President Corner

Thank you Millie & Simon for opening your home and Koi Pond to us. We all had a wonderful time.

It is time for our Annaul Picnic at Mountain View Koi Fish & Aquatic Plants in Hereford, Arizona. A chance to get in to cooler tempentures and have a great meeting.

The weather is hot and humid. How is your pond? What is your water temp? How much oxygen is present in your water? Are your fish eating? How much? What is the chemical balance of your pond, and why? These are just some of the questions a pond and Koi owner need to answer. This is also why you became a member of SAKA. You can learn so much just by coming to the meetings, and sharing with each other. Be an active member the knowledge you can learn is limitless.

For the love of Koi,
Bob Panter
Bob Panter
President SAKA

July 24 Potluck

Our next club meeting will be potluck. It will be held @ Mountain View Koi Fish & Aquatic Plants in Hereford, Arizona. The divisions of items to bring are as follows:

A-E Appetizers
F-L Deserts
M-S Side dishes (Macaroni or Potato Salads)
T-Z Side Dish (Veggie, Salad or Rolls)

Mountain View Koi Fish & Aquatic Plants will provide the Sodas, BBQ Chicken, Hamburger & Hot Dogs and Lisa & Kurt will also provide Chef Kurt (boy are we in for a treat. Could you please give Lisa or Kurt a call @ (520) 378-3710 as soon as possible, to tell them that you are coming, so they know how much food to order?

You Might be over Feeding your Koi If……...

By Ray Jordan, edited by Tom Ayers
http://www.texaskoi.com/Articles/you_might_be_over_feeding_your.htm

Many of the phone calls and questions I get concerning Koi problems are directly or indirectly related to feeding. Feeding is a much bigger topic to present than you might think. First and last, everyone feeds his or her fish too much! You do it and I do it. It is just so much fun to see them come to us and eat. But, we could be killing our pets with kindness. Please consider the following:

You might be over feeding your fish if… (or feeding the wrong food)

1. Your water is cloudy or green
2. You see foam on the surface of your pond (Turn off your simmer if you have one for several hours)
3. Fish poop is floating instead of sinking
4. Your fish look more like sumo wrestlers than gymnasts
5. The white color in your adult fish is yellow or pink instead of bright white
6. Your fish start losing their color
7. There is unconsumed food more than 90 seconds after feeding begins
8. Your fish are getting sick or dying

The most common questions I get about feeding fish are:

Q – What should I feed my Koi?
A - Most hobbyists feed a basic diet of a manufactured Koi food and supplement with fruits, vegetables, cereals, shrimp, krill, worms, etc.

You should feed a fresh high quality manufactured fish food as your fish's basic diet. Koi need the same types of nutrients as we do. That is, they need carbohydrates, fats, protein, vitamins and minerals. Fish digest carbohydrates at a lower rate than we do and should receive very little fat. Koi do very poorly on fish food based on corn. Since corn is cheap some pond fish foods or catfish foods use it as the main ingredient. Avoid food that lists corn as one of the top four ingredients. Wheat and Wheat Germ is a much better main ingredient for koi . Good foods will have about 32%-36% protein based on wheat germ, fish meal and/or shrimp/krill meal, sea weed (spirulina) soybean meal, assorted cereals and added vitamins. Fat should be 6% or less.

Look for vitamins: A, B1, B2, B6, B12, C & E. If your koi or goldfish food doesn't clearly tell you what is in it they probably don't want you to know.

TIP: Look at the Champion fish at shows that have deep colors, bright whites, and strong body shapes then ask their owners what they feed
their fish.

You want the freshest food you can buy and you need to keep it fresh. If possible buy food that has a manufactured or expiration date. Buy
from a dealer that sells lots of food and therefore has fresh food. Buy in small enough bags that you can use it within 2-3 weeks of opening.

Vitamin levels start dropping as soon as manufactured and even faster as soon as you open the bag. Do not let fish food get warm or damp. It will quickly spoil and get moldy. Many times sick or dead fish can be traced directly to "spoiled" food. I recommend putting opened fish food in airtight containers such as a ziplock bag in the refrigerator. This will allow you to squeeze out the air each time you reseal the bag. If in doubt about your food being spoiled throw it out. I once visited someone that kept having fish die and I noticed some fish swollen from
internal infections. When I saw a huge half used open bag of food in the tool shed I check it out. I found just under the surface of the food was
a solid lump of moldy disgusting yucky stuff. The owner threw out the bad food and his fish health problems quickly disappeared. I know a
big bag is cheaper but please believe me when I tell you it can cost you a lot more in the long run.

Q - How much and how often should you feed your koi?
A – Short Answer - Feed less total food per day and give more frequent feedings.

Long-Long Answer: Everyone I know feeds his or her fish too much! I do it and so do you. Koi and goldfish feeding should be based on a combination of water temperature and total weight of fish in your pond. Fish are cold-blooded creatures and cannot digest food once pond water drops and stays much below 50 degrees. In colder winter months koi and goldfish in outside ponds become dormant. Yes, they will eat if fed but the food just passes through them and then pollutes the water and your filter system without doing your fish any good whatever. In fact, your biological filter is also mostly inactive below 50 degrees so any ammonia and waste produced by the undigested food cannot be process by your filter system. If ammonia or nitrite levels go high enough it can easily stress or even kill your fish.

Here is the feeding schedule I try to use. Use average weekly water temperature. Optimum water temperature is about 72-76 degrees for koi.

Ø Below 50 degrees – do not feed

Ø Start feeding in spring as water warms and stays above 50 degrees. For first few weeks feed only every other day and very sparingly maybe 2-3 pellets per fish. Try to feed in late afternoon when water is warmest and fish will be better able to digest.

Ø 50 to 60 degrees - Slowly feed to 1% of fish weight divided into two daily feedings if possible mid and late afternoon.

Ø 60 to 70 degrees feed 1% - 2% of total fish weight divided into three daily feedings

Ø 70-80 degrees feed 3 to 3-1/2% of total fish weight divided into 3-10 feedings.

Ø 80-90 degrees feed 2% to 1% of total fish weight divided into 3-10 feedings

Ø 90-100 degrees reduce feed to less than 1% total fish weight divided into two feedings. Feed early and late when cooler

According to this formula if you had 35 lbs. of fish in your pond (This is a lot of fish folks - about 44 - twelve in. koi) and the water temperature is 75 degrees you could feed up to 1lb. Of food a day divided into 3-10 feedings. Remember this is the optimum water temperature and in our area you might only feed at this rate for 3-4 weeks in the spring and maybe about the same in the fall. For those of us that are gone during the day we are limited to feeding about three times. Before work, when we get home and then just before dark. On the days you are home you could increase the frequency of feedings. You might also consider using an automatic fish feeder for the mid day feedings. For example if you were going to feed 1 lb of food per day you should still do the first and last feeding to observe your fishes behavior to be sure they are "happy" and also that's one of the pleasures of having koi. Use the automatic feeder to deliver the rest of the food allocated into feedings every 1-2 hours.

But how do you find out how much your fish weigh? Well you could guess or you could put one of average size in a plastic bag and sneak into the grocery store and……

Or you can estimate each of your fish's length in inches and use the following chart to calculate each fishes weight and then add up the weight of all your fish.

(Example)

Koi Length/Weight conversion Chart*

Size	Wt/lbs.	# koi	Total Wt.
6-7 in	0.15	3	0.45
8-9 in	0.23	3	0.69
10-11 in	.5	3	1.5
12-13 in	0.8	3	2.4
14-15	1.3	3	3.9
16-17	2.0	3	6.0
18-19	3.0	0	0.0
20-21	4.2	1	4.2
22	5.3	3	15.9
23	6.6	0	0.0
24	7.9	0	0.0
25	9.4	0	0.0
26	11.5	0	0.0
27	13.8	0	0.0
28	15.3	0	0.0
29	18.8	0	0.0
30	21.6	0	0.0
Totals		22	35.04

*Estimate based on length of "average" koi. Adjust for fatter or skinner koi. With Long Fin Koi and goldfish I would not include tails in the length estimates.

There is some pretty interesting information in the chart above. Notice how the weight of fish increases almost logarithmically as the length increases. For example almost 50% of the total fish weight is the three 22 in. fish. If you really want to do the calculations and you have excel as a program on your computer chick on the attached file an a excel spreadsheet will do the work for you.

KOI-WEIGHT-CALCULATOR

With some fish foods such as Tetra koi sticks almost all the moisture is removed so the food is very light weight. The calculation suggested above would not work with that type of food. In practice this chart and formula is just a starting point. You should look to your fish to tell you if they are getting the right nutrition. Healthy fish will have bright colors, and a very bright shiny white color. Their skin will almost glow and they will be very active and feed vigorously. Look to the clues listed in the beginning of this article for problems that suggest over feeding or poor nutrition.

I feed the amount of food I use by volume. For example, at optimum water temperature I feed my koi about 2 cups of food a day divided into as many feedings as possible. This weighs about * of a lb. I measure the 2 cups into a zip lock bag each morning and then I can space out the feedings from that bag so that it lasts all day. This way I don't lose track and overfeed. We have a 100-gallon aquarium with 5 small oranda's. I feed * teaspoon of goldfish food daily divided into several feedings.

Q – What Feeding Supplements are recommended?

A - In addition to the basic manufactured koi foods I like to feed some additional foods to help insure my fish get a well balanced diet. Also many of these foods seem to be a real treat for the fish and they turn into a "Fish Tornado" when certain foods are offered. The things that my fish seem to like the most are freeze dried krill and baby peas. They go nuts when I offer these treats. You can buy Freeze died krill in most places where you buy fish food or it can be ordered. They also love canned baby peas (silver can of course). I just toss a handful to the fish a few times a week. I bet you can hear the slurping sounds of happy greedy koi a block away. Koi can also be trained to eat romaine lettuce, oranges, Grapefruit, watermelon, cantaloupe, bananas, bell peppers, carrots, spinach, zucchini, Swiss chard, cooked rice and pasta, whole wheat bread and pinto beans.

I buy a jar of vitamin C powder from a health food store each spring and dissolve a teaspoon in a small amount of water and mix into the koi food I feed for the first few weeks each spring. I believe this has helped cut down on spring disease problems and is very easy to do.

I bet you could tell me many other things that your fish eat as well. Many of the koi magazines and web sites offer recipes for

making your own fish food if you would like to experiment. Let me know how your fish like the homemade foods if you try any.

Special Foods

There are koi and goldfish foods that are called "Color" foods. These foods contain coloring agents often "spirulina" which is from blue green algae and can enhance red colors. Color food is much more expensive and higher in protein than basic food. Therefore if used it should only be feed at optimum water temperatures an only for short periods of time. If you feed color food too long your fishes white color will turn yellow. Also color food only enhances the reds so fish of any other color will not benefit. I personally, do not feed any color food. I save the extra expense and buy better basic food. This past spring I bough some paste food. I fed this once every other day along with the regular pellet food. The paste food was easy to mix into dough balls and I added vitamins C&E plus a immune booster. It seemed to work well and the fish thought it was great. You have to be careful with this type of food as it tends to make your koi fat fairly quickly. You should not feed this alone but give in place of one feeding every other day or every third day.

Q – How can I train my Koi to eat out of my hand?

It is a special treat to train your fish to eat from your hands. This can also be a lifesaver if a koi gets sick. You could feed medicated food just to that fish without treating your entire pond.

Before hand feeding remove all jewelry including your watch. As your koi get bolder they will rub all over your hands and arms and can get scratched very easily by your jewelry. Quit feeding for several days to get your fish really hungry. At first the fish will be shy of your hands so place a small amount of food on the water near your hand and hold your hand in the water and stay very still. Don't bother to try this if your fish are small babies. Only the larger adults will be bold enough to approach your hand. As the fish begin feeding and become accustomed to your hand in the water start placing a few pellets very near your hand. Avoid sudden movements. As they approach you do not try to pet them yet. Once they are feeding near your hand put the food only in your hand and again stay very still. It may take a few feeding sessions but soon the bolder fish will be willing to swim up and eat right from your hand. Later you can pet and rub them and let them suck on your fingers. I had a koi that would let me lift it completely out of the water for a few seconds without trying to flop around. Some fish will never be bold enough to feed from your hands. The friendliest fish and ones easiest to train are an older variety called a Cha Goi. Which is a subdued brown colored koi with beautiful black edging around each scale that appears like the fish is covered in netting. Goldfish seem to learn hand feeding faster than koi.

Vacation Feeding

I have heard many sad stores of pond owners leaving on vacation and asking a neighbor to "feed" their fish. They frequently come home to over feeding disasters. I recommend that if you are leaving town for one week or less do not have your fish fed at all. You will probably be amazed when you come home to the prettiest cleanest pond water you have seen for quite a while. If you are going out of town for longer than one week. Cut back the feeding by * and carefully measure the exact amount of food you what fed each day into separate labeled ziplock bags.

Summary

Feeding your fish is a very important part of your responsibilities as a pond owner. Please do not over feed. If you are not into all the calculation stuff just start by cutting the amount of food you have been feeding in half. If you water gets clearer and your fish look and act happier in a few weeks then you know you are on the right track. Feed high quality fresh food and keep it fresh. Divide your feedings in to as many times a day as possible. Then sit back and enjoy your healthier and prettier koi.

NISHIKOI

Feeding for Health

The two most widely debated topics amongst koi keepers are nutrition and filtration. This is very understandable when these two areas of the hobby are likely to have the greatest combined impact on koi health. As filtration is a very 'hands-on' and practical aspect of koi keeping, the science and principles involved are well understood and widely practiced. Koi nutrition however, is completely different. Our understanding and appreciation of koi foods is limited, being at the mercy of koi food manufacturers that present us with long lists of ingredients and claims about their products. As we are not able to test or in extreme cases interpret the science we are rarely in a position to question such claims. Consequently, myths abound in the world of koi foods and as our general understanding compared to that of filtration is quite limited we cannot fully appreciate the what, why, how and when of koi nutrition. That is, until now.

This is the first in a series of 6 articles on koi nutrition, looking at how koi foods achieve what they claim, (in delivering health, growth and color), how they can interact with our ponds to cause other changes and how recent innovations may soon lead to a new generation of koi foods.

Feeding for Health

Fast food and convenience meals have given western culture the accolade of topping the world's obesity rates. Equally, our level of education about our health and environment has never been greater. We know what is good and bad for us, and yet we continue to choose the non-balanced route; a recipe for disaster and certain ill health.

Our first consideration for our koi is that unlike us, they do receive a well-balanced and complete diet. Unlike the 'natural' conditions of a koi farm pond, where koi can graze and forage all day, and where snacking is actually encouraged, our gin-clear, hyper-filtered ponds cannot satisfy the nutritional requirements of our koi. Put simply, if we don't feed them a complete and balanced diet, they won't get one, and their health will suffer as a result.

Not too much, Not too little

What do we mean by a balanced diet? A diet is described as balanced when all of the constituent parts are neither limiting nor excessive relative to an animal's nutritional requirements. Consequently, each animal requires a different balanced diet. If the diet is deficient in a particular area, or excessive in others, then prolonged exposure to such a diet will cause health problems. 'Fast food' is not bad for us, as long as it is part of a balanced diet.

A complete diet is on that fulfils all of the nutritional requirements of an animal, and it is our responsibility to provide any captive-reared animals complete nutrition, be they in a zoo, aviary or koi pond.

To be able to fully appreciate how a diet can influence the health of koi, we need to analyze the components of a healthy diet in the light of the functions each part of the diet plays. Furthermore, it is necessary to understand how koi breakdown and utilize each component.

Components of a koi diet

Artificial koi foods can contain a wide range of raw materials in their formulation and these can be blended to provide an overall balanced diet. The formulation of a balanced diet must contain the correct quality and quantity of the various nutrients groups. These are Proteins, carbohydrates, lipids, vitamins and minerals.

Protein

Protein is very important to koi, as it is the only nutrient to provide growth. It is also the most significant contributor to the price of a diet.

Koi require protein for growth, repair of damaged tissue and the production of sperm or eggs. Proteins are made up of soluble building blocks called amino acids. There are 24 amino acids, with koi requiring 10 essential amino acids in their diet. They are able to manufacture the remainder themselves. Raw ingredients such as fishmeal, poultry meal and wheatgerm are included in the diet as high quality sources of these essential amino acids.

Protein requirements decrease with the age of koi, but increase with the water temperature. Juvenile koi that are actively growing require high protein diets of 30-40% to fuel such rapid growth whereas larger koi on a maintenance diet will require less protein in their diet. Similarly, as the temperature increases, so do the koi's metabolic rate and its demands for energy and protein.

Carbohydrate

Carbohydrates are vegetable in origin and include the complex sugars such as starch. They also include cellulose (fiber) as a source of roughage, which assists the movement of food through the gut. To keep waste in ponds to a minimum, artificial koi diets will have a reduced fiber content compared with their natural diet.

Carbohydrates are included in high quantities in koi diets as a source of energy. Too little carbohydrate in the diet may lead to koi using the relatively expensive protein as a source of energy. This will lead to a drop in growth rate and an increase in ammonia excretion, which may cause the water quality to deteriorate. Too much carbohydrate energy) in the diet can lead to fish putting on fat causing a detrimental change in bodyshape.

Lipids

Lipids (oils and fats) are used by koi as a source of energy. They also play an essential role in the formation of cell membranes and are carriers of the fat-soluble vitamins A, D, E and K.

Lipids are included in the diet as fish or vegetable oils. The oil content of a koi diet should be less than 10% as excessive oil levels can lead to koi health and water quality problems. This is one of the reasons why koi should not be fed exclusively on trout pellets that are traditionally very oily.

It is essential that koi are fed unsaturated lipids (oils) that remain liquid at low temperatures. If koi are fed saturated fats then dietary problems are likely to occur, as they are unable to utilize large quantities.

Vitamins

Koi require vitamins in their diet to carry out essential functions for healthy growth. Vitamins are complex organic substances that are required in minute quantities. A number of vitamins are notoriously unstable and may have to be supplemented by adding premixes during the manufacture of pellets to guard against deficiencies. These will deteriorate over time, so keep an eye out for 'best before' dates on food.

Minerals

Minerals are inorganic compounds required in the diet to aid metabolic functions and the deposition of tissue such as skin, scales and bone. They are also required in small or trace amounts and are included in the diet in the form of ash. Koi have the luxury of obtaining minerals from either their diet or the pond water. Something we cannot do.

Koi pellets may also be formulated to include a number of additives to improve or enhance various functions of koi.

Stabilized Vitamin C

Vitamin C is vital in the diet for fish health, fighting disease and repairing damaged tissue. The fragile nature of vitamin C means that it can be lost during the manufacture of expanded koi pellets. As koi are unlikely to obtain vitamin C from within a koi pond it must be included in the diet to maintain health and to prevent the occurrence of deficiency problems. A stabilized form of vitamin C is now an important additive to many koi foods that will remain unchanged through the manufacturing process and prevent deficiency problems in koi.

In summary, the health and vitality of our koi rests in our hands. We should be satisfied that the food offered to our koi provides all they need to remain healthy. Check the labeling for vitamin declarations and best before dates and that there is a good balance between animal and vegetable ingredients.

NISHIKOI

Feeding for Growth

Living in a world where biggest is best and quantity dominates quality, it stands to reason that we have the desire to see our koi grow to their full potential, and a sizeable potential at that.

Koi can grow to an enormous size, with several varieties now exceeding the previously mythical 1-meter mark and 'wild' colored carp reputedly reaching 90lbs in weight in Australia. It is human nature for our eyes to be drawn to the largest koi in a pond, irrespective of their grade or quality and having seen large koi at shows or in other ponds, we are keen for our own koi to also achieve their full growth potential.

There are 3 factors that interact to control a koi's growth rate and ultimate size of our koi. These are:

1. The koi's genetic make-up.
2. The koi's growing environment (water temperature, water quality and stocking density)
3. The koi's diet.

We cannot influence the koi's genetic make-up, but can work with its blueprint for growth. The genetic coding for the particular growth characteristics of each koi will interact with their environment and diet to determine the size and growth rate of each koi.

Although koi are cold-blooded, they are warm water fish, growing optimally in a stable 27degrees C with excellent water quality and a low stocking density. Assuming that koi are provided with an environment that will allow them to grow, then a koi's diet is the final piece of the growth jigsaw.

Growth Diets

Protein is found at the heart of any diet. It is the only component of a diet that koi can use for growth, but must also be part of a complete and balanced diet also containing adequate oils, carbohydrates, vitamins and minerals. Protein levels in a diet are the first thing a koi keeper will scrutinize, but the absolute protein content of a koi food is not the only factor that will impact on koi growth rates.

Protein Quantity

Naturally, carp will feed on a diet that has much higher protein levels than those offered in an artificial koi food. Preferring to feed on worms, insects and other invertebrate life, carp will often consume a diet of 50-60% protein whereas most koi diets will provide protein levels between 30% and 40% - So why the difference?

Research has shown that fish can choose to use the food they consume in different ways, particularly protein.

Fish are just like any other animal, in that they will eat to satisfy their energy requirements. For koi, this will enable them to swim, feed, breath, and maintain basic physiological functions. They can obtain this energy through their intake of oils, carbohydrates and proteins, using proteins as their preferred energy source. Consequently, 'wild' carp naturally consume a high protein diet that satisfies their energy demand, with any excess being used for growth.

So why not offer koi a similar 50-60% protein in a koi food?

To offer koi an ultra high protein diet has several disadvantages.

1. Proteins are complex compounds made up from carbon, hydrogen, oxygen and nitrogen molecules.

When koi opt to 'burn' protein as a source of energy (rather than utilizing it for growth), they burn the carbon, hydrogen and oxygen but excrete the nitrogen – in the form of ammonia. Therefore, the more koi utilize protein for energy, the greater their ammonia output. In a 'natural' environment this does not pose a problem for carp, but where koi are stocked intensively, this would lead to water quality problems.

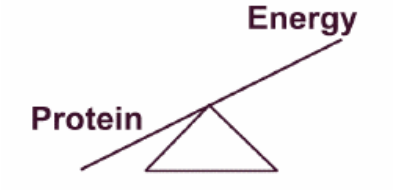
2. As protein, particularly high quality protein, such as fishmeal, poultry meal and wheatgerm is in high demand across the world, it commands a high price. Supplying a high protein (50%+) diet for koi would cause a prohibitive increase in the cost of diets and be a needless extravagance as a koi's ability to utilize protein efficiently tails off as protein levels in the diet increase.

Replacing valuable protein as a source of energy.

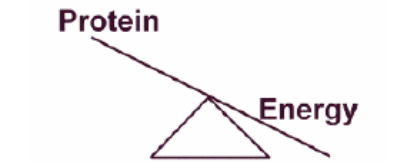
Research has shown that by replacing a proportion of the valuable protein in the diet with alternative sources of energy (oils and carbohydrates) that koi will utilize those for energy, reserving the premium protein for growth. This practice is called 'protein sparing' and is used in many aquaculture diets to ensure that cost-effective growth is achieved.

The Protein-Energy Balance

Focusing solely on the protein content of a diet does not give us an accurate picture as to how koi are likely to use it. Protein in the diet must be balanced with a diet's energy content to ensure it is used for growth.



If the diet contains too much energy in relation to protein then koi will store excess energy as fat.



If the diet contains too much protein in relation to energy then koi will be forced to use protein as an energy source. This will adversely affect growth rates in koi.

The ideal balance. When protein levels are in balance with the energy content of a diet, koi will not store excess energy and there is sufficient protein for growth.

Protein Quality

Having determined that putting excess protein in the diet should be avoided in koi diets, we must ensure that the protein in the diet is of sufficient quality to allow tissue growth.
We should not simply be satisfied by the protein level in a koi food, as the quality of the protein will also affect growth. For example, imagine two different diets (Diet A & Diet B), each offering 40% protein – Apparently there is nothing to choose between them. However, Diet A uses feathermeal as its protein source and Diet B uses white fishmeal as its protein source. The protein levels of either diet are identical, but Diet B will offer your koi the best growth potential as the protein is of a high quality. This is an extreme example, but illustrates the point well, that the sources of protein should be investigated rather than simply the protein level when comparing different koi foods.
When a food is described as containing 'highly digestible protein' it relates to the fact that koi can break it down and utilize the amino acids. I.e. Diet B contains highly digestible protein whereas Diet A does not, making the protein in Diet A unavailable for koi to use in growth.

Proteins are made up of soluble building blocks called amino acids. When a protein is digested (not that straightforward for a stomachless koi) it is broken down into amino acids which are absorbed into the blood and taken to areas of tissue growth. Koi require 10 of the 24 amino acids to be provided in their diet (they can manufacture the other 14 themselves). These 10 essential amino acids must be provided in the diet or koi health (never mind growth) will be impaired. Animal sources of protein (fishmeal, and poultry meal) offer the complete range of essential amino acids whereas vegetable sources may only provide the majority of the essential amino acids. Therefore, to allow growth, a diet should provide between 30-40% of protein, the majority of which is animal in origin.

How much food?

Having identified that a growth food should contain a good percentage of highly digestible animal and vegetable protein that is balanced with the food's overall energy content (so that koi use the protein for growth rather than energy) then we need to identify how much food we should feed. This is governed by temperature and food quality but speaking generally, research data shows that a maintenance ration equates to feeding approximately 3% of a koi's body weight each day. (When did you last weigh your koi?)

For a 1 Kg fish, 30g of food a day is required to maintain its health and current bodyweight. Data suggests that an optimal ration for growth is 6%BW per day with ratios that exceed 3%BW likely to be sufficient for growth at cool UK temperatures. Beyond 6%BW, the more food offered, the less efficiently it is digested and utilized for growth, leading to greater excretion.

Furthermore, there is evidence that koi utilize food more efficiently if it is offered in small amounts in regular intervals rather than in a single large feed. This relates back to a koi's digestive physiology

which, being without a stomach, handles smaller feeds more effectively.

In summary, the growth potential of every koi is locked up in its genes and we can unlock that potential through feeding a suitable diet. Growth foods focus on the quality and quantity of protein, its digestibility and its relationship with other ingredients in the diet. Further growth improvements can be achieved by feeding the correct quantity of food in a manner that koi can utilize the protein most efficiently for growth.

NISHIKOI

Feeding for Color

Feeding koi should not simply be regarded as satisfying their hunger. It is an opportunity. We have seen that a koi's diet is instrumental when endeavoring to improve their health and growth. The final of the 3 most desirable characteristics that can be enhanced through their diet is color.

Myth, mystery and even magic formulations abound when the topic of feeding for color is discussed. True, there are some closely guarded secrets and practices that professional breeders will not disclose (Coca-Cola style) but coloration and pigmentation in koi is controlled by a number of well established research-backed physiological processes. So just as we can work with a koi by feeding to enhance their health and growth, science dictates that we can do the same for color.

A koi's coloration is determined by the interaction of a combination of internal and external factors.

Internal factors: The koi's genetic make up inherited from its valuable brood parents will code for the color, distribution and development of a koi's pattern. The internal factors will only be expressed if the koi are offered an appropriate diet (in the same way that recent research shows that where obesity is caused genetically, it will only be expressed if the individual consumes the necessary quantity of food).

External factors: Besides other factors, the most important external factors that influence koi color include water quality and specifically, their diet.

The Roles of Color Enhancers.

Koi are only able to exhibit pigments if they receive them (or their precursors) in their diet. Each type of chromatophore in the skin stores and exhibits a different carotenoid (a group of natural pigments). For example, a melanophore will store black pigment while erythrophores will store red pigments and only those colors that a koi exhibits can be enhanced by feeding a carotenoid-rich diet. Carotenoids are organic, unstable compounds that are closely related to Vitamin A, imparting color by the way they absorb and reflect light. Those pigments at the lower end of the spectrum (lutein) will produce yellow pigmentation while those higher up the spectrum (astaxanthin) will produce the more desirable red pigmentation.

As carotenoids degenerate over time (in the same way as vitamins) koi colors can fade. In the same way as a car needs to be topped up with petrol to keep it running, so a koi's color-tank needs to be kept topped up for a koi to maintain its vibrant coloration.

Carotenoids are, of course, not unique to the world of koi. They occur naturally in a range of natural products from tomatoes, peppers, flowers, insects (ladybirds – cochineal food coloring) and many aquatic organisms such as lobster and krill. They are synthesized by plants and algae and then passed up the food chain. For example, marine algae will be consumed by filter feeding crustacea, which inadvertently pass on their pigmentation to wading flamingos which will adopt a similar pinkish color.

The algae consumed by krill will be rich in pigments such as carotene, lutein and zeaxanthin (which are definitely not pink) and upon assimilation, krill are able to convert these carotenoids into the red pigment astaxanthin (named after the lobster – Astacus).

Crafty Koi

Koi too are quite cute when it comes to manipulating color enhancers. Like krill, they are able to convert pigments commonly found in algae (spirulina) such as lutein and carotene into the more desirable red pigment astaxanthin. (Something trout and salmon are unable to do, requiring astaxanthin to be included in their diet if their flesh is to take on a pink appearance). Also if a koi's chromatophores express yellow pigment (as in a Yamabuki) then koi will exhibit the same yellow pigments from spirulina unchanged in their skin. When stripping ripe female koi of eggs, each koi will release eggs that differ in color, even though they will have been fed the same diet. This is further indication that individual koi can manipulate and express different pigments that they assimilate from their diet.

Sources of carotenoids that koi can utilise to enhance their coloration.

Recognising that koi color is most intense in a natural clay pond environment, we are able to mimic the coloring effects of their natural diet to an extent by including similar additives to their artificial diets.

There are two approaches to enhancing coloration in koi. The broad-brush approach (using the breadth of carotenoids available in natural sources) or the more deliberate and precise approach (using synthetic color enhancers).

Natural Sources.

There are several recognised natural sources of carotenoids suitable for color enhancement. Like any natural commodity, qualities and pigment content can vary from source to source, and being organic, can be liable to degradation during food manufacture. However, natural sources are also renowned for offering a superb range of carotenoids giving koi (who have the ability to convert carotenoids) excellent color potential. For example, marigold petals have more than 20 different carotenoids, which koi can work with and manipulate. They also have a high concentration of these compounds (approximately 9000mg per kilo), whereas shrimp or krill meal will only have about 200mg per kilo, with the added issue of the exoskeletal material having an exceedingly high ash content.

Furthermore, there is a price to pay for koi using natural carotenoid sources as the process of converting them into more desirable astaxanthin requires energy.

Artificial Sources.

Aware of some of the limitations with natural sources of color enhancers, much research has led to the formulation of potent, stable and effective man-made color enhancers. These will provide koi with a precise amount of pigment in the form in which it will be deposited in the skin. So rather than feeding a natural source of unknown quantity or quality of carotenoid which koi will convert into red, they can be offered a metered dose of pigment in the final form in which it will be used.

Where does all the color come from?

Color and pattern in koi is produced by clusters of tiny microscopic color cells called chromatophores.

Types of Color Cells.

There are two groups of color cell situated in the skin – those that are colored and can be enhanced and those are not colored.

A koi's appearance is determined by the interaction between the group of cells called iridocytes (which are packed with guanine to reflect light, giving the koi a metallic lustre) and those cells which exhibit a specific color and can be enhanced by feeding a color enhancing diet. These include the black melanophores (sumi) which also produce blue when set deeper in the skin, and the erythrophores (hi) which give a koi an orange or red coloration.

Look for foods with the following ingredients, as they will enhance the coloration of your koi.

1. Marigold Flower Meal. Probably one of the most potent natural sources of carotenoids available. The pigments require manipulation by koi to convert them into reds.

2. Artificial color Enhancers. Astaxanthin and Canthaxanthin are guaranteed, potent sources of color in the form that will be exhibited immediately in the skin.

3. Spirulina. This has an above average carotenoid content that is easily assimilated, being found in very simple algae cells.

4. A Yeast – Phaffia rhodozyma. This is easily digested and is a recognised source of carotene and astaxanthin.

5. Paprika. Red Pepper Meal. More potent than spirulina, and contains red pigments ready to be absorbed and assimilated immediately.

Other Environmental Factors.

Managing the water quality to complement the effects of a
color-enhancing diet is likely to lead to further improvements in color.

Coloration and skin quality improves greatly in harder more alkaline waters where the ready supply of minerals enhances darker pigmentation and improves the lustre of the guanine-rich iridocytes. The regular dosing with a high quality calcium montmorillonite clay and the buffering of the water with a calcium rich substrate will be effective in producing a mineral-rich pond environment.

In summary, when seeking to enhance the appearance of koi, we can only work with what we've got – that is the 'internal' genetic code that koi have inherited from their parents. While many sources of color enhancers are available, some obviously outperform others due to their quality and composition of specific carotenoids. Scientific understanding of how carotenoids work in partnership with a koi's color potential has lead to the production of potent synthetic color enhancers that have a precise and predictable effect on koi.

NISHIKOI

How feeding can affect water quality

Every environment has problems if the inputs into the system are out of balance with the rate at which they are removed or broken down. Currently, on a global basis, this is the case with CO2 and the earth's atmosphere and it is also true for every Koi pond, where the regular addition of food into the pond environment will unavoidably lead to a change in water quality.

It is helpful to understand the various implications for both Koi and Koi pond that are being fed regularly, the reasons why particular changes in water quality occur and the measures we can take to reduce them.

The stability of our pond environment is going to be threatened through the activities of feedingat many different stages from the moment the food hits the pond's surface through to it digestion, assimilation and excretion and ultimate collection in the pond and filter.

The impact of feeding on water quality

Leaching

Water is the world's best solvent and will readily draw solutes out of food, the moment the two come in to contact. Many water-soluble compounds in foods (most vitamins and minerals) will have a tendency to leach out of the food into the water and longer the food is in the water before being consumed, the more extreme the leaching is likely to be. There is a danger of leaching making foods nutritionally deficient but most food manufacturers recognise
this potential problem and ensure that food contains excess levels of water soluble vitamins. However, even a tiny degree of leaching is inevitable at each feed, causing nutrients to accumulate in the pond water, thus altering the water chemistry. Therefore, even through the natural course of feeding, the balance of the pond's chemistry is under threat.

Pre-soaking Food?

With the extent and speed at which leaching occurs, it should really bring in to question the practice adopted by a number of Koi keepers, of pre-soaking food in the belief that it aids feeding and digestion. Pre-soaking food will cause most of the water soluble nutrients to dissolve, increasing the speed at which they leach into the pond. Is this good for water quality and Koi nutrition?

Ingestion, digestion and assimilation

Even if Koi consumed their food the second it was offered, feeding would still have implications for water quality, through their breakdown and utilization of food.

As Koi are cold-blooded and their metabolism (biological tick-over rate) is governed by water
temperature, it is logical that they are offered different types of diet at different temperatures.

There is no reason why Koi cannot be offered a 'summer' diet all year round, as Koi will simply
digest and assimilate (take up and utilize) what they require, excreting any surplus. However,
feeding a summer growth food all year round will have a detrimental effect on water quality
(which in turn will affect Koi health) by the levels of food excreted by Koi.

What makes a summer food different from an autumn food?

As summer is the warmest period of the year (allegedly) it is the period when Koi will utilize their food for both growth and storage of energy for the fallow winter period that is anticipated by their physiology. Consequently, such diets are high protein and high-energy diets, ready to satisfy their increased nutritional demands. Yet if these diets are offered when Koi cannot utilize them efficiently, then levels of excretion will be increased having a knock-on effect on water quality. Excess protein in particular is likely to affect water quality.

If protein in the diet is in excess of what Koi require, Koi will not utilize all of the protein in the diet for growth, but either break it down and burn it for energy or excrete high levels undigested.

Protein is made up of 4 elements, carbon, hydrogen, oxygen and nitrogen. When protein is used as a source or energy, Koi utilize the carbon, hydrogen and oxygen element but excrete the nitrogen in the form of ammonia. Consequently, too much protein in the diet is likely to lead to an increase in the levels of ammonia excreted by Koi.

In addition, the undigested proteins excreted by Koi (along with other organic material) will attract significant bacterial action by oxygen demanding heterotrophic bacteria. Interested in the organic element of the waste, such bacteria will also lead to an additional release of ammonia into the water. When Koi are ever subjected to excess food (both quality and quantity) it will have serious implications for water quality, but if your filtration is adequate, will avert any short term toxicity problems (ammonia) but still ultimately lead to a build up of nitrates. The accumulation of excreted products (both solid and soluble) will also lead to further noticeable changes in water quality.

Build up of soluble organics.

The accumulation of soluble organic pollutants either directly from food or indirectly from excretion will cause water to become discolored, often taking on a yellow-ish tinge. This may also be accompanied by excessive frothing that is caused by the build up of soluble organic matter, created around waterfalls or venturis where pond water mixes vigorously with air. The presence of a high organic content in the water causes the formation of stable bubbles that do not ready burst.

Build up of Inorganics.

Besides the accumulation of nitrates after the filter's handling of ammonia, feeding can also cause quite a build up of other inorganic compounds - particularly phosphates and sulphates.

Although not as directly observable as organic compounds that cause discoloration and foaming, phosphates can lead to the proliferation of algae. As most Koi ponds are plant-free and fitted with an UVc to kill green water, blanketweed is likely to proliferate in such a nutrient-rich and competition-free environment.

Reducing the Impact.

In the current fight against global warming, we recognise that a proportion of CO2 emissions can be added through careful management and the use of alternative energy sources. The same is true for reducing the impact of feeding on a Koi pond where the main objective is maintaining healthy Koi and to provide them with a stable and healthy pond environment. Having identified that feeding can cause both short-term and long-term instability to water quality, our Koi's health will benefit if we can reduce such instability.

Measures to reduce the impact of feeding on Koi pond instability.

1. Feed the most appropriate diet:

Ensure that Koi are offered the protein and energy content they require and can most adequately utilize. This means feeding lower protein diets at cooler temperatures, moving to a higher protein diet when the water warms up.

2. Feed on a basis of a little and often:

If too much food is offered at any one time, nutrients have longer to leach out into the water. Not only does this risk causing fish deficiencies, but will also taint the water color and lead to the proliferation of algae.

3. Reconsider pre-soaking food before feeding as this pre-leaches nutrients prior to adding the food to the pond.

4. The best strategy for creating a stable water quality is not to leave lengthy periods between water changes. This keeps you on top of any build up of food-related compounds and ensures that the addition of freshwater is not too dissimilar (and therefore stressful) to the pond and to Koi.

5. The installation of a protein skimmer can be a useful tool in removing dissolved organic compounds from the pond water. It should not be used in place of regular partial water changes, but may allow you to reduce the frequency of water changes.

In summary, we feed our Koi to enhance their health, growth and coloration, but in doing so, unintentionally present our pond with potential water quality problems which must be managed to maintain a stable and healthy pond environment.

Up Coming Events

July 24, 2005
Mountain View Koi Fish & Aquatic Plants

August 28, 2005
Dennis & Kathy Leonard

September 25, 2005
Faye & Winton Hall

October 23, 2005
Ken & Mary Struck

November 11-13, 2005
SAKA 26th Koi Show & Auction

December 2005
Tom Ayers

January 2006
TBA

February 2006
TBA

March 2006
Dan and Martha Cover
April 2006
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May 2006
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June 2006
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Would you like to serve on a committee?

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