

WHAT DO YOU FEED YOUR GOLDFISH

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Rain Garden Goldfish

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I'm often asked what I feed my goldfish but seldom have a satisfactory answer. Because of economic constraints, we have to use a blend of industrial feeds purchased in bulk, plus homemade food and aquatic plants. It is not something that can be easily replicated at home. Some of these feeds are too rich for goldfish and others are not rich enough, but the mix produces the desired effect. If I could afford it, I would use the high-end goldfish pellets sold through pet stores and on line. Personally, I don't like flake food because it leaches a lot of nutrients into the water and its difficult to develop a sense of exactly how much you are feeding.

To understand how to feed a goldfish, it is useful to consider the diet of their wild ancestor, a carp. Call them Gibel carp, Prussian carp, crucian carp, funa, or whatever; they are still carp. The ancestral carp are not top-level predators or carnivores. They are usually called plant-oriented omnivores meaning they eat a variety of plant and animal matter, including decaying material, with the bulk of the forage being plant matter. The ancestral carp are not very good at chasing down large live prey. Swimming prey is usually limited to aquatic insects, insect larvae, Daphnia and other zooplankton, and perhaps fish fry. Much of their prey is foraged from bottom sediment and matted plants. An important component of the carp diet is periphyton, the microorganisms growing on bottom sediment and plant matter. The periphyton can include algae, fungi, bacteria, plus the larger but still microscopic nematods, ciliates and a wide variety of other creatures. While the individual periphyton organisms are tiny, they congregate together and can be slurped-up by the fish in mass.

The wild carp eat a lot of plant matter, although they are fairly selective. When talking about higher forms of plants (vascular plants), the fish are looking for a soft fleshy consistency, particularly the new growth at the tips. Some aquatic plants contain compounds which make them unpalatable. If it has a pungent distinctive smell or a coarse texture then the fish may not be interested. While coarse material cannot be eaten when the plant is alive, it can become a source of nutrition when the plant dies and begins to decay. The decay process breaks down and softens fibrous material and the decay organisms themselves (bacteria, fungi and microorganisms) have nutritional value. The fish may consume large quantities of decaying plant matter. The decay organisms are easy to digest, but the plant fibers are not. So, much of the fibrous material passes through the digestive tract and is excreted as fecal waste while the decay microorganisms are digested.

The other important type of plant life is algae, both filamentous algae and the unicellular algae that turns water green. Filamentous algae can grow attached to a surface or in

free-floating mats. It is often called string algae if it is long and carpet algae if it is short. Some species of filamentous algae are not palatable while others are readily eaten. Like higher plants, the filamentous algae may be coated in periphyton. The carp or goldfish cannot consume unicellular algae free-floating in the water because they have no means of concentrating it. However, unicellular algae have a short life span and the cells settle to the bottom as they become senescent. Bacteria attack the senescent algae cells and the gelatinous sheath covering most bacteria tends to stick it all together forming clumps. When the clumps get large enough, they can be slurped up by the fish. Many species of unicellular algae are easy to digest while others have a silica shell that makes them more difficult to digest. Again, the associated organisms of decay may be more nutritious than the algae itself. Dry wafers made of Spirulina algae is very nutritious and has numerous health benefits. However, it has a lot of protein (65%) and may not be the right supplement for diluting the goldfish pellet protein.

Wild carp are very opportunistic and take advantage of whatever food stuff they can find at the time. Seasonal and other cyclical forces make abundant rich forage, high in protein and fats, available for brief periods. At other times, the best they can find is fibrous cellulose with little protein or fat. Like most animals, they can store fat during good times to help tide them through the lean times.

Compared to most omnivores, goldfish and the ancestral carp have a relatively short intestine which is only about two times the length of the body. They do not have a true stomach although the front end of the intestine is somewhat elastic and can briefly store food. Since there is no true stomach, they do not have the acid phase of digestion which precedes nutrient absorption in the intestine. The fish is able to regurgitate food from the front end of the intestine at will.

Since carp do not capture large prey and do not have a true stomach, they are equipped with pharyngeal teeth instead of teeth we would recognize in the mandible. Pharyngeal teeth are located top and bottom at the back of the throat (the pharynx). The pharyngeal teeth look like hardened knobs and they are used to crush and grind food to make it more digestible before it enters the intestine. They work particularly well for grinding plant matter to make it more digestible.

Wild carp tend to feed through most of the day and process a lot of material through the gut. The bulk of what they are eating is difficult to digest, passes through the intestine and is excreted as feces. The most easily digested bits are assimilated and the fish receives the nourishment it needs. The lack of dense nutrients in the forage is compensated for by a large volume of ingested forage. This approach may seem less efficient than a bass, salmon or other top-level predator which is able to slowly digest most of what it eats. But, it works for the carp as the material they are feeding on is usually readily available in large quantities. Whether it came about through evolution or design, this is the carp's niche; its place in the natural world. It works perfectly for them.

Goldfish look very different from their carp ancestor both in body shape and color. But, they are still carp and their feeding habits and digestive processes have changed very little. From the description of carp feeding above, it seems a wonder that goldfish were ever domesticated at all. It is the way genetically encoded traits are expressed and inherited that make goldfish uniquely suited to domestication and, along the way, we have had to learn how to feed them.... sort of. The fact is, many goldfish keepers still struggle to find a suitable feeding regime. Not only has the domestication process not changed nutritional requirements and feeding habits but, in some respects, the goldfish is even less adaptable to changes in diet than the ancestral carp. This is because domestication has shortened the body length while all organs inside remain unchanged. When the organs are compressed into a smaller space, they are more susceptible to damage by fat accumulation. Of particular concern are the swim bladders, liver and kidneys.

Fish accumulate fat in the muscle, the body cavity between organs, and within various organs of the body cavity. Fat accumulation within the muscle tissue is normal and is the fish's way of storing resources for use during periods of food shortage. However, there are limits to the amount of fat that can be stored in muscle and it appears that when this limit is reached fat begins to accumulate in the body cavity. Upon dissection the fat can be readily seen as clear globules interspersed around the internal organs. There is a second type of fat accumulation in the body cavity that appears as a wax-like layer of material attached to the flanks of the body cavity walls. It is suspected that this wax-like fat is the result of both too much fat in the diet, and either an severe imbalance in essential fatty acids or rancid fat in the diet. Finally, fat can accumulate within the organs themselves. Carp are susceptible to fatty liver disease where excess fat accumulations disrupt liver function and poisons accumulate in the blood. Fat accumulation within the kidneys disrupts the ability to excrete water and the fish swells with dropsy (kidney infections can also result in dropsy). Fat does not accumulate within the swim bladder itself. But, when fat accumulates in the interstitial spaces around the swim bladders they are no longer able to expand and contract and buoyancy problems develop (floaters and sinkers).

The energy needs of fish are provided by fat, protein and carbohydrates in the food. Protein has a second function in that it is used to replace and generate new tissue (growth) as well as manufacture enzymes, hormones and other essential substances. Terrestrial animals find it more difficult to use protein for energy because of the way they must excrete the nitrogen that protein contains. In an aquatic environment nitrogen is much easier to excrete and is readily used as an energy source for fish. Protein can come from animal or plant sources. The protein from aquatic animal sources will have the most suitable amino acid profile (for more detail see the article http://www.RainGarden.US/bloodworm_legos.htm). Fat can generate twice as much energy per unit weight as protein or carbohydrates. All plant and animal sources of nutrients contain fat to varying degrees. Leafy green vegetables have very little fat,

seed grains and legumes have more, and animal products usually have the most fat. Carbohydrates are from plant sources and are the most readily available energy source in natural forage. Carbohydrates are also the least expensive component in formulated feeds. Starch is a type of complex carbohydrate (usually from grain) that binds a formulated pellet together and gives it stability. It would be impossible, or at least impractical, to make a formulated goldfish food which does not have all three; protein, fat and carbohydrates.

Goldfish pellets from the better manufacturers are designed to be highly digestible with very little fiber. The high digestibility results in reduced solid waste (fecal matter) in the aquarium. Good quality pellets have a fairly high percentage of protein and fat. Good quality pellets are designed to be a complete ration, meaning they supply all the nutrients the fish needs to sustain them indefinitely. The fat and carbohydrates are designed to meet the energy requirements. The protein is there to build tissue and other essential compounds. The percentages of protein and fat listed on the label do not tell the whole story as the sources of fat and protein are also important. A good quality goldfish food will also have the requisite vitamins and minerals, and the amino acid and fatty acid profiles will be balanced against known nutrient requirement. This often requires inclusion of more expensive ingredients.

Good quality goldfish pellets work well... as long as the amount of pellets each fish receives every day is closely controlled. The trouble is, goldfish can get all the nutrition they need with just a few pellets. A common rule-of-thumb is to feed the fish all they can eat in ten minutes; the rationale being that there will not be left-over feed to pollute the water. From a nutritional standpoint, they may get all the pellets they need for the day in about thirty seconds. Carp and goldfish instinctively spend much of their time foraging but in a well-kept aquarium there is little to no forage except for the daily ration of pellets. The rest of the day it feels hungry. The fish soon learn to beg for food whenever someone walks by the tank. They act like they are starving, but are really just bored. The compassionate goldfish keeper often obliges with a few more pellets and the goldfish ends up eating more than it needs to meet its nutritional needs. In other words, they are over-fed.

When over fed with rich food, they receive more protein than they need for building tissue and begin using the excess protein for energy. Since protein is easily metabolized for energy by fish, the fat can be stored for later use. Storing fat during times of plenty for use during times of food scarcity works well for a wild carp. However, feeding a pet goldfish too much of a rich diet, day after day, inevitably leads to problems. As fat deposits accumulate in the body cavity health problems develop, especially related to the swim bladders, liver and kidneys. There is evidence that feeding a rich goldfish pellet may also have adverse effects on the digestive system. There are reports of constipation and even descriptions of what desirable/healthy and undesirable/unhealthy goldfish feces look like. I have to admit that I have never been

able to evaluate a diet based on the appearance of feces, but do not question that it works for other people.

Some people think they want their goldfish to be fat because they like the plump look. What they really want are goldfish that are stout, not fat. A stout goldfish will look plump because of good husbandry when it was young, muscle tone, and genetic conformation. Fat accumulations do not improve a goldfish's appearance.

Most keepers want their goldfish to grow large. Overfeeding does not make goldfish grow faster or larger, it makes them sick. If you want a goldfish to grow larger quickly, then give it more space, not more food.

So, we face a conundrum. If we feed our goldfish too much rich food they will get sick. If we provide just enough goldfish pellets to meet their nutritional needs, they will be hungry all the time. Our goldfish pet will not bring much enjoyment if we feel as though we are torturing the poor thing. The solution is to not rely solely on commercial goldfish feed and try to mimic the natural diet to the extent possible. Provide an appropriate amount of goldfish pellets, but supplement the pellets with food stuffs which are high in fiber, but very low in protein and fats. The pellets will insure the fish gets the nutrients and micronutrients it needs. The other stuff will give the fish something to forage on throughout the day and keep material moving through the intestine.

The choice of "other stuff" is not an easy one and there are no perfect solutions. One of the best options is to provide aquatic plants for the goldfish to pick on. Anacharis (Elodea) sold in many pet stores works well, as does duck weed, water hyacinth (they pick at the roots) and many others. You may have to work with what is available to you. There are several problems with providing your goldfish with aquatic plants to pick at. In an indoor aquarium, if the plants are doing their job then the goldfish will probably ruin them. All the leaves will be plucked off the Anacharis, all the roots will be plucked off the water hyacinth, the duck weed will completely disappear, etc. It may not be possible to provide enough space and enough light to keep the plants growing faster than the goldfish can consume them. So, the plants may have to be replaced on a regular basis. Introducing and replacing the plants has its own set of problems. If they are from a pet store or a natural water body you should be concerned about introducing unwanted pests with the plants. This includes everything from snails to fluke eggs. Pests may be killed with a bath or dip in a chlorine bleach solution but this can kill the plants as well. Several parts per million of potassium permanganate does less damage to the plants but is unlikely to kill snails and some arthropods like Gammaris (little grey shrimp-like creatures). The snails and arthropods may serve as treats for the fish, but sometimes they get out of control.

Another option is to feed the fish leafy green vegetables from the refrigerator, freezer or pantry. Lettuce, turnip greens and spinach work well. You can also use dry alfalfa pellets or even grass clippings if there is no risk of pesticides. Sometimes, we use

banana leaves. Do not expect goldfish to gobble up leafy green vegetables as soon as it is placed in the tank. These items are more coarse than the fish would prefer and do not taste as good as pellets. Microwaving the vegetables for a few seconds will wilt and somewhat soften it. Often the goldfish will show no interest until the leafy vegetable matter begins to decay. The obvious problem is that having rotting vegetables on the bottom of your goldfish tank is not very attractive. These are, after all, supposed to be ornamental fish in an attractive display. There are no perfect solutions here and everyone must find their own way.

Peas, squash and other fruiting parts of plants are often fed to goldfish. Peas have quite a bit of protein and, personally, I would prefer that the goldfish get their protein from fish meal or other aquatic sources. Squash have little protein or fat, but the fiber content is lower than leafy green vegetables. Oranges have low protein and fat, are high in fiber, but are also very acidic. If some of these work for you then go with it.

It is important that the pellets are withheld to the extent that the fish is obliged to eat their salad too. If they are not eating their veggies then do not give them any more pellets until they do.

Of course, in an outdoor goldfish pond much of the above does not apply. When there is sunlight and each fish has a lot of surface area to work with a natural forage base develops. There will be carpet algae and probably "oxygenator" plants or other vegetation to graze on. There will also be periphyton, insect larvae and other good things to eat. Nutritional problems are much less likely under these conditions.

We should probably mention homemade food here. Many recipes for homemade goldfish food can be found on line. Most blend a variety of ingredients and bind it all together with gelatin. Homemade food is only as good as the ingredients. Those who go to the trouble to make their own food do so because they know what's in it. But, it is not a chore that should be taken lightly. Look up the moisture, protein, fat and fiber content of each ingredient and make sure the end product will have acceptable levels. A spread sheet helps a lot when doing the calculations. Make sure there is enough of the required vitamins and minerals. Do not neglect the amino acid profile because these are the building blocks for fish tissue growth. Some say that when you buy a good quality commercial feed, you are also buying the expertise of a professional fish nutritionist. It's a judgment call and we should be thoughtful about it. On our little farm, homemade food as a way to make use of garden trimmings and some pests like snails and crawfish. We also use wheat flour as a binder and turn it all into a dry shelf-stable pellet. The ingredients are free but it requires a lot of labor so the overall cost is about the same as commercial feed.

There is a lot of confusing and conflicting information about goldfish keeping and very few unequivocal truths. But, it is pretty safe to say that most problems are caused by overfeeding and starving a pet goldfish to death is almost inconceivable.