

Fish Feeds and Nutrition Primer

John Tullock

“Most fish farmers use complete diets, typically made up of the following components and percentage ranges: protein, 18-50 percent; lipids, 10-25 percent; carbohydrate, 15-20 percent; ash, <8.5 percent; phosphorus, <1.5 percent; water, <10 percent; and trace amounts of vitamins and minerals.”—Craig et al, 2017.

Introduction

The nutritional requirements of fish have been intensively studied only in species of importance to aquaculture, with the goal of creating nutritionally complete, efficient, cost-effective feeds. When the findings of aquaculture research are applied to formulation of feed for marine aquarium fish, they may or may not be applicable. Approximately 200 species of marine fish are collected for aquariums. Many species feed on a relatively narrow range of natural prey, regardless of their ability to adapt successfully to artificial feed. Intense competition in the coral reef environment favors dietary specialization. Further, characteristics of the physical environment, water temperature, water quality, and the age and genetics of individual fish all influence dietary requirements. Given the range of species potentially available to marine aquarium enthusiasts, the varying degree of faithfulness to the natural environment across different aquarium habitats, and the largely unknown effects of interspecies interactions in confined spaces on the feeding behavior of individuals, it is impossible to specify a feeding regimen or an individual feed product that can be relied upon to satisfy all the nutritional requirements of any given collection of aquarium fish. The best advice to hobbyists remains, “Feed as wide a variety of foods, including dried, frozen, fresh and live foods, as your fish will accept, consistent with other aspects of proper marine aquarium maintenance.”



With that stipulation in mind, it is nevertheless possible to identify some aspects of fish nutrition that appear to be common across multiple species.

Protein to carbohydrate ratio

Fish feeds must contain a higher percentage of protein, relative to carbohydrate content, than terrestrial animal feeds. This is due to the lower energy needs of fish, which in turn results from their aquatic lifestyle, cold-bloodedness, and excretion of nitrogenous waste as ammonia. Research also demonstrates that fish are susceptible to hyperglycemia when fed excessive carbohydrates. Protein requirements are typically higher for:

- Marine fish
- Carnivores
- Smaller fish species or juveniles
- Fish living in high-density, recirculating systems

Thus, marine fish being maintained in aquariums need a diet high in protein. The recommendation, based on aquaculture research, is that fish feeds contain 45% protein. Aquarium maintenance routines must take into account that up to 65% of protein added as food is excreted to the environment, 90% in the form of ammonia and 10% as solid waste.

Essential amino acids

All animals require certain amino acids that they are unable to manufacture physiologically. These are: arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. All fish feeds must supply these amino acids. Most accomplish this by combining different types of proteins, in addition to supplementation with purified amino acids. Lysine and methionine are the amino acids characteristically in low concentration in feed components, often requiring supplementation.



Lipids and fatty acids

Marine fish require highly unsaturated (>4 double carbon bonds) omega-3 fatty acids in the range of 0.5 to 2 percent of the dry weight of the food for optimal health. Algal oils and marine fish meal are excellent sources (up to 30% by weight) of the eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) required by marine fish. Note: freshwater fish do not require the same fatty acids.

Carbohydrates

Starches and sugars are cheap components of fish feed, compared to the other ingredients. Besides contributing to the energy needs of the fish, carbohydrates aid in the manufacturing process as binding agents. Heat applied during manufacture makes these components more digestible for fish. Nevertheless, fish are less than half as efficient as mammals at extracting energy carbohydrates. Feeds should contain a maximum of 20 percent carbohydrates by weight.

Vitamins

Water soluble vitamins include the B vitamins and vitamin C, along with several others. Vitamin C is considered among the most important, owing to its antioxidant properties and its role in maintaining the immune system of fish. Among the fat soluble vitamins (A, D, E, and K), vitamin E is important due to its strong antioxidant properties. Both vitamins C and E also help to preserve the lipid content of dry fish feeds, and thus increase the products' shelf life. While specific symptoms result from deficiency of individual vitamins, fish feeds are formulated with multiple vitamins to ensure normal growth.



CSPro Ingredients

- salmon fish meal-provides protein, essential amino acids, and lipids
- gluten flour-also known as "vital wheat gluten," provides protein and essential amino acids
- soy flour-provides protein and essential amino acids
- brewer's yeast-supplies protein, essential amino acids, and vitamins
- cornstarch-provides carbohydrates, aids in feed manufacture
- dried spirulina algae-supplies protein, essential amino acids, fatty acids and carbohydrate
- freeze dried plankton-provides protein, essential amino acids, and fatty acids
- freeze dried krill--provides protein, essential amino acids, and fatty acids
- dried kelp-supplies protein, essential amino acids, fatty acids and carbohydrate
- freeze dried Calanus-supplies protein, essential amino acids, and fatty acids
- fish oil-supplies fatty acids
- lecithin-interactive role in the absorption of cholesterol by the gut, thus enhancing growth
- garlic powder-boosts immunity and encourages feeding response
- earthworm powder-provides protein, essential amino acids, and vitamins
- vitamin A-fat soluble vitamin essential for fish health and disease resistance
- vitamin D-3-fat soluble vitamin essential for fish health

- biotin-water soluble vitamin essential for fish health
- methionine-an essential amino acid in limited supply from other feed components
- double-stabilized vitamin C-water soluble vitamin that boosts fish immune response; also protects lipid feed components from oxidation, thus increasing shelf life; stabilization with glutathione prolongs storage time with full activity

Nutritional Analysis of CPro Flake

- Min. Crude Protein 45%-maximum protein content for optimal marine fish health
- Min. Crude Fat 4%-recommended fat content for marine fish feed
- Min. Crude Fiber 3%-means product is 97% digestible components
- Max. Moisture 8%-low moisture content ensures long shelf life and nutrition/weight value for consumer

References

Craig, Steven, Louis Helfrich, David D.Kuhn and Michael H. Schwartz. (2017) Understanding Fish Nutrition, Feeds, and Feeding. Virginia Cooperative Extension Publication 420-256

Wilson, Robert P. (1986) Protein and Amino Acid Requirements of Fishes. Ann. Rev. Nutr. 1986. 6:225-244