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Fish Nutrition and Related Problems

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Fish are a popular addition to many households. Even though most practitioners might not accept a fish as a patient, many clients expect veterinarians to be knowledgeable regarding basic fish husbandry and nutrition questions. Often, the owners of canine or feline patients ask questions directly relating to fish in the home environment. Fish owners expect veterinarians to know a little about fish or to at least be able to direct them to someone who does.

In general, the most common environments for pet fish are the home aquarium and the outdoor fishpond. These environments are very different in every respect, including how and what the fish are fed. This article focuses primarily on nutrition for fish kept in a home aquarium.

Basic Nutritional Requirements

Protein

Protein is arguably the most important component in fish food. Fish can efficiently convert food protein into body tissue (e.g., 1.6 kg of food can produce 1 kg of fish); therefore, the quality of the protein is a limiting factor for producing and maintaining healthy fish. In the wild, fish consume food that can consist of 50% protein; however, in a home aquarium setting, a feed containing 35% to 45% protein is adequate. Younger fish usually require more protein than their older counterparts. The protein content of fishpond food is usually <20% to 35% crude protein. Fish maintained in a pond setting forage most of the day on natural foods.

Protein is probably the most expensive ingredient for fish food manufacturers; therefore, it is worth confirming the guaranteed analysis of any nutritional offering for the percentage and origin of the protein it contains. While herbivorous fish can survive on a lower-quality (plant-derived) protein source, carnivorous fish need a high-quality, animal-derived protein source.

Energy

The energy content of fish food must have a strong correlation to the protein content. Fish eat until their energy requirements are met. If the energy content of a diet is too high in relation to the protein content, the fish will not meet their protein requirements, and overt clinical signs of disease will follow. A well-designed fish food provides appropriate protein and energy levels without causing or contributing to obesity.

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The energy contained in food can be supplied in different forms. Energy supplementation is usually provided as fats and/or carbohydrates. Simple carbohydrates (sugars) are much more digestible than more complex carbohydrates (e.g., starch) and fats. Usually, fish food contains 5% to 8% crude fat; however, fat is very difficult to digest, especially for herbivorous fish species or fish held at low water temperatures (e.g., koi pond fish in springtime). Carnivorous fish digest fats with relative ease, but they have a special need for polyunsaturated fatty acids (PUFA), which should be provided by the main food source. To avoid oxidation of vulnerable fatty acids, fish food must contain supplemental antioxidants. Without the protection of different antioxidants (e.g., vitamin E, ethoxyquin), fats will quickly turn rancid, producing toxic components that cause serious disease conditions when consumed.

Vitamins

Vitamin requirements vary significantly between fish species. Even within the same species, vitamin requirements vary depending on the physiologic state of the individual and, most importantly, the environmental conditions to which the fish is exposed.

Currently, the data on requirements for certain vitamins originate from research on species of economic importance (e.g., salmonids). Specific vitamin requirements for most tropical fish have not been scientifically established at this time.

Health Problems Related to Nutrition

Investigation and Diagnosis

The lack of established specific nutritional requirements for many fish species should not limit the ability to diagnose a disease related to malnutrition. As with other animal species, the clinical

Additional Readings

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evaluation of the patient should be based on the presenting clinical signs and physical changes. If possible, owners should be asked to provide information or resources such as the following to help diagnose a nutritional disease problem:

- Pictures of the aquarium/pond setup
- The original food packaging material
- Details about any food supplements
- Other information that could be provided via a questionnaire

Unfortunately, clinical signs of malnutrition may not be specific to a particular nutrient deficiency, and infectious agents may be the underlying cause of many clinical signs. The most common clinical signs associated with malnutrition are skeletal disorders (e.g., stunted growth, scoliosis), ophthalmologic conditions (e.g., cataracts, exophthalmoses), and generalized conditions (e.g., hemorrhages, anemia, gill hyperplasia). A definitive diagnosis of malnutrition is rarely made on clinical disease signs alone.

The investigation and approach to diagnosing a suspected nutritional disorder in a fish patient are very different depending on whether the patient is maintained in a pond or a home aquarium. Principles of small animal medicine should apply to the pond fish investigation, and a herd health approach should be used when investigating a population of fish housed in an aquarium. A koi owner may not agree to sacrifice a single fish, which may be worth thousands of dollars, to determine an underlying disease problem within the environment. However, a retail store client who lost 100 fish overnight may not hesitate to sacrifice one or two fish in order to get accurate diagnostic test results as quickly as possible. Even though histologic examination cannot guarantee successful diagnosis of a nutritional disorder, it is a very important tool in the disease investigation. As with other specimens submitted for histologic evaluation, a fresh tissue sample increases the odds of determining the primary disease condition associated with the presenting clinical signs. Fish owners should be educated not to freeze a dead fish for histology, but to keep the carcass refrigerated and have the necropsy performed as soon as possible after the fish dies. If the client is willing, euthanasia and immediate necropsy of an affected fish showing clinical signs is the best diagnostic option.

Protein-Related Issues

Fish receiving less protein than the recommended daily requirement initially show signs of decreased growth, decreased production, and anemia. These signs appear in younger fish first, followed by the most productive individuals (e.g., producing females). An increase in mortality in the fish population may be observed as the malnutrition becomes more chronic. Weakened fish may also be more susceptible to secondary bacterial diseases (e.g., fin rot). At this stage, it is important to not be misled into focusing on these secondary disease signs, mistaking them for a primary problem.

A chronic oversupplementation of protein results in increased protein excretion by the fish and an increased level of ammonia in the environment. The resulting disturbance in the water chemistry will lead to serious health problems for the entire fish population.

Figure 1. Overfeeding is a common mistake that can lead to serious health problems for the entire population. *© Jörg Mayer*

Fat-Related Issues

Obesity is one of the most common health problems in both pond and aquarium fish populations (**FIGURE 1**). The common goldfish appears especially prone to obesity. Herbivorous fish (e.g., koi, goldfish) forage most of the day without using much energy. A good-quality line of fish food will have separate goldfish food and tropical fish food, with the goldfish food having a slightly lower crude fat content. Obesity in feeder fish not only is unhealthy for the fish but also may result in health problems in the animals to which the fish are fed.

Fatty infiltration of the liver is one of the most common problems diagnosed in fish patients and is correlated with a high-fat diet. As in other companion animal species, the fatty liver appears pale and enlarged and has a softer-than-normal consistency on postmortem examination. A fatty liver can be the direct result of a high-fat diet or due to the deficiency of biotin and/or choline in the diet.

Deficiencies of certain PUFA are difficult to diagnose, as the clinical signs are nonspecific. In salmonids, a deficiency of PUFA in the diet has been linked to the loss of pigmentation and irregular swimming movements. If PUFA in the food become oxidized or rancid due to the lack of antioxidants or prolonged storage, the associated disease problems can increase in intensity. When PUFA become oxidized, the newly formed compounds of oxidation are extremely toxic to the fish, leading to anemia, muscular dystrophy, nephrosis, ascitic fluid (dropsy), and an enlarged spleen. Unfortunately, due to the high amount of fishmeal in most commercial fish foods, it is difficult to detect rancid products by smell.

Vitamin-Related Issues

Clearly, oxidation of fats during long-term storage also affects the fat-soluble vitamins present in a food. Water-soluble vitamins also degrade over time. Vitamin C is likely to degrade quicker

than any other vitamin contained in fish food. Approximately 90 days after opening, a package of fish food contains almost no available vitamin C. In an effort to increase the shelf life of fish food, stabilized vitamin C, in the form of L-ascorbyl-2-polyphosphate, is often used in the manufacturing process. It is generally advisable to avoid feeding food greater than 90 days old.

Clinical signs of hypovitaminosis C include scoliosis (**FIGURE 2**) and lordosis. Adding vitamin C directly to the water can provide necessary supplementation. Vitamin B deficiencies are common nutritional problems, and clinical signs associated with these deficiencies include central nervous system signs and muscular disease. The requirements for certain B vitamins are significantly increased after prolonged antibiotic treatment and supplements should be considered for these patients.

Water-soluble vitamins also degrade quickly through immediate short-term interactions with water. It has been demonstrated that when fish flakes come into contact with water, up to 90% of water-soluble vitamins are lost within 30 seconds. To help ensure that fish get the greatest benefit of vitamins in flaked food, owners should be advised to feed smaller amounts of food more frequently so that the entire portion is eaten quickly.

Other Food-Related Problems

Even if the food being fed appears to be adequate in composition and freshness, other factors can be associated with nutritional disease. Despite popular beliefs, fish are very aggressive and defend their territory rigorously. A bleeding heart tetra, for example, can spend most of the day harassing conspecifics by chasing them out of its territory. This prevents proper food intake by submissive animals, and the increased stress will adversely affect a submissive animal's health. Separation or addition of more conspecifics, depending on how social the species is, usually takes care of the territory problem.

Other species are specialized feeders, and to keep them successfully in captivity, owners must provide special conditions to trigger their feeding response. These requirements might include providing dark, hidden areas or different colors of food.

Increased nutritional demands of certain individuals might not be immediately obvious to the owner. Live-bearers (e.g., guppies) can produce young constantly, especially if they live in a community tank where the young are eaten right away. After the physiologic stress of repeated breeding, malnutrition may develop quickly in highly reproductive individuals.

Figure 2. This fish has a slight degree of scoliosis, a sign of possible malnutrition (e.g., hypovitaminosis C). *© Jörg Mayer*

Supplementation with live food can have several benefits, including color enhancement. Live food also provides behavioral enrichment for the fish and may be needed to trigger a natural feeding response in certain individuals. However, live foods can also introduce pathogens and parasites into the environment. Live foods should always originate from controlled artificial cultures; wild-caught, live food supplements should be avoided. Owners must keep in mind that freezing live food supplements does not kill all pathogens (e.g., mycobacteria survive freezing) and bears a risk of introducing disease to the stock.

Conclusion

Nutritional diseases in pet fish are quite common, either as primary or secondary problems. However, determining the definitive diagnosis of nutritional problems is often difficult. Knowledge regarding the natural history of the fish (e.g., herbivore vs. carnivore) is essential in the clinical workup. More research is needed to determine the significance of malnutrition in other disease processes. For example, hole-in-the-head disease was originally thought to be caused by a flagellate; however, it now appears to be associated with improper supplementation of calcium, phosphorus, and vitamin D_3. Fish nutrition is a topic veterinarians will be hearing much more about in the future. Be prepared!