Vitamin / Mineral Supplements for Sharks and Rays

Any animal kept in captivity needs correct nutrition to not only survive but also to thrive. In most cases it is not possible to completely replicate the diet that is consumed in the wild because either it is not known in detail or it is not possible to source the diet commercially.

This discussion paper is not a comprehensive review of elasmobranch (sharks and rays with a cartilaginous skeleton) nutrition, but rather an explanation of the need for a vitamin and mineral supplement for elasmobranchs. There are three main reasons that sharks and rays need a regular vitamin and mineral supplement –

1. In captivity we may not feed a completely balanced diet

2. Feeding frozen fish is associated with vitamin deficiencies

3. In closed systems with recirculated water (and especially protein skimmers or foam fractionators) there is a removal of many trace elements and, especially iodine, which can cause thyroid pathology and disease.

We will now examine each of these in detail.

1. Food variety and amounts

In most cases it is impossible to replicate what the elasmobranch eats in the wild, and so a range of different foods are advisable including fish and molluscs (shellfish and squid).

It is important to avoid excessive feeding leading to obesity in elasmobranchs. The ideal feed rate varies with the species, but is between 3 and 5 % of bodyweight **per week**. Depending on the species, this may be divided into two to four feeds per week. Babies and juveniles will need a higher feed rate and daily feeding. The best idea is to monitor the body condition of the elasmobranch. A very full (rotund) belly is to be avoided (unless there is a pregnancy!!) and decreased feeding commenced. Body condition scores are being developed for a few species and these will become more common in the future and assist in maintaining ideal body weights.

2. Frozen food

Frozen food is often fed to elasmobranchs because it is the most readily available source. Many of the foods fed contain the intermediate stages of parasites with the final stage

occurring in the elasmobranch. Thus, there are additional health benefits by feeding frozen food as the risk of parasites decreases significantly because they are killed in the freezing process.

The food ideally should have been frozen for seven days and should never exceed twelve months of being frozen and six months is ideal.

The thawing procedure is very important to minimize vitamin and mineral loss. Thawing should always occur over a 24 to 36 hour period in a fridge at 4 to 7^{o}C. During this time the food should also be covered. Thawing in running water whether freshwater or sea water is NOT advisable as there will be leaching of vitamins and minerals. This will significantly reduce the nutritional value of the food.

Once food has been thawed it should never be re-frozen and should be used within 24 hours.

Maintaining the hygiene of any food preparation area is essential to minimise bacterial spoilage and infections. All chopping boards, benches and knives should be cleaned thoroughly in water and then disinfected with an iodine-based product to ensure sterility.

Frozen Fish and Vitamin Deficiencies

There are two main groups of vitamins. The first is the fat-soluble vitamins which include vitamins A, D, E and K. The second group is the water-soluble vitamins which is predominantly the B group of vitamins and vitamin C.

It is possible to overdose on the fat-soluble vitamins as they can accumulate in the body and problems can arise. Thus any supplement should have low levels of these fat-soluble vitamins. It is very difficult to overdose with the water-soluble vitamins and they are also the ones that are most at risk of being destroyed by a variety of means as described below.

The following vitamins can be affected by the freezing and thawing process:

Vitamin B1 (thiamine) is essential for brain function and is an appetite stimulant. Many fish contain enzymes called thiaminases which after death can quickly destroy the thiamine present in the fish. This can occur in less than 90 minutes and thus even feeding fresh fish has the potential to be associated with a thiamine deficiency. Thiaminases are not inactivated by freezing and so the process continues even after freezing. Feeding of such fish can lead to thiamine deficiencies. Examples of fish that contain thiaminases are various members of the Scrombridae family (includes Mackerels and tunas), Carangidae family (Jacks), Clupeidae family (Herrings), Salmonidae family (salmonids) and Cyprinidae (carp and minnows). Many different invertebrates have also been found to contain thiaminase, including mussels, clams and shrimps/prawns which are also commonly fed to elasmobranchs. Extra thiamine is needed via vitamin supplementation to prevent this problem. Being a water soluble vitamin it is also possible to leach out with water thawing.

Vitamin E is essential for reproduction i.e. good ovarian and testicular development. Could a Vitamin E deficiency be a contributing factor to the low reproductive efficiency of some

elasmobranch species in captivity? Vitamin E is also very important for good muscle function, the nervous system and the immune system. Supplementation of frozen food is essential.

Vitamin C (ascorbic acid) is excellent at stimulating the immune system and assisting with wound healing. Extra supplementation is therefore beneficial.

Vitamin A – there is a reasonable amount present in the liver if fish are fed whole, and so minimal supplementation is required.

3. Removal of Trace Elements especially Iodine

Foam fractionators (protein skimmers) are frequently used in marine systems for removing proteinaceous material and other wastes. In this process they can remove many trace elements and especially iodine which can cause thyroid problems. The injection of ozone into foam fractionators will increase the process of removing vital minerals from the water.

Iodine and Thyroid Function

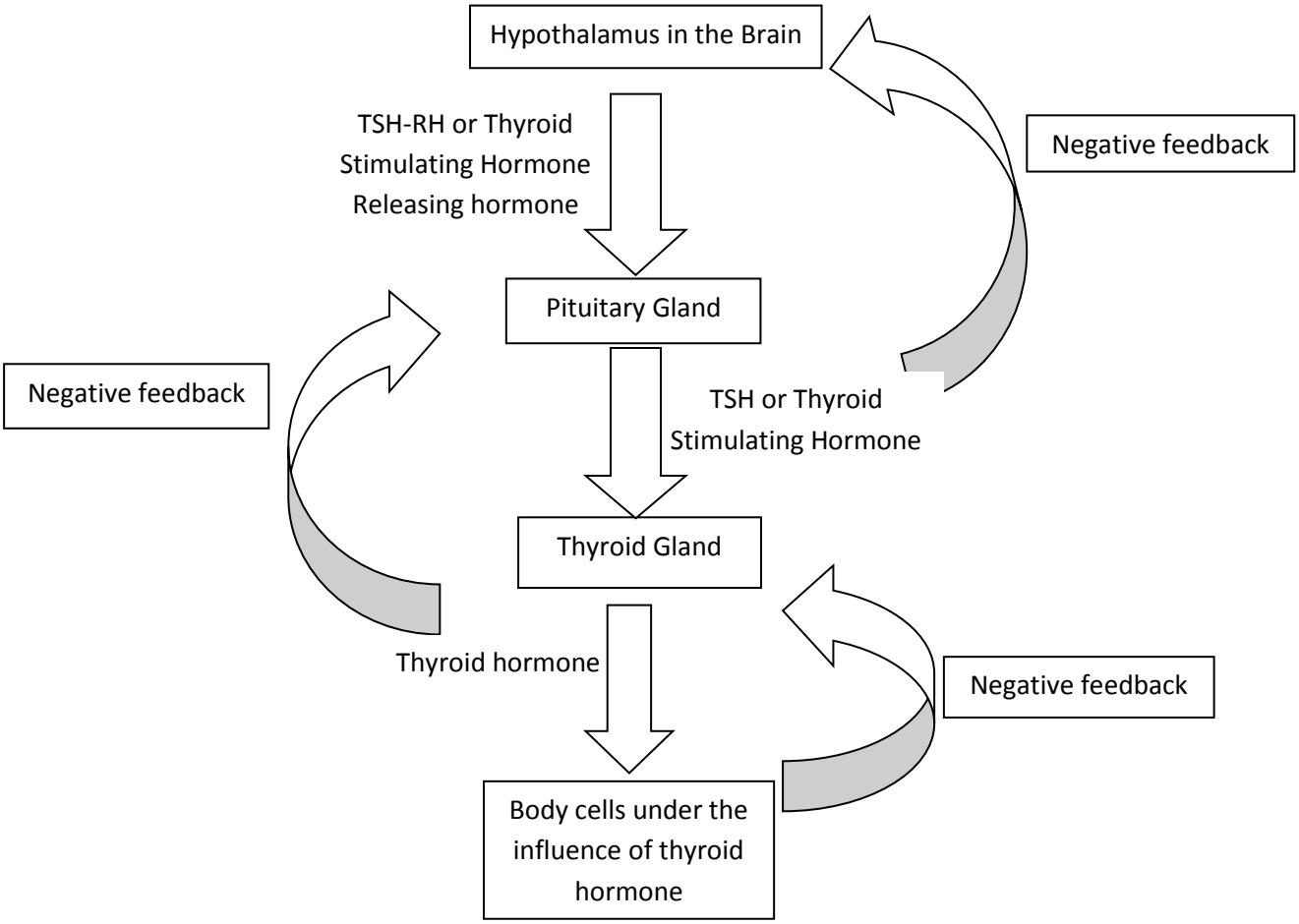
The element iodine (molecular weight = 53) occurs in seawater at approximately 60 µg/L, with far greater amounts concentrated in organic surface sediments (Spotte, 1992). This level in seawater includes the following two ions - iodide (I^-) and iodate (IO^-).

The thyroid gland in fish, with a few exceptions e.g. elasmobranchs, lungfishes and parrotfishes, is not a discrete gland. It is usually an encapsulated agglomeration of follicles, mostly in the sub-pharynx or pharynx between the first and second gill arches (Spotte, 1992).

The thyroid gland assimilates and concentrates the iodide ion (I^-) from the food and water (via the gills) which is then transported to the thyroid gland. Here it is converted to the thyroid hormones (triiodothyronine = T3 and thyroxine = T4).

Thyroid stimulating hormone (TSH) is released from the anterior pituitary gland (base of the brain). TSH acts on the thyroid gland to control the production and release of thyroid hormone. Thyroid hormone then travels via the blood stream to the muscle, heart, liver and kidney where they assist in regulating metabolic processes.

The following diagram depicts the hypothalamic control over thyroid hormone production and its release from the thyroid gland.



Goitre

Goitre (abnormal enlargement of the thyroid gland) occurs with either hypertrophy (enlargement of cells) or hyperplasia (increase in number of cells) or a combination of both.

There are several possible causes –

1. Iodine depletion in the water. Foam fractionators (protein skimmers) are very good at removing iodine from the water, especially when ozone is incorporated. Recirculated seawater may also lose iodine to the detritus and perhaps to the atmosphere during aeration (Spotte, 1992).

2. Iodine deficiency in the diet; not that likely to occur.

3. Environmental toxins such as goitrogens. Goitrogens include ammonia, urea and nitrate. High nitrate levels have been shown to inhibit iodine assimilation by the thyroid in freshwater fish (Spotte, 1992) and in elasmobranchs (Morris et al, 2011).

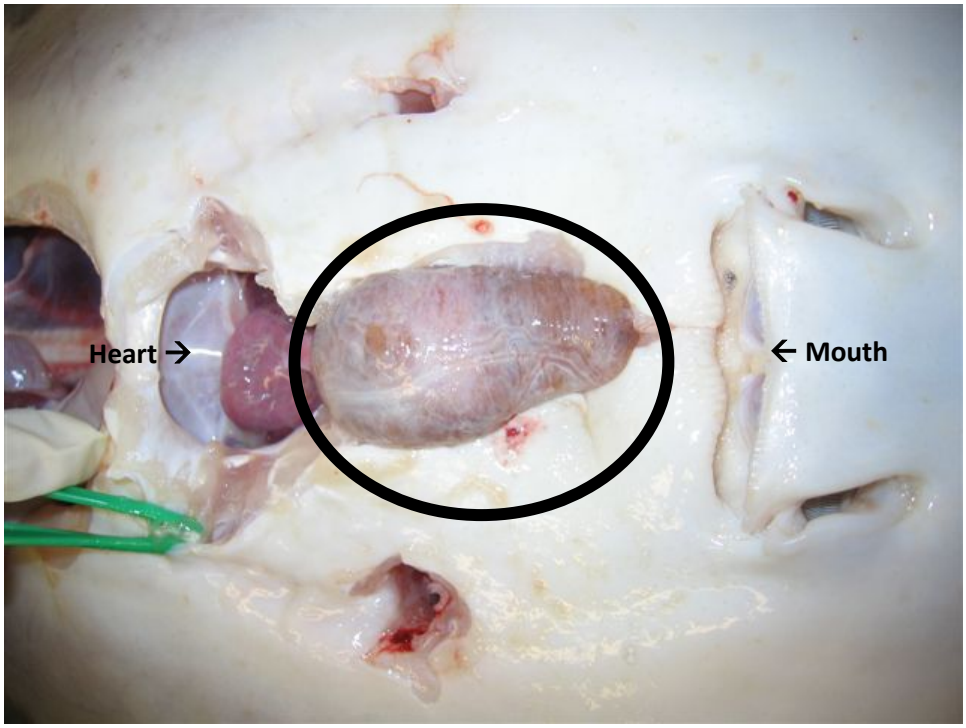
Ozone has been shown to significantly reduce the iodide (I^-) in seawater. It converts the iodide (I^-) to iodate (IO^-) which is not absorbed as well across the gills.

The level of iodine in fresh water is very low and thus goitre is even more likely to develop in freshwater fish which are then more dependent on an oral source.

Clinical Signs – The lack of iodine causes a loss of negative feedback, which in turn causes increased TSH levels with hyperplasia (cellular enlargement) and goitre developing.

In elasmobranchs with advanced goitre, there will be a swelling under the jaw in the midline. Teleosts (bony fish) with goitre will have constantly flared gills and a mass may even be visible at the operculum. Some fish are emaciated and breathing may be laboured (Spotte, 1992).

The photograph below is of the underneath of a ray at post-mortem. The ray had not received sufficient iodine supplementation and had severe goitre (circled). The thyroid gland was approximately ten times the normal size.



Vitamin Supplementation

Because of these reasons, The Aquarium Vet in conjunction with Vetafarm has produced a multi-vitamin and mineral supplement for captive elasmobranchs. Our commitment is to enhance the health and longevity of captive fish by replacing any lost vitamins and minerals.

Dose and Storage

The dose given depends on the weight of the food fed and not the bodyweight of the elasmobranch. There are two sizes of tablets –

- One tablet per 250 grams of food (large)
- One tablet per 25 grams of food (small)

Both tablets are scored so that they can be easily halved if required.

Do NOT overdose.

The tablets can be stored at room temperature and have a shelf life of three years due to their special coating.

Administration

The easiest method of administering the tablets is to place them inside the mouth of the fish, under the operculum (gill cavity), inside the abdomen of the fish or make a small incision in the skin or muscle and insert the tablet.

If feeding squid the tablet can be placed under the mantle of the squid.

Supplementation, up to three times a week is advisable, to prevent problems and ensure that the elasmobranchs in our care live long and healthy lives.

Dr. Rob Jones

"The Aquarium Vet"

www.theaquariumvet.com.au

References

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