Live Feed Nutritional Supplementation

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Adequate nutrition of amphibians ensures;

- rapid growth and normal development
- successful reproduction
- the production of fit and healthy offspring
- health and low mortality rate
- adequate calcium metabolism

The most commonly recorded nutritional deficiencies in captive amphibians are poor of calcium metabolism and vitamin A deficiency. Low calcium ingestion or low serum vitamin D_3 levels prevent sufficient calcium uptake through the gut. This leads to serious problems such as metabolic bone disease, which can exacerbate nutritional problems through reducing prey capture. Low dietary levels of vitamin A cause squamous metaplasia of the tongue and associated poor feeding. This and other syndromes may be associated with even small deficiencies of unsaturated fatty acids. The poor feeding cycle impacts on health, reproductive ability and success, and may lead to premature mortality. A wide range of proteins, lipids, and other macronutrients, and micronutrients including vitamins, minerals, and corotenoids are also necessary for health.

The effect of feed quality on the nutritional value of feeder insects prior to the 12 hrs before nutritional supplementation is not well documented. Most studies of improving the nutritional value of feeder insects through long term diets have concerned the use of calcium supplements to address low calcium levels. However, it is probable that the provision of high quality feed prior to nutritional supplementation improves the nutritional value of feeder insects. The most accessible sources of high quality feeds are complete commercial pellets for fish, birds or mammals. A mixture of ground vegetarian turtle pellets and carnivore pellets (fish) would provide a good basic cricket diet.

Right: Small crickets or fruit flies can be dusted with vitamin/calcium powder and then fed immediately to small amphibians.

Most nutrients are normally supplied through amphibian diet. Besides nutrients supplied from the 'raw' feeder insect, they can be supplied through UV-B or medications, external dusting, and through nutritional supplementation or "gut loading". Deficiencies can be rectified through topical or oral medications. Vitamin D_3 can be synthesised in the skin through the effect of UVB. In special cases vitamins, minerals and even macro-nutrients such as proteins or lipids can be supplied by injection into wax worms. Unlike crickets or mealworms, wax worms can accommodate the required increase volume because of their elastic cuticle.

Physically shaking the feeder insects up in a plastic bag/bucket with a suitable multi vitamin/mineral powder has been practiced widely for decades. The insects can be held in cool conditions prior to feeding to make their immediate capture by amphibians easier. Unfortunately, about 50% of the dusted supplements are lost from feeder insects within minutes. Some have used ground human multivitamins in preference to commercial products for reptiles.

An economical and efficient way to provide a nutrient-rich diet for amphibians is through the nutritional supplementation of live feed. Dusting of live feed alone is inefficient because most dust is lost shortly after application and lacks many nutrients. The principle of nutritional supplementation is to provide live feed a palatable diet of concentrated nutrients for several hours before their feeding to amphibians. The live feed ingests the nutritional supplementation diet and also becomes dusted with the diet. When the nutritional supplementation diet contains unsaturated fats these also coat the cuticle of the live feed and assist adhesion of further nutrients.

Above: Small crickets before nutritional supplementation with *Spirulina* based diet.

A proven nutritional supplementation mixture uses four ingredients. A base of ground fish feed, *spirulina*, fish oil, and vitamin-mineral mix. Ground fish feed pellets are an excellent source of protein, calcium and most nutrients.

Above: Small crickets after nutritional supplementation with *Spirulina* based diet. Their darker colour and the green line of supplementation diet can be seen dorsally.

Spirilina, is high in carotenoids, unsaturated fatty acids, and micro-nutrients. Fish oil is high in unsaturated fatty acids and vitamin A. vitamin-mineral mix provides other nutrients for a balanced mix. Vitamin D and calcium powder is also often used in nutritional supplementation mixtures. However, although excessive calcium does not normally illicit health problems in amphibians, hypervitaminosis could cause problems and care should be taken not to over-supplement.

There are a number of vitamin/mineral mixes on the market mainly designed for reptiles. As for all feed, or nutritional supplements, these should be stored below 5˚C in airtight containers. Storage at higher temperatures or with ready flow of oxygen will result in the loss of vitamins, micronutrients and the oxidation of lipids, which can produce toxic compounds.

Problematic in deciding the degree of supplementation are the small number of scientific studies of amphibian dietary requirements. Nevertheless, a recommended nutritional supplementation mixture consists of 75% ground fish feed mixed with 20% *spirilina* and 5% vitamin/mineral mix. To this is added fish oil until the mixture is crumbly. Simply a mixture of 90% *spirulina* with 10% vitamin-mineral mix is also satisfactory but less varied. The amount of vitamins varies considerably between these two mixtures. However, both have been used with apparent benefit and without harm with amphibians. Unfortunately, although we do know that the provision of micronutrients is necessary for amphibians the variation of supplementation of feed between different amphibian taxon is still uncertain.

Crickets

Crickets up to the length of the width of the anurans mouth are a suitable feed for most adult frogs, toads and other amphibians, and these are easily enriched. Crickets for enrichment should be placed in containers with the nutritional supplementation mixture 6-8 hours before feeding.

Crickets should be kept in a warm dry environment and will thrive without moisture for the nutritional supplementation period. If a higher level of nutritional supplementation is required, smaller crickets can be used, as these have a higher surface area to volume ratio than larger crickets, and more fine surface hairs. This gives a higher degree of dusting but not of internal nutritional supplementation.

Diptera

Right: Flies can be nutritionally supplemented with a paste made of the nutritional supplementation mixture with water provided within their box so they carry it with them when entering the amphibian enclosure. There are numerous other 'recipes' using fluids to such a fruit juice with vitamins to enrich flies.

Fruit flies

Left: Fruit flies fed to metamorphs or small amphibians such as Dendrobatids can be enriched prior to feeding out using a slice of banana coated with vitamin/mineral mix.

Mealworms

Right: Mealworms are particularly low in calcium and high in fat. Mealworms can have their nutritional value increased through feeding a high-calcium substrate such as wheat bran/calcium cricket mix enriched with *Spirulina* and vitamin powder. Mealworms can also be fed ground fish feed based nutritional supplementation mixtures as described for crickets but will then only survive for a few hours. This could be because the oils in this nutritional supplement block their stomates.