new life SPECTRUM® ▪ The Facts About Fish Nutrition

So you have an aquarium, but finding the scoop on your aquatic companions' needs is a jumble of contradictory information, myths and guesswork. We cut through the confusion to provide straightforward facts about aquarium nutrition.

INTRODUCTION

Since the dawn of the aquarium-keeping hobby, enthusiasts have struggled to provide our companions with optimum conditions. The two pillars of a healthy aquarium are, of course, water quality and nutrition. Meeting the nutritional needs of the wide variety of fish kept in captivity has been one of the biggest challenges over the past century of keeping fish.

Fish are a highly diverse group, and meeting each species' nutritional needs is difficult. Particularly when you consider that a single tank can contain a range of herbivores, carnivores and omnivores. Add in aquarium corals and invertebrates, and the challenge can be daunting. A common misconception peddled by "experts" is that no single food can meet all your aquarium dweller's nutritional needs, with food-rotations between products and various frozen foods as the best way to cover the 'gaps' in your fish's diet.

The nutrition supplied to your aquarium companions is the most important factor in keeping many species alive in captivity

Here's the reality: cycling from one nutritionally deficient product to another doesn't solve the problem. It's better to stay with one product, if that product contains the complete nutrition profile needed to fill your aquarium companions' dietary needs. Ideally, the food you choose combines nutrients from a variety of aquatic plant and marine animal sources (along with vitamins, minerals and trace elements) into a single diet.

By way of contrast, let's look at the last 25 years in the dog food industry. An explosion of premium dry kibble varieties have hit the market and been embraced by dog owners worldwide. Some are marketed as holistic diets, and even tout grain-free formulas containing beneficial herbs and botanicals. Higher quality formulas offer complete and balanced nutrition, and most dog owners will feed their pets this diet for the entire life of their companion. Dogs today are healthier and longer-lived than ever. Much of this can be credited to a vastly improved diet.

Yet ask this same dog owner what they feed their fish, most will hold up several brands of tropical fish food and frozen food supplements tucked away in the freezer.

COMMERCIAL FOODS & NUTRITION MYTHS

Keeping fish healthy in the artificial environment of an aquarium is becoming increasingly viable and convenient thanks to advances in aquarium-keeping technology. While marine and reef tanks are still a challenge, it's now possible to keep varieties of fish and coral that were virtually impossible a few short years ago.

Only recently have a trickle of products marketed based on holistic premium nutrition started to appear (of course, this is easier to claim than accomplish). However, today by far the largest-selling foods are lowest-common-denominator products that have barely advanced in 30+ years.

Aquarium nutrition is one of the most misunderstood aspects of the hobby. Myths and fallacies have become 'common knowledge' — and mistaken as fact — through repetition over the "grapevine". When you consider that there are an estimated 60 million aquarium hobbyists worldwide, bad nutrition information leading to fish being "disposable" has a serious impact on hobbyists' wallets, keeping people in the hobby, and pressure to harvest tropical pet fish.

Water quality (a favorite obsession of the aquarium-keeper) is very important — but often overlooked is that a healthy fish given proper nutrition is more resilient and can tolerate larger fluctuations in their environment. Thus, water quality and nutrition work hand-in-hand.

The nutrition supplied to your aquarium companions is the most important factor in keeping many species alive in captivity; yet enthusiasts will spend thousands of dollars on their fish, corals, aquarium and stands, filters, heaters, lighting systems, reef controllers and more. Yet when deciding their companions' optimum diet, they either blithely follow the cues provided by armchair experts, or choose their food based on the images on the label. After all, a food with a picture of a Regal Blue Tang must be designed specifically for that species, right? Maybe — maybe not.

ARE MOST FISH OMNIVOROUS?

To the marine aquarium enthusiast, Atlantic Blue Tangs (Acanturus coeruleus) are considered herbivorous — and they are indeed grazers, with lips and dentition designed for snipping off the tips and branches of algae.

However, the study *"Captive Nutritional Management of Herbivorous Reef Fish"* from the University of Florida (by Dr. Ruth Francis-Floyd and Chris Tilghman) has confirmed

they need more than just algae in captivity. The feed trial used Atlantic Blue Tang, divided into three groups, as test subjects. The first group was fed washed seaweed (ulva spp.). The second was fed commercial food designed for herbivores. The third group was fed another all-purpose commercial diet (i.e. marine protein was in the formula). The first and second group suffered high mortality rates of about 80% — with the surviving fish showing clinical signs of malnourishment like emaciation. *The third group had only an approximately 30% mortality rate and showed a 400% weight gain!*

Information on this study was made available in a lecture on November 29, 2001, at the Marine Ornamentals International Conference held in Lake Buena Vista, Florida. Yet outside that conference room, the results were never made public, due to pressure to avoid controversy within the aquarium feed industry.

Most fish have specialized feeding methods and ingest a certain type of food matter more than others. However, in the wild almost all are opportunistic feeders. Even the most specialized, like Atlantic Blue Tangs, ingest a certain amount of nutrients from other sources.

Herbivores have been observed eating invertebrates. They also receive protein via organisms within the plant matter they ingest. Carnivorous fish get plant-based nutrients from the contents of their prey's digestive tract (which is gut-loaded with various organics, including phytoplankton and zooplankton).

Beyond fish, other common aquarium dwellers like crustaceans are scavengers, and thus opportunistic omnivores. Filter-feeders likewise consume both phytoplankton and animal zooplankton.

For freshwater examples, we need look no further than the fish in the African lakes of Malawi and Tanganyika. These are some of the most specialized feeders found on the planet — yet they too are opportunistic feeders. Algae does dominate the stomach contents of certain species of African cichlids classified as herbivores. However, protein-rich organisms in significant quantities are also present. Breeders know that the foods that make these fish grow are insect nymphs and larvae, crustaceans, snails, mites, micro-organisms, and zooplankton — not vegetable matter.

Feeding and the Omnivorous Aquarium: The reality that most tropical fish are omnivorous — with herbivorous or carnivorous specialization — has some clear implications when feeding your companions. First, any commercial herbivore diet should include sources of protein, and any diet aimed at carnivorous fish should contain aquatic plant matter.

Wild herbivores must graze at least 12 hours daily to ingest enough nutrients. During grazing, they discharge waste almost constantly. In the artificial conditions of an aquarium, these fish don't have unlimited food to graze upon. Even if you could feed them every hour, you couldn't maintain the needed water quality due to fish waste. An aquarium isn't even a fraction of a drop compared to the water volume of the ocean or a large lake. In order for nominally herbivorous fish to thrive in an aquarium, a higher nutrient density solution is required.

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It's helpful to think of an aquarium as an environment for your fish that is like a space station habitat would be for humans. In such a 'contained' environment with limited space and resources, the food you consume should be as little in mass, and as nutrient-dense as possible to reduce waste products in a closed environment and get the most benefit out of each one of your limited daily meals. Accordingly, meals prepared for astronauts are usually focused on packing as much nutrition into each morsel as possible.

Hobbyists may believe feeding Surgeonfish a diet of algae (or commercial foods that are purely plant based) is more 'natural' than a pellet or flake food. That couldn't be further from the truth. First hand experience with attempts at wholly plant based diets have failed miserably — and the results from the study performed at the University of Florida bear these conclusions out.

Carnivorous fish likewise have a much different life in the aquarium than in the wild. Outside captivity, their prey is part of the natural food chain, and is gut-loaded with nutrients derived from their environment — but which the carnivores don't eat directly. In particular, plant matter. Frozen silversides found in your local pet shop don't provide the same, needed nutrients as wild prey. The reality is carnivores don't just eat meat, any more than herbivores just eat algae.

NUTRITION BASICS

The key to choosing the right diet for your aquarium companions is understanding a bit about how your fish's bodies utilize the nutrients you provide via your choice of foods. So let's take a look...

Protein: Life's Building Blocks

There's a lot of confusion among hobbyists when it comes to protein. What are the correct percentages and what is the desired quality? The protein percentages on a fish food label don't give you insight into the protein quality.

The value of a protein is directly related to it's amino acid content. Amino acids include Arginine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan, and Valine. These are the building blocks of muscle, and the basis for growth. The protein's source is a key factor of whether your fish can fully utilize the protein — or even fully digest it. Unless it's fish digestible, the crude protein content on the label becomes somewhat meaningless.

High-quality protein derived from sources found in the aquatic environment doesn't cause gastrointestinal issues even in fish considered nominally herbivorous. Excess is mainly excreted as waste. The source of bloat (or many other gastrointestinal issues) in these fish is poor quality protein that's hard to digest and may contain components not useable by aquarium dwellers.

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The best approach is to worry less about the crude protein numbers for either carnivores or herbivores. Focus instead on the quality of the sources — since that is the key factor for your fish's health. The ingredients on the label are your first clue to the quality of the content. Avoid fish foods with too much grain (such as wheat middlings, corn, brans, potato flour). Likewise, avoid foods that use soybean-meal derived protein where possible. Instead, look for foods with high-quality, marine based proteins at the top of their ingredient lists: Whole Krill, Herring or other whole fish, squid, Omega-3 fish oil.

It's a common misconception that all fish meal is a poor quality protein source. Fish meal can be an excellent source of protein, and rich in essential amino acids, fats, vitamins and minerals. The key is to only accept Whole fish derived ingredients. Lower quality meal derived from post-processing waste (i.e. heads, scales, tails and bones stripped of meat) have resulted in fish meals getting a bad rap.

If fish (or krill or similar) is not listed as the first ingredient, and the ash content is less than 9%, it can indicate too much soybean, wheat gluten or blood meal being used. While some fish, like Koi, can assimilate large amounts of these lower-grade ingredients, most tropical species cannot. Blood meal is high in protein, but is low in some essential amino acids such as methionine.

Obviously, it's much cheaper for a manufacturer to use these lower-quality ingredients versus high-grade marine proteins like Antarctic krill, squid or whole fish. However, doing so is a critical ingredient for aquarium health.

Plant Matter and Vegetation

The source of plant matter is a factor in how well your aquarium companions' digestive systems can utilize nutrients. One item to be aware of is cellulose, which is the source of fiber. While there are aquatic plants high in fiber — like fibrous Kelp (a primary food source for Abalone & Sea Urchin) — algaes and many of the microphytes that are common sources of vegetation in aquatic environments have little cellulose. Fiber should be fed in moderation. Fish can't digest cellulose unless bacteria and enzyme actions take place inside the intestinal tract. Fiber is a laxative and too much will cause diarrhea. This in turn shortens nutrient retention time and allows insufficient time for the intestine to absorb nutrients. Some kelp or other fibrous plants in a formula is good, but moderation is key.

Aquatic versus Terrestrial Vegetation: Aquatic sources like seaweeds and algae are preferable for fish. They are simply better adapted to assimilate nutrients from these sources than from terrestrial plants. This doesn't mean terrestrial plants are without nutritional value for the aquarium. Although less easily digested and utilized, terrestrial vegetables can provide valuable nutrients to your fish — particularly if aquatic sources are unavailable. In general, however, high quality foods will use primarily a variety of aquatic vegetation.

There are cases where specific non-aquatic plants can benefit your aquarium since they have properties not readily available in marine or freshwater counterparts. For example, garlic is a strong fish attractant. Likewise, studies have shown it to have both positive effects on fish immune systems and anti-parasitic qualities.

The bottom line: foods using a majority of algae and seaweeds are overall preferable to those primarily using terrestrial sources.

Many foods will tout spirulina or kelp as a selling point. This is particularly true with herbivore foods. When confronted with this, a look at the label is helpful; many so-called "herbivore" diets' main ingredients will be fish meal or binder, a fairly small amount of spirulina, and green food dye to create the impression of a high concentration of algae. Spirulina (along with many seaweeds) is an expensive ingredient, and it's not uncommon for brands to take this shortcut.

Vegetation variety within the formula is another consideration. Although spirulina or kelp are both useful nutrients, a diet consisting of a single plant source is not complete. Yet this is the route a number of food formulations take. A "basket" approach using a variety of seaweeds and algae (including spirulina) is preferable, as each provides different minerals, trace elements and nutrients for a well-rounded nutrition profile.

Spirulina: In particular, spirulina algae has been touted as the ultimate superfood, to the point that almost every hobbyist and manufacturer alike has jumped aboard the bandwagon. Most believe they need large amounts of spirulina in their aquarium diet — which isn't the case.

Spirulina is indeed a high quality ingredient, and is very high in vitamin A and minerals. An inclusion rate of 5-10% increases growth rates and enhances blue coloration. However, vitamin A is a fat-soluble vitamin and excessive levels can be toxic in fish and can cause long-term health issues. It can also impart unnatural coloration. Most good fish foods already contain sufficient and beneficial amounts of spirulina. Feeding more than required is counterproductive.

CARBOHYDRATES IN AN AQUARIUM DIET

Fish don't use carbohydrates efficiently. Some is nevertheless included in pellet foods because without some grains, pellets (and flakes) wouldn't hold together. In quality feeds, the use of carbohydrates is the minimum amount needed as a binding agent.

However, some foods may use grains as a source of inexpensive energy and add a high amount to the formula. This is better for the profit margin of the manufacturer than for your aquarium companions. Grains have some place in aquarium foods beyond serving as binders. They can help synthesize lipids and proteins. However, too much ends up stored as fat. It also increases the amount of undigested waste expelled by the fish, leading to pollution of your aquarium water.

Grain by-products are also very difficult to digest by many species and can cause gastrointestinal issues due to poor digestibility and absorption rates. This can, in turn, lead to bloat due to pathogenic bacteria multiplying within the intestinal tract (as quickly as doubling their population every 20 minutes). In most cases, this condition is both extremely contagious and fatal.

LIPIDS: FINDING THE RIGHT BALANCE

Lipids (aka "fats") are high-energy nutrients supplying about twice the energy as proteins and carbohydrates. In aquarium diets this is Omega-6 and Omega-3. They typically should comprise about 5–10% of a tropical fish's diet. Lipids also supply essential fatty acids that serve as transport for fat-soluble vitamins.

Yet finding this correct fat balance in a fish diet is essential. Fatty infiltration of the liver has been designated as one of the most common metabolic disturbances and frequent causes of death in aquarium fish. The connection between excessive lipids and fatty liver disease has been common knowledge in the aquaculture industry for years. The Department of Fisheries and Aquatic Sciences at the University of Florida has confirmed this is a study involving African cichlids as test subjects.

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We believe 5% fat isn't enough to maintain the typical energy expenditure in an aquarium for any species of fish. Without sufficient lipid content, they will end up tapping into bodily protein to compensate. More than 10% is more lipid-based energy than warm water fish use in a captive environment and runs the risk of fatty deposits in or around vital organs such as the liver. There's a big difference between a fat fish and a muscular, toned fish. Balance that takes into account typical activity levels in an aquarium is key.

Increasing dietary fat in a fish food reduces costs for manufacturers by lowering the requirements for expensive protein sources like krill or whole fish in the formula. However, this is at the expense of your fish's health.

Foods designed for commercial food fish are typically higher in fats than recommended for tropical fish. This makes sense if you consider that for food fish production, the feed must be cheap, and the goal is to promote rapid growth in fish with a limited lifespan before harvest. However, for our tropical companions, our goal is as long a lifespan as possible

VITAMINS & MINERALS

Somewhat recently, Vitamin C has been the focus of a lot discussion and hobbyists now specifically look for it when choosing an aquarium diet. However, it's important to remember the other essential elements in a well-balanced fish food, such as: Vitamins A, D2, D3, E, K, B6, B12, as well as Thiamine, Riboflavin, Pantothenic acid, Niacin, Biotin, Folate, Choline, and Myoinositol. Also minerals like Calcium, Phosphorus, Magnesium, Sodium, Potassium, Chlorine, Iron, Zinc, Manganese, Copper, Selenium, and Iodine.

Unfortunately, the vital role all these nutrients play is often overlooked.

Copper: This is a common mineral found in the blood-stream of crustaceans like Krill, a main ingredient of a better quality food). Copper is an essential trace element for all living things, including fish. It's a natural component of enzymes and vital for life processes. Natural seawater contains copper. Yet many hobbyists worry about the presence of any copper in fish food.

In water, at a rate of 0.8ppm (parts-per-million), copper sulfate is toxic to almost all fish. Copper sulfate within fish food can be up to 700-1,000 ppm, with the only symptom in some species being growth retardation. In commercial foods, only trace amounts of copper — far below even a tiny fraction of this concentration — are present. Biologically appropriate trace amounts of copper are beneficial, and are present in copper-rich crustaceans that are frequently used in higher-quality fish foods.

How about reef systems and invertebrates, including crustaceans? The hemoglobin (aka blood) of invertebrates like shrimp and crabs is copper-based in the same way our blood is iron-based. Iron isn't toxic to humans at normal levels (humans often even take iron supplements). Copper in normal, trace amounts is likewise necessary for crustaceans. In excess amounts, copper can be toxic to invertebrates, similar to the way iron toxicity can occur in humans.

In fact, the effects of copper deficiency are noted even in papers like "Copper Hazards to Fish, Wildlife and Invertebrates: A Synoptic Review" by Ronald Eisler on behalf of the U.S. Geological Survey. The paper notes that copper and its compounds are not harmful at "environmentally realistic concentrations". Commercial aquarium diets have only a trace amount of copper. This is mainly from trace elements in the tissue of plants and animals used in the formulas.

GARLIC

Garlic is a key ingredient in quality foods. When the right amount is used, this single ingredient plays a major role in your fish's long term health. It makes the food an attractant for fish. Yet more important is garlic's anti-parasitic properties and strengthening of the immune system. We've been using garlic as a fish food supplement for over 20 years in both our commercial foods and farm feeds and the observed results over the years is a drastic drop in disease and parasite infestations to near zero. In our aquaculture facilities, since adding garlic to our ponds, vats or aquariums, we've not had a single case of "Florida Deep Well Disease" — caused by pathogenic bacteria Aeromonas sp. and Pseudomonas sp.

There are now many scientific studies on the effect of allicin complex (the active ingredient in garlic) in aquarium diets. These studies support the conclusion of allicin's efficacy in increasing fish resistance to parasites. A 2006 study by A.M. Shalaby for the Central Laboratory for Aquaculture Research in Egypt found a 3% inclusion of garlic increased overall digestibility of protein, carbohydrates and fat in addition to lowering the total bacteria count within the intestines and muscles of the fish — as well as the water column of the aquarium. This research has been joined by similar findings from the aquaculture science departments around the world, including Australia, Israel, India and more.

There are many scientific studies on the effect of allicin complex (the active ingredient in garlic) in aquarium health. These studies support the conclusion of allicin's efficacy in increasing fish resistance to parasites

Like any ingredient, balance is key. Recently, it has been suggested by some that garlic is harmful to aquarium life (due to it's terrestrial oils and lipids). Garlic is indeed terrestrial, and we do advocate aquatic vegetation in aquarium diet formulas. Yet no aquatic plant has Allicin — for which there's a wealth of research supporting it's benefits in fish.

Much of this misconception is based on studies not about garlic specifically but heart and liver lesions on fish fed exclusively terrestrial plant diets. It's also based on some industry-funded studies that use megadoses of processed purified Garlic oil that is far beyond even the most aggressive inclusion of garlic in consumer brand fish foods. Beyond this, in our opinion these results were not attributable to the allicin itself, but the high concentrations of oil fed to the subjects. Also not accounted for is the balance of other essential nutrients 1in the diet used.

THE "ALL OR NOTHING" FALLACY

"Hi, I've heard on some forums recently that garlic is actually poisonous to my fish. Is that true? I'm worried about using it in my aquarium."

We're regularly asked a variation on this theme about the trending "ingredient boogeymen" — whether it's garlic, lipids, copper, vitamins, etc. Unfortunately, aquarium enthusiasts are susceptible to "panics" about their fish's diet based on misinformation and questionable logic.

The common thread in these concerns is the "All-or-Nothing Fallacy": the mistaken assumption that if a mega-dose is bad, it means the ingredient in any quantity is harmful and the best solution is it's complete absence from your aquarium.

Virtually all biologically active substances are harmful in huge doses. Vitamin E is healthy, yet excess is toxic. A very large increase in aquarium salinity is deadly. This doesn't mean salt is inherently "harmful" for marine fish — the very suggestion would be considered ridiculous. Yet this same logic is the basis for these "all or nothing" arguments. The key is inclusion in biologically appropriate amounts.

PUTTING IT ALL TOGETHER

More and more evidence has proven that many common fish ailments such as lateral line disease in Surgeonfish, hole in the head in Angelfish, and fin erosion in Tangs, are almost always nutritional issues.

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In many ways, fish food is like an interweaving basket, remove one strand, and the whole thing can unravel. There is no one single ingredient that has more value than all others. Each and every ingredient used to make up a premium fish food is vitally important to your fish's long term health.

FISH FOOD ECONOMICS 101

Digestibility & Conversion Ratio: It's amazing how fish hobbyists often compare fish food by just the sticker price. The true cost of an aquarium diet is impossible to determine based solely on the price on the jar. Many so-called "expensive" foods are actually more economical due to nutrition density and higher digestibility of the ingredients.

The key here is the feed conversion ratio: the percentage of the food mass convertible by the animal into biologically useful nutrients. A higher conversion ratio has two big results. First, your aquarium companions can eat less to receive the nutrition they need. Second is less waste —both because they're eating less mass and because a higher proportion of what they are consuming is absorbed rather than expelled.

For this desirable feed conversion ratio, the ingredients used must not only be high in nutrients, but be in a form the fish can digest easily. For fish and other aquarium dwellers, this is quality marine-based protein sources, aquatic plant matter, etc.

You don't have to be running a huge number of tanks for this savings to be noticeable. Even for the average hobbyist, the difference in the amount of food needed to keep your fish in optimum health when using a premium quality product just might surprise you.

UNDERSTANDING LABELS & INGREDIENTS

Today, we all understand the importance of reading food labels. Aquarium diets often have ingredients not commonly found in other animal diets, and some specific knowledge when reading them will help you make an informed decision. There's a lot of confusion surrounding the issue, and this makes it possible to manipulate the ingredient list to favor your own product while still technically following label requirements. This article's goal is to help you become more informed and able to evaluate the reality behind the ingredient list.

Ash: Found in the Guaranteed Analysis (Analytical Constituents in EU labels), this is an item that seems wholly undesirable. Yet the story is a bit more complex. Ash is from the shells, scales and bones of marine animals that are high in calcium and phosphorus. Ash is also from the minerals in raw ingredients such as kelp and spirulina. Ash from these sources are beneficial in small quantities, but should be limited. Fish can only assimilate so much mineral content and any excess will simply add unwanted pollution to the aquarium water.

The presence of some ash is unavoidable. It's important to understand that any food that uses whole aquatic protein ingredients like krill, shrimp or fish will have some due to shells, bones and scales. Some foods tout a low ash content; but if a food has low single-digit ash content, this can be an indication of using protein sources such as a large amount of soybeans, gluten…etc.

On the other hand, excessive ash content can indicate the food isn't using whole ingredients, but rather post-processing

waste: shrimp heads and shells, or fish stripped of their meat leaving tail and bones. If the ash content is high, the easiest way for a manufacturer to solve this is simply not list the ash content on their label — although any label failing to do so is not following U.S. or EU labeling requirements.

Whole Ingredients: For proteins, there are several ways manufacturers can misrepresent contents. A manufacturer can list items like lobster, shrimp, crab and/or a large variety of different fish in their ingredients to signify quality — but in reality be using leftover parts of the animals — aka post-processing waste.

Looking for the term *"Whole"* in the protein ingredients is a good indicator that the product isn't using stripped leftovers. Another tip is Krill versus Shrimp. If a manufacturer is truly using krill, it isn't possible to use anything but the whole animal, versus shrimp which can be separated.

The term *'Whole'* is a better indicator of quality than the use (or non-use) of the term 'meal'. The term 'meal' has become directly associated with ground post-processing waste. Many brands will omit the word 'meal' so as not to be associated with this. Yet if they don't specifically indicate 'Whole', the ingredients may or may not be leftovers.

The result of these issues is that there's an extreme range in the utilization of nutrients and overall digestibility within any ingredient category. Shrimp meal is typically comprised of cull portions not fit for human consumption: heads and shells, and many fish meals are likewise typically made up from the processing waste of the fish (not the whole fish). High quality food uses only krill, squid, whole fish, etc. — not leftover waste from processing plants.

Ingredient Padding: Another way manufacturers can make ingredients seem more plentiful is choosing to list several species of fish rather than use the term "fish meal". This bumps binding agents (like middling and wheat flour) further down the list — while creating the illusion that a lot more fish protein is included in the formula.

In reality, these "several variety of fish" are simply the various ingredients that went into the fish meal. Ironically, the reason for this variety is often that the meal is using cast-off odds and ends that were leftover. The fact is, whether the meal is single source or made of a variety of species, a pound of meal is a pound — it doesn't matter how many types of fish you used. It doesn't represent a single gram of extra fish protein. This can be used to obscure the fact that the true second or third ingredient is a binding agent such as flour.

All prepared fish foods require a high-quality binding agent or they would simply fall apart in water. Premium foods use as little as 25% binding agent, while lower-quality foods can be as high as 50%. For the discerning hobbyist, it's necessary to ensure that this "ingredient padding" isn't being used to obscure the real contribution of these binders.

Mixing Dry and Wet Weights: The proportions of ingredients used in an aquarium diet are determined by weight. Brands can influence the order in which the ingredient is listed by using the 'wet weight' for those ingredients they want to list higher and the 'dry weight' for those they want less emphasized (implying that more of the premium ingredients are in the mix). A label should consistently use either the dry or wet weight for all the non-liquid ingredients; dry weight is generally the better metric, because once mixed and formed into pellets, this is the closest to the final product. Unfortunately, it can be quite difficult to tell if a food is mixing dry and wet weights from the label.

For manufacturers, it's tempting to make decisions that render the product appealing for human customers at the expense of your aquarium companions...yet these tactics can be misleading and even compromise nutrition

FOOD COLORING

For manufacturers, it's tempting to make decisions that render the product more appealing for human customers at the expense of your aquarium companions. In dog food, this may be relatively benign ploys like forming the food to look like little pieces of steak or chicken (as if the dog cares!). Yet these tactics can be misleading and even compromise nutrition.

One example is food coloring. A manufacturer can use little of a common ingredient like spirulina, use green-dye to color the food a rich green, and promote it as designed for herbivores. Yet read the label closely — in some cases this "herbivore diet" is based on generic fish meal and contains little spirulina or aquatic veggies. Instead, it may be loaded with fillers like corn, middling, wheat or potato flour. The reality is: a nutritionally complete pellet for herbivores won't be bright green naturally due to the need to mix plant matter with other nutrient-rich ingredients. However, any

quality herbivore diet should have algae and seaweed as the top ingredients. Beware of pellet and flake foods that claim they are 100% spirulina: the raw ingredient is many-times more expensive than the sale-price of many so-called "pure" spirulina pellets or flakes on the store shelves — and that's not even counting the cost of manufacturing it. Thinking this through, no business exists to lose money on every sale.

Brands will often use dyes for general color consistency to appease shoppers. Color variation is to be expected in any product using natural ingredients. Krill, for example, will have variations in color depending on season and water temperature during harvest. The same applies to most organics. As consumers, we've been trained to expect an artificial uniformity that manufacturers accommodate using dyes — which can find their way into your aquarium's water.

FINDING THE FACTS ABOUT FISH NUTRITION

It can be frustrating getting the real scoop on feeding your fish. This is where aquaria publications could be very helpful. Yet the silence is deafening when it comes to providing meaningful consumer information and comparisons for aquarium diets.

This leads to a question of whether a fish can thrive on a single food. The answer is **YES!**

Most aquarium publications are geared towards promoting the hobby, and assisting enthusiasts — but because of their need for advertising, they don't publish comparative fish food studies.

Hobbyists want a controlled feed trial study of top commercial foods. These studies have been done. In 2002, an in-depth feed trial study of 33 top fish food brands was performed by a group of highly accredited veterinarians in Singapore. In February 2007, Sparsholt College in the United Kingdom completed a feed trial on Lake Malawi cichlids. Yet the results of have not been made public due to the politics involved.

The best approach for hobbyists is to perform your own trials — as ad-hoc and imperfect as these experiments may be. It's the only way you'll find out what works best. We also believe enthusiasts that truly want to benefit the hobby will share their findings with others. Fish nutrition has been a long neglected facet of aquarium keeping, but it doesn't have to be. Understanding nutrition's role in a healthy aquarium is beginning to rise thanks to activist hobbyists who have tried various options for themselves and have advocated on aquarium hobby forums, YouTube and more.

The bottom line is that you should draw your own conclusions instead of relying on manufacturers' claims. This includes our claims. Find out for yourself. Don't we owe it to our aquarium companions to provide them with long-term optimal health?

As an example of the difference a personal investigation can make: in 1996, we published a book called "*Marine Aquarium Companion*". Amongst all the information contained in the book was each fish's survivability rating in captivity. We listed the Moorish Idol as "doomed" due to their specialized diet in the wild. At the time, it was a "fact" that this species simply couldn't be kept long-term in an aquarium, as no commercial food could sustain it (nor many other delicate marine species). As a side note, at the time we listed it's temperament as "peaceful" when in fact it's docile nature was due to listlessness.

Conventional wisdom proved wrong in both counts. Once we began feeding idols with the formulations that later became Spectrum, we discovered two things. First, is that though difficult, still they could be kept in captivity if given sufficient nutrition with sufficient olfactory (scent) appeal. The second is that once well-fed, Moorish Idols weren't peaceful at all but quite aggressively territorial. Their 'docile' nature was a side effect of starvation. Our own observations and experiments gave us insights we wouldn't have gotten from commercial publications nor the rumor-mill.

FEEDING: MYTHS & BEST PRACTICES

Fish Food Variety: *Variety Is The Spice Of Life.* It's a common saying. This leads us to the question: do fish get bored with one food? A common answer is:

"Would you want to eat the same food all the time?"

This attributes human thoughts to your aquarium dwellers. Many marine butterflyfish eat only coral polyps in the wild, and would starve to death rather than switch foods in captivity. Harlequin Shrimp only eat the tube feet of starfish. Outside the world of aquaria, Koalas will die before eating anything other than specific varieties of eucalyptus — and Monarch Butterfly caterpillars only eat milkweed.

Assuming a single food can healthily sustain your aquarium companions, this isn't an issue. Fish can't become 'bored' with a food.

Thriving on a Single Food: This leads to a question of whether your fish can thrive on a single food. The answer is *YES!*

One reason a diet of various products is still promoted is that until this past decade or so, most commercial aquarium diets didn't provide optimum nutrition. This led to a cycle of feeding fish a basket of foods deficient in one way or another in an attempt to "cover the gaps" in the nutrition being provided each.

Fish do require a varied diet. Yet if a single food is made from a wide variety of nutritionally balanced ingredients, in their proper ratios, this "varied diet" can be found in a single formula. If a food contains krill, fish, spirulina, a basket of other algaes and seaweeds, trace elements, minerals, fish oils, beta-carotene, et. all — isn't it like feeding these foods separately? And if only high quality, premium ingredients are being used, that single food is far healthier for the fish.

This concept is proven in commercial aquaculture — which is responsible for the vast majority of science used by commercial fish food brands when formulating their products for tropical fish.

The information gleaned from these aquaculture studies is basically sound, but a majority of the research is on fish raised for human consumption. Coloration and longevity of the animal isn't a consideration (with certain exceptions like salmon where the flesh color is important for sales). Formulas for tropical fish must be modified. Examples are: lowering the amount of lipids (fat) used, utilizing high-quality marine protein, and including a wide variety of natural color-enhancing ingredients such as krill, spirulina and astaxanthin.

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Finally, when evaluating whether varying your fish's foods is inherently better: imagine a diet where every other day you ate grilled fish, brown rice and a salad — and the alternate days you ate a Fast Food Cheeseburger, Fries and Soda. This is "variety": but not the good kind. Supplementing your fish's diet of nutritionally balanced dry foods with several, less nutrient-complete foods is a similar type of dubious "variety".

LIVE FOODS, FROZEN FOODS & BEEF HEART

Live Food. With many species, there's a risk of fry mortality due to failure to eat within the first few days. This is why many commercial breeders use foods like baby brine shrimp or micro-worms to get the fry to start eating. Fry fed baby brine shrimp have a more uniform growth rate than those fed commercial dry food. Yet once they pass 2+ weeks, a high-quality dry food can often out-perform live diets.

Most live foods risk introducing pathogens (diseases and parasites) and pollutants to a system. They also aren't as nutritionally complete and have nutritional drawbacks. Black, White and Tubifex Worms, for example, contain excess fat that can cause deposits around the vital organs.

Frozen Foods. Most commercially prepared frozen foods for aquariums are about 80% water. The very process of freezing foods like Brine Shrimp causes the cell membranes to rupture. When this food is thawed and rinsed, much of the nutrient will leach from the animal and what is left is mainly shell with little nutritional value.

Both live and frozen foods have their place in an aquarium diet. The reality is that there are some fish that simply will not eat dry food. In these cases, hobbyists have no choice but offering frozen or live food to entice fish to eat as soon as possible, with the hope of eventually training the fish to eat the more nutritionally sound dry formulas.

Beef Heart. This aquarium diet is worth a special mention due to its popularity with Discus breeders (allowing their fry to grow-out rapidly and conditioning their breeders for egg production). It works for these purposes. It also might account for the short life expectancy of many Discus. This food has the highest water pollution potential. Many Discus breeders in Asia change their water as much as 2-3 times daily to maintain water quality in their grow-out tanks!

Discus can sometimes be resistant to pelletized food because they've been raised on beef heart. Yet with some effort, even Discus can be trained to accept the cleaner and nutritionally balanced dry food.

The Dangers of "Yo-Yo" Feeding. Diets of live and frozen foods do work to an extent, and have since the advent of fish breeding. However, for much of this time commercial, nutritionally formulated fish foods weren't available.

Commercial diets have come a long way in recent years, and are better at ensuring that your fish are provided with what they need for optimum growth, long-term health, color and vitality. Frozen and live foods work on short-term basis. However, continually "supplementing" your fish's diet with these so-called "treats" can have an undesirable consequence. Due to the palatability of these types of food, fish will often prefer them to the balanced dry foods — making them more likely to reject the healthier diet. We call this "*yo-yo feeding*".

There's always a temptation to indulge your aquarium companions. But this is like giving kids a choice between veggies and a piece of chocolate cake. The cake tastes good, but isn't good for them.

FLAKES VS. PELLETS

Any discussion of fish food must include a brief comparison of the two main types of commercially formulated foods: pellets and flakes. Flakes have been the most popular form of food among hobbyists for over 50 years. However, commercial operations learned long ago that pellets are a far superior choice for feeding applications.

Pellets boast a few key advantages over flakes: nutrient density, water stability and nutrient integrity.

Pellets are much more nutrient dense, and thus are the optimum method of providing nutrition to your fish. This is particularly true for species of fish over 2-3 inches. This means you can feed much less volume of pellets to achieve the same results versus flakes.

Not only can you feed less, but those pellets you introduce to the tank will remain stable in the aquarium for an extended time. By their very design, flake foods are paper-thin. This leads them to absorb water quickly. Because water can flow into, saturate, and flow out of these thin flakes quickly, water-soluble vitamins leach into the water in a very short time. Some studies suggest that once flakes are added to an aquarium, the majority of water-soluble vitamins (like vitamin C) are leached out of the flake food with 60-90 seconds. As a bonus, not only are pellets better for your fish, but P-pelletized food costs less per ounce.

This has been common knowledge in aquaculture circles for decades, but inertia within the hobby has led to insistence on using this outdated and suboptimal form of feed. Yet the use of pellets has been proven in aquaculture since it's modern inception.

FEEDING TIPS & GUIDELINES

Feeding fish seems easy, but is actually one of the most difficult things to teach. It's as much an art as a science. Doing it correctly requires an observation, and an awareness of the fish and their needs: when are they overfed or underfed?

The first rule of thumb is: when in doubt, underfeed. If needed, you can always fix the situation later by increasing your feeding amount. However, if you overfeed you eventually run into some serious problems.

Overfeeding is more common than underfeeding. However, there are times when a hobbyist will underfeed their fish to an extent that their fish look emaciated. Some reef keepers end up doing this because of concerns about phosphate and nitrate levels in the water. Also, underfeeding their filter-feeding corals (who are used to having an abundance of plankton) is not unheard of.

If a fish is overweight, simply feed less. If the fish is too thin, just feed more. A hobbyist needs to remember: he or she is in control, not the fish. A healthy fish will always beg for food even if not needed. Generally, for a high nutrient-density food, the quantity your population consumes in 30 seconds or less is a good starting point. Also, pay attention to the vigor with which the fish pursue the food to help judge the correct portions. Another thing to focus on is making sure that those that are slower feeders or bottom-feeders are also receiving food. In some cases, target feeding may be called-for.

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If a fish shows no interest in food, there are likely big problems with that animal; either they are sick or under stress from very bad water conditions.

For pellets, choosing the correct size is vital. Large fish can (to a certain extent) eat small pellets. However, if the pellet is too large for the fish, they'll usually spit it out or expel a large portion into the water column while chewing. The key is to use a pellet size that allows the fish to swallow it whole. A good starting point is about half the size of their mouth.

If you keep a mix of sizes in the aquarium, mix different size pellets to ensure all of the fish receive a share appropriate to them.

A common error is to pre-soak pellets. This is based on the mistaken belief that it will aid in the digestion and prevent swelling inside the fish's gut. This is an urban myth. Fish digestive systems contain copious enzymes and gastric acids that turn the pellet into pulp in a short period. If a pellet causes gastrointestinal issues, it's usually due to use of ingredients with poor digestibility. This includes excessive grains and grain by-products and low quality protein. It is not due to pellet swelling. In fact, when you pre-soak pellet foods, you are encouraging nutrients and water-soluble vitamins and minerals to leach into the water before even introducing it.

WHAT MAKES A SUPERIOR FISH FOOD?

There are unknowns in regards to tropical fish nutrition, particularly if you consider the thousands of varieties of

ornamental species kept in captivity. Yet when it comes to commercial diets, we believe the best overall approach is to use a high-quality food that satisfies the crude requirements of all species. This is particularly true of marine fish.

Freshwater fish on a mediocre diet may simply look mediocre and act lethargic. But most will survive. For marine fish, a nutritionally complete and properly balanced diet is a matter of survival. This is particularly true of demanding species like Surgeonfish, Angelfish, etc.

Here are some basic guidelines for choosing a superior fish food:

Palatability. Fish are governed by olfactory senses (aka smell) and to a lesser extent taste. Of course, unless the fish is attracted to the food, no matter how nutritionally superior it may be, it's useless.

Food's energy input has to exceed energy output. Output takes the form of movement and metabolic functions. This balance is especially important in marine fish. For some, despite eating in the aquarium, waste away until death. A nutrient packed food can help counteract this and produce both substantial growth rates and optimum health.

Digestibility. As mentioned previously, the protein used must be easily digested and absorbed by herbivores, omnivores and carnivores. Fish don't have access to an abundant food source in our miniscule aquarium environments.

This is one reason many "natural" sources like mysis or brine shrimp are inferior to high-nutrition formulas: their nutrient density is attuned for the fish being able to forage constantly, and their abundance within the oceanic environment — an environment very unlike an aquarium. Engineered nutrition solutions are designed for an environment where sheer quantity of food is limited, as is living space.

Whatever food you feed, it must provide ample daily nutritional requirements for the fish to thrive. Superior food generally produces less waste, hence less pollution in your aquarium.

Fat content should ideally be below 10% to avoid fatty liver disease, except in the case of juvenile fish — which require fat as an immediate energy source in order to spare the much-needed protein for building muscle.

Longevity. Choose a food that can maintain health for years, not months. We have maintained numerous Angelfish, Surgeonfish, Butterfly Fish, etc., for over 10 years. How long do fish live if their nutritional needs are met? In many cases it could be 20+ years (although few hobbyists have kept the aforementioned species of fish alive for such long periods of time). Yet in some cases, one or two years would unfortunately be considered a success. We're not talking about Damsels, Clownfish, Triggerfish, or other species that are fairly easy to keep in captivity, but marine species that are considered ultra-delicate by most hobbyists.

Less Waste. Superior food produces less waste. This equals less pollution in your aquarium. Excess undigested protein, fiber, and minerals (ash) expel through the gills and feces. This introduces phosphate, ammonia, and nitrogen compounds. It's also why kelp, spirulina, grain and difficult-to-digest proteins should be kept at a reasonable percentage.

It's a common belief that regardless of the formula, it's best to add more Kelp, vegetable matter or spirulina into their fish's diet, unknowingly adding more pollution to their aquarium. Fish can't utilize the additional mineral (ash) and fiber from these materials. A quality food will contain ample vegetable matter and minerals.

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Color Enhancement. A high quality fish food should be able to bring out the wide spectrum of natural colors in a fish (not just red). Likewise, the source of these color enhancing ingredients should be natural — in many cases derived from the ingredients (like krill, spirulina, marigold, and red pepper) themselves. Under no circumstances should the colorants be derived from added hormones.

THE SOLUTION

And here's the part where we have to say it: *New Life Spectrum®* fish food and aquarium nutrition products best fit all the criteria of a superior aquarium diet. This recommendation may seem entirely predictable for this article — and even self-serving. This perception is understandable and a healthy consumer skepticism. But we feel it would be irresponsible to not inform hobbyists about the best product available simply due to a fear of appearing to have commercial motives.

It helps to understand how Spectrum was born. By 1996, New Life had been a successful wholesale commercial fish breeder for over 20 years — as well as publishing two aquarium books that were considered standards in the hobby. In 1996, a third book, Marine Aquarium Companion, was

released. In it, we took an uncompromising stance when evaluating what fish were survivable in marine aquariums of the day. This didn't do it any favors in the pet shops trying to sell these fish! Yet we made a conscious decision to place the need for real information about fish mortality above expedience.

However, seeing the number of fish designated "doomed" made us wonder if the fate of some of these fish couldn't be helped if we applied our experience, knowledge and philosophies to creating a better food. New Life Spectrum® was born from this foundation.

Spectrum was a passion project, which has since gone on to become a prominent brand. This can be attributed to a simple fact: it has worked to enhance fish health, vitality and color... and has continued to do so for almost 20 years since it's introduction.

We believe in marketing through education, because "an educated consumer is our best customer". That's the purpose of this article. The same understanding about the dietary needs of fish we share here is the knowledge that has gone into our formulas. It's also why we feel passionately about exposing myths, marketing gimmicks and falsehoods about aquarium nutrition circulating within the hobby.

Spectrum was a passion project which has since gone on to become a prominent brand. This can be attributed to a simple fact: it has worked to enhance fish health, vitality and color

One of the ways we demonstrate our conviction is the *New Life Spectrum® Guarantee*.

Feed your fish Spectrum exclusively for 30 days. Your fish that eat it will experience a noticeable increase in health, vitality and color within that time. If not, send us back the unused portion and we'll give you a full refund no questions asked. That guarantee is unique among fish food brands; we can make it because we know the quality. We know the results. Because of this, we can afford to do so.

Why exclusively? This is a question many ask when learning about the guarantee. First, you'll get the best results by feeding Spectrum exclusively; it's balanced nutrient dense formula contains high quality ingredients in proper balance. Supplementing dilutes their total nutrition intake.

Second, feeding Spectrum exclusively allows you to evaluate the results. Using other foods to 'supplement' the food, hobbyists could attribute their fish's increased health to this varied diet — or simply not know which element is producing results. Using the single diet allows you to know exactly where the results are coming from.

Third is that when you feed multiple brands, Spectrum would be guaranteeing results with their food as well —and we simply can't vouch for their ingredients, since we don't know exactly what's in them. We know what the fish is eating when they eat New Life Spectrum®. Whole Antarctic Krill, Squid and whole fish are the most easily digestible protein sources. They also have the best amino acid profile and are rich in Omega-3 fatty acids. Likewise for high quality algaes (like chlorella, ulva, wakame and spirulina).

However, good ingredients cost money and result in less profit for the manufacturer. When maximizing profits collides with maximizing fish health... the bottom-line often wins. At New Life, we take pride on focusing on your aquarum's needs. We believe profit flows naturally from producing the best possible product.

Complete Nutrition. The beauty of New Life Spectrum® is the simplicity of a single food that can provide your fish an optimal diet. This even includes much of the trace elements and vitamins that reef keepers often dose their water with to ensure these elements are biologically available. Spectrum takes the guesswork and complexity out of aquarium feeding.

An example of the benefits of simplicity is vitamins and trace elements. In order to thrive, fish need a complex of elements in correct proportions. These include: *Calcium, Iodine, Phosphorus, Magnesium, Sodium, Potassium, Iron, Zinc, Manganese, Selenium, Chorine, Vitamin A, B6 & B12, C, D2 & D3, E, K2 & K3, Pantothetic Acid, Niacin, Biotin, Thiamin, Riboflavin, folic Acid, Myoinositol, Omega 3 & 6, and several Amino Acids (Arginine, Histidine, Isoleucine, Lysine, Methionine, Phenylalanine, Threonine, Trytophan, and Valine).*

Used in excess, vitamins can cause hypervitaminosis in fish. Too little results in poor health. Feeding a variety of foods, can you really hope to create the right combination to give them a balanced diet? Do you honestly know what's in your "mix" of foods?

The Results. New Life has painstakingly experimented for many years to come up with the right proportions for healthy fish. We've also successfully kept Parrotfish, Angelfish, Surgeonfish, Triggerfish, Butterflyfish, and even more difficult species like Moorish Idols, Rock Beauties, and Regal Angels. And of course we've also tested on Malawi and Tanganyikan cichlids as well as numerous species of herbivore, omnivore,

and carnivore freshwater tropical fish. All were fed exclusively with New Life Spectrum®. These fish don't have digestive issues; even fish with ultra-sensitive digestive tracks like Tropheus moorii and Labeotropheus don't suffer bloat when eating Spectrum. In fish fed with New Life Spectrum®, we've yet to encounter fish that develop lateral line disease, fin erosion or hole-in-the-head syndrome. If they will eat Spectrum, chances are they'll thrive. The proof is in the results.

Do Your Due Diligence. Change tends to meet resistance. New concepts might not be immediately embraced by hobbyists. Ideas like feeding a varied diet has been so fixed in the minds of hobbyists by "experts" that it seems like heresy to suggest otherwise.

Yet if we had just accepted the wisdom of "experts" without doing our own investigation and experiments, New Life Spectrum® wouldn't exist today. In developing it, we challenged many of the status-quo assumptions about how to keep fish (and other aquarium dwellers) alive and healthy. There are always new things being discovered on the frontiers of aquarium keeping.

So always try for yourself and experiment in your own aquariums. Draw your own conclusions. Chart the results. And keep in mind this quote by David E. Boruchowitz (editor of Tropical Fish Hobbyist magazine): "much of the scientific wisdom today began as heresies of another time".**BIBLIOG**

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