

Aquatic Animal Nutrition for the Exotic Animal Practitioner



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KEYWORDS

- Fish nutrition • Fish medicine • Aquatic animal diets • Koi nutrition
- Tropical fish nutrition • Aquarium nutrition

KEY POINTS

- Fish have higher protein requirements and lower carbohydrate requirements than most other exotic animals.
- There are essential amino acids and vitamin requirements that must be addressed by diet.
- Omega-3 fatty acids are required by aquatic species.
- Essential amino acids and omega-3 fatty acids are best provided by fish meal protein in the diet.
- Most minerals can be obtained from the water.
- Fish have lower basal energy requirements than land animals because of their ability to excrete ammonia without first forming uric acid or urea.
- Nutritional needs are variable for many species depending on temperature, season, age, day length, and other external cues.
- In addition to the proper food, behavioral needs must be addressed for proper nutrition.
- Improper nutrition leads to health problems similar to many other species.

NUTRIENT REQUIREMENTS FOR FOOD SELECTION

Proteins

Proteins in fish, just like other animals, are the building blocks of the body. They are used to form muscle, skin, and other tissues. They are essential for immune function, catalyzing reactions, and replicating DNA. They are also used for energy. In fish, proteins are more important than carbohydrates as an energy source. Part of the reason is

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that fish have lower energy requirements than mammals.¹ There are also significant differences in carbohydrate metabolism in fish that are discussed further later.

As a percentage basis in the diet, there is some dispute in the research. The percentage based on studies varies from 25% to 55% of the diet.¹⁻⁶ The low end of this range is based on the need to use the minimal protein amount in production fish in order to save money. The best consensus is a range of 35% to 45% for herbivorous and omnivorous fish, and 40% to 55% for carnivorous fish.²⁻⁴ These percentages are general guidelines and depend on many other factors. The percentage of proteins needs to be balanced as a percentage of the total dietary energy because fish eat only enough to meet dietary energy requirements. Proteins in excess of this need could lead to deficiency in one or more of the other nutrients.^{3,4}

The quality of protein is as important, or more important, than the amount. The protein must be bioavailable and provide all essential amino acids. Essential amino acids are those that are unable to be produced by the organism from other constituents.

Research on several different species of fish has identified the same 10 essential amino acids, which are similar to those for many other species of animals.^{1,2,4,6-9} Among the essential amino acids, arginine seems to be one of the most important to consider in supplementation (**Box 1**). Fish seem to have a greater need for arginine than do mammals.^{1,2,8} In mammals, the urea cycle can act as a source for arginine, but fish lack this ability.² As a percentage of the total protein in the diet, the essential amino acids should compose 50% to 60%.^{2,5,7} This amount helps prevent deficiency in amino acids when fish eat to their total energy requirements.

The best source of protein is animal protein. Fish meal provides the best choice for the source of essential amino acids and digestibility of proteins.^{3,6,7,10} If greater than 50% of the protein is plant protein there can be decreased complement activity in the immune system.⁶ Sometimes availability and cost require that a mixture of fish protein and other protein sources be used. Alternative protein sources should first be other animal proteins. If vegetable proteins are used, soybean meal is the best source.^{1,2}

Fat

Fats in the diet provide a valuable energy source. Fats are also deposited in the body to provide thermal insulation from the surrounding environment of an organism. In fish,

Box 1

Essential amino acids in aquatic animals

1. Arginine
2. Histidine
3. Isoleucine
4. Leucine
5. Lysine
6. Methionine
7. Phenylalanine
8. Threonine
9. Tryptophan
10. Valine

Data from Refs. 1,2,4,9

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