
Peroxide value	<5 mEq/kg
Pesticides (total)	<0.4 μg/g
Nitrogen	<1.0%
Moisture	<1.0%
Antioxidant	<500 μg/g

Feed Categories

Feed formulation is a balance between nutrient levels or ingredient sources and cost. In some cases this involves setting nutrient levels above the estimated requirements of the fish and using highly palatable ingredients, which may be more expensive than equivalent ingredients but are necessary in the diet to stimulate feed intake and support high growth.

First-feeding fish benefit from being fed diets with higher nutrient levels and/or palatability enhancers such as liver meal than fish in the grow-out, post juvenile stage of production. Fish generally dislike the flavor of medicated feed.

In feed formulation, it is important to first determine the function of a feed, such as supporting maximum growth, feed intake, feed efficiency, or reproductive performance.

Once the function or use of the feed has been defined, the type of feed, its formulation, and the appropriate manufacturing technique can be determined.

1. First Feed for Fry and Larvae

Many terms have been used to describe the first feed that is offered to young fish. The terms “**starter feeds**” and “**larval feeds**” are sometimes used.

Starter feeds are larger than larval feeds, typically larger than 400 μm in diameter compared to larval feeds, which are less than 400 μm . Larval feeds are developed for species of fish which, at first feeding, may not be aggressive feeders and, also, may not possess fully developed digestive systems. Starter feeds are intended for species of fish which are aggressive feeders and do have fully functional digestive tracts at first feeding, e.g., salmon or trout fry. The manufacture of larval feeds is more involved than that of starter feeds, and the techniques used are more sophisticated.

Good growth and survival of catfish, salmon, trout, and tilapia fry can be obtained by feeding starter feeds. In contrast, performance advantages are seen when sea bass, sea bream, walleye, and striped bass fry are fed larval feeds.

Although larval feeds are more expensive than starter feeds, they are more than worth the extra cost for first feeding of many fish species.

Although larval feeds and starter feeds have somewhat different applications , they do have several characteristics in common. First-feeding fry and larvae have nearly used up their yolk material when the search for exogenous feed begins. At this developmental stage, fry and larvae have virtually no nutrient reserves. Thus, it is critical that they consume the feed or they will rapidly starve to death.

Feeds must possess several characteristics for optimum fish performance. The most important of these are as follows: (1) the feed must be readily consumed by the fish; (2) the feed must be highly digestible to accommodate a developing, and often not fully functional, digestive tract; and (3) the feed must be highly water-stable to maintain water quality and, thereby, limit bacterial contamination of the culture system. Both the feed formulation and the feed manufacturing method determine the critical characteristics of feed particles.

The feed formulation affects consumption by influencing the color, texture, taste, and smell of the feed. Manufacturing affects consumption by influencing the feed particle size, shape, texture, density, and buoyancy. A high-quality feed results from feed formulation and manufacturing methods working in harmony to optimize fish performance. Poor fish performance results when the interaction of formulation and manufacturing is not optimized.

For example, expensive, highly palatable ingredients are useless in a diet if the method of feed manufacturing results in a feed texture that is unacceptable to larvae and thus reduces feed consumption.

During this phase of production the most important consideration is maximum survival and fish health. The cost of the starter or larval feed should not be a factor that determines the feed ingredient selection, formulation, and particle manufacturing method. Only a small quantity of larval feed is used relative to the total quantity of feed used during the production cycle, making economic outcomes dependent on the successful production of healthy fry, not on the cost of the feed.

Once fry or larvae are actively feeding and reach a weight of 0.50–0.75 g, they can be switched from a starter feed to a fry feed. Dry fry feeds have traditionally been produced by crumbled compressed particles and screening the particles to appropriate sizes. New processing techniques and modifications of older methods now permit the production of small particles and pellets without crumbling. These small particles have several advantages over crumbles, which are covered in Section 9.5, below. Fry feeds for most species are formulated to contain relatively high levels of protein, since nearly all species of fish require high levels of dietary protein as fry, regardless of their protein requirements at later life history stages. At the fry stage, the greatest relative gains in growth can be made for the least total feed investment.

In other words, a 25% increase in weight gain between groups of fry fed different diet formulations may be a small difference in actual weight, but the 25% advantage will persist between the groups up to harvest, all other things being equal. Thus, the gains obtained with fry will increase later production. Fry feeds should be formulated and used with this in mind. Cost savings at the expense of nutritional quality in fry feed is false economy due to advantages gained in growth rate and to the fact that fry feed is a very small percentage of the total feed consumed during a fish production cycle and, like starter feed, not a major element of feed cost per weight of fish harvested.

The formulations and processing methods used for conversion feeds and transition feeds are slightly different from those used to produce larval feeds. Conversion and transition feeds are larger than larval feeds but utilize similar formulations and manufacturing technologies. Conversion and transition feeds are fed to fish that have been transferred to a hatchery after first being reared in ponds or tanks, where they consumed live, natural foods. The term conversion is usually applied to feed offered when fish are “converting” from live food to formulated feed. Fish fed conversion feeds after hatchery transfer exhibit higher survival and initial growth rates than those fed grower feeds. A key factor in this difference is the fact that conversion feeds are formulated to be highly palatability, a characteristic that enhances feed acceptance by fish when they are first given formulated feed. Although conversion feeds enhance fish performance, they cannot perform miracles. It is critical that the fish coming from a pond are in good condition. If the fish are in poor condition as a result of food scarcity in a pond, survival will be low no matter what feed is offered after transfer to the hatchery.

Transition feeds are fed when fish have been fed highly palatable starter feed, but are ready to move to a lower palatability fingerling or grower feed. Transition feeds are intermediate in many characteristics and ease the “transition” period. This feed type is most useful for undomesticated species of fish, such as those being cultured for reintroduction by conservation hatcheries, or for new species that are being reared for aquaculture production.

While conversion and transition feeds have different applications, their formulation and manufacture are similar. In fact, the primary considerations in selection of a conversion/transition feed are similar to those for larval feeds: (1) a high palatability, (2) a low contribution of the feed to water pollution (water stability), and (3) a high energy content to compensate for interrupted feeding. Since conversion and transition feeds are fed to a larger fish than are larval feeds, ingredient selection can be less restrictive. Conversion feeds may contain ingredients with relatively low digestibility coefficients due to the mature stage of development of the gastrointestinal tract in fingerling fish and the shorter period of feeding these feeds. Palatability, however, should not be compromised.