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The majority of ponds or aquaria contain a range of species, each of which is likely to require a unique diet. As these individual fish species grow and begin to reproduce the dietary requirements of each species is likely to change. Furthermore the presence of a range of species is likely to affect the feeding behaviour of almost every other species that are held within the same tank or pool. Providing a range of feeds that are able to match the individual dietary requirements of every species of fish throughout the course of their entire life represents one of the most challenging aspects of fish keeping.

## Energy

Like all other animals, fish require their diet to provide them with a controlled, slow release source of energy that is able to fuel every metabolic process. The controlled release of energy from any feed is influenced by a series of complex enzymes, each of which require the presence a range of vitamins or minerals to function properly. The health of most species of fish will soon begin to suffer if their diet that doesn't provide the source of energy or the vitamins or minerals required by these controlling enzymes.

Although the fat and protein content are regarded as the key source of energy within the diets of most fish, fat is the preferred source of dietary energy as it can supply twice the energy of protein.

Diets that utilise proteins as the key source of energy are likely to be linked with the excretion of nitrogen based waste products such as ammonia or urea and an associated decline in water quality. In addition, as fat also plays an important role as a carrier for the fat soluble vitamins A,D, E and K, many successful fish keepers will not utilise a diet that contains less than 10% fat.

The single most important factor that affects the energy requirement of a fish is water temperature. An increase in water temperature will increase the body temperature of the fish, which will, in turn, speed up the metabolic reactions and increase the energy requirements of the fish. Consequently, the amount of food required by a fish will increase as water temperature begins to rise and will decrease as water temperature starts to drop. As most species of tropical fish are kept at a constant temperature, the aquarist can match the energy requirements of fish by simply feeding their fish with as much feed as they can consume over within two or three minutes on two or three occasions per day. The seasonal variation in water temperatures will require the pool keeper to vary the amount of food provided to their fish over the course of a year. Many successful pool keepers use will feed their fish two or three times per day during the summer, will slowly reduce the amount of feed as water temperatures decline and will stop feeding altogether when water temperatures fall below 100C or 50C.

## Proteins

Fish require protein in their diet to supply those enzymes required to regulate metabolic processes and provide the basic structure required for growth and repair of body tissue. Although the exact protein requirement of most fish has yet to be established, most fish require diets with 35 – 50% of protein. Small, fast growing tropical fish with high metabolic rates are likely to require a higher proportion of protein within their diet than large, slow growing coldwater pool fish. Whilst the health problems associated with feeding too little protein may be easily predicted, the consequences of feeding too much protein are often overlooked.

Fish that are presented with a diet that contains more protein than they require for the growth or repair of body tissue may begin to metabolise these excess proteins as a source of energy. The waste product associated with the metabolism of protein as source of energy is ammonia, which is then excreted into the water surrounding the fish and results in a decline in water quality.



Feeding too much protein may also result in the fish storing a high proportion of fat within its body tissues or organs. Many recent

studies appear to suggest that a high protein diet may even be related to a build up in fats within the cardiac blood supply and could even result to an increase incidence of cardiac problems.

The quality of dietary protein will also have an impact upon the health of a fish. Proteins may be regarded as being composed of a number of building blocks known as amino acids. Poor quality proteins are unlikely to contain the balance of amino acids required to support healthy metabolism and are likely to result in a range of health problems such as stunted growth, poor colouration or even reduced breeding efficiency.

The ecological impact associated with the use of dietary proteins is now being appreciated. The traditional source of most proteins has been fish meal derived from by catches or 'trash fish' composed of such species as sardines, sprats or anchovies. Unfortunately, the demand for high quality fish meal for aquaculture or pet foods has led to many of these fisheries being over fished and a dramatic increase in costs. Consequently, many fish feed manufacturers have begun to search for alternative sources of proteins from sources such as plants such as soya bean.

## Carbohydrates

Unlike mammals, fish do not appear to require a dietary source of carbohydrates and only appear to have a limited ability to utilise it as a source of energy. However, carbohydrates do appear to form an important role within the diet of most species of fish. Diets that lack carbohydrates require the fish to digest many other dietary components such as proteins and fats to provide various essential compounds that are usually supplied by carbohydrates. Generally, warm water fish appear to be able to digest more carbohydrates than coldwater or marine fish and that most species of fish are able to digest more carbohydrate in warmer water when compared to the same species being retained in colder water. There is also some evidence to suggest that larger amounts of dietary carbohydrates may be associated with 'stickier' faecal pellets, making them more difficult to flush out of the pool or aquarium and possibly leading to more difficult filter maintenance and even poorer water quality and water clarity.



## Vitamins and Minerals

Supplying the correct balance of dietary vitamins and minerals is necessary to maintain the healthy growth and reproduction of every species of fish. However, as many vitamins or minerals may also be present within the water and many more may leech quickly from the food, the exact dietary requirement for vitamins or minerals is very difficult to estimate. Consequently, many feeds contain far more of these dietary components than the fish actually requires.

In 30cm deep aquarium it may take up to 2 minutes for the first flakes to sink to the bottom. If the tank contains a high number of surface feeding fish then it can take considerably longer for the remnants to arrive at the tank base. Even if bottom feeding fish, such as Corydoras or loach, are fed with sinking pellets, the fish may have to wait for up to 5 minutes to 'soften up' before they can be eaten. Even this short period of time can lead to a dramatic decline in the nutrient content of food.

Depending upon solubility, it can take no longer than 30 seconds of immersion in water for up to 90% of B vitamins and 65% of vitamin C to be leached from the food. Accordingly, the problem of vitamin deficiency may be a problem in a large proportion of tanks or pools.

Some vitamins are not only required to maintain optimal health but many, such as vitamin C and E, help to reduce the risk of disease and infection by boosting the efficiency of the immune response. However, feeding too many vitamins may begin to represent a danger to the health of fish. For example, feeding too much vitamin A can result in slower growth, anaemia and even necrosis of the caudal fin.

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