Fat Soluble Vitamins: A, D, E & K in Dogs

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According to Stedmans Medical Dictionary, a vitamin is 'one of a group of organic substances, present in minute amounts in natural foodstuffs, that are essential to normal metabolism.' As defined, vitamins are present in very small quantities in most foods and it is this fact that leads to the manufacture of vitamin supplements for pets and people. Not only are vitamins naturally present in only small amounts, they are also essential for life.

The importance of vitamins has been known for only a short time, however, their actual effects were demonstrated long ago. Around 400 B.C., the father of modern medicine, Hippocrates, first advocated using liver to cure night blindness. We now know that the essential component of the liver was vitamin A and it was the lack of Vitamin A that caused the night blindness. Beriberi, the once feared paralytic disease of humans, was found to be curable by feeding unpolished rice. It is now known that the unpolished rice was rich in the Vitamin B1 - thiamine. Low thiamine levels were the real cause of beriberi and a simple diet change could cure the paralysis.

The primary vitamins are normally identified as vitamin A, D, E, K, C, and B complex. Of these, A, D, E, and K are the fat soluble vitamins. Vitamins C and B complex are water soluble vitamins. The fat soluble vitamins are commonly stored in special fat storage cells called lipocytes, whereas, the water soluble vitamins are not stored within the body except in small amounts. It is for this reason that the fat soluble vitamins pose the biggest threat if oversupplemented. They are stored and build up within the body.

Fat soluble vitamins

Vitamin	Recommended Minimum Daily Dose for Dogs	Toxic Dose (This dose must be given daily for months to create toxicity.)	Sources	Signs of Deficiencies
A	2272 IU/lb of food consumed on a dry matter basis	113,600 IU/lb of food consumed on a dry matter basis	Liver, fish liver oil, vegetables, dairy products	Night blindness, retarded growth, poor quality skin and hair
D	227 IU/lb of food consumed on a dry matter basis	2272 IU/lb of food consumed on a dry matter basis	Sunshine, dairy products, fish liver oil	Rickets, poor eruption of permanent teeth

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E	23 IU/lb of food consumed on a dry matter basis	455 IU/lb of food consumed on a dry matter basis	Cold pressed vegetable oils, meats, nuts, green leafy vegetables	Reproductive failure, brown bowel syndrome
K	Synthesized in the body	none	Kelp, alfalfa, egg yolk	Increased clotting time and hemorrhage

Vitamin A

The first fat soluble vitamin to be discovered was Vitamin A. Vitamin A is found in several forms such as retinol, retinaldehyde, retinoic acid, and in the liver storage form, retinyl palmitate. If fed in amounts exceeding the capacity of the liver, Vitamin A 'floats' freely in the bloodstream and can possibly create toxicities.

The main source of Vitamin A is the yellow pigment found in plants. This pigment is called carotene. When fed to dogs, carotene is easily converted by the intestinal cells into the usable Vitamin A. Not so in cats. Cats have a greatly reduced ability to convert plant pigment (Beta Carotene) to Vitamin A. Because of this, cats must be fed Vitamin A already in the liver storage form as retinyl palmitate.

Vitamin A, once ingested, is stored in fat cells mainly within the liver. Here it remains until needed by the body. Vitamin A has many roles. It is important for vision and other functions. Deficiencies lead to poor low-light vision (termed night blindness), retarded growth, poor-quality skin and hair development, and reproductive failure. To those who raise puppies, the Vitamin A link to growth is of prime importance. Lack of Vitamin A in puppies directly relates to low growth rates, muscle weakness, poor vision, and loss of hair coat. Skeletal and nervous disorders such as hydrocephalus and cleft palate are also common results of a Vitamin A deficiency. Females will not ovulate properly and males can become sterile if they are deficient in Vitamin A. The amount of Vitamin A needed in the first two years of life is sufficient to warrant supplementation in the diet. Later in life, once full growth is attained, the need for it is still important, but reduced.

From a practical standpoint, Vitamin A supplementation is necessary especially to the growing puppy. Infants are born with no liver storage of this vitamin. The colostrum (first milk) is rich in Vitamin A and provides an important first source. Name brand commercial pet foods are vitamin fortified and many excellent vitamin supplementations are available in tablets, granular, and liquid form.

Vitamin A is one of the two vitamins in which oversupplementation can have negative effects. However, we have never seen a case of oversupplementation causing toxicosis, and in dogs, toxicity has been demonstrated only under experimental conditions. Toxic doses of Vitamin A could produce muscle weakness and bone abnormalities. Realistically, oversupplementation or toxicity is virtually impossible unless mega-doses are given for long periods of time (months to years).

Vitamin D

Vitamin D is also known as 'the sunshine vitamin.' Ultraviolet radiation from the sun is important to convert Vitamin D precursors into the active D form. This conversion takes place in the outer skin layers. In dogs and cats, however, this conversion is inefficient, and supplemental Vitamin D must be available in the diet. It is usually supplied in the form of synthetic Vitamin D.

Vitamin D plays a major role in regulating the calcium and phosphorous levels within the bloodstream. Vitamin D stimulates the kidney conservation of calcium and therefore helps the body to retain it. Because of its interplay with calcium, Vitamin D is extremely important in bone formation and nerve and muscle control.

Deficiencies of Vitamin D were very prevalent in the past, but only occasionally surface today. Low levels of Vitamin D will cause a bone demineralization referred to as rickets. Again, supplementation is highly advised in both puppies and kittens and to a lesser extent in adults.

Vitamin D toxicities, as with Vitamin A, are extremely rare. A dog fed Vitamin D in excess could have abnormal amounts of calcium deposited within the heart, various muscles, and other soft tissues. This is rare and we have never heard of it happening in real life situations. Suffice it to say that Vitamin D plays a major role in skeletal growth, muscle control, and

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nerve functions. Deficiencies are fairly common and toxicities are rarely, if ever, present.

Vitamin E

Vitamin E is the third of the fat soluble vitamins. Foods rich in Vitamin E include plant oils such as safflower and wheat germ. As with the other fat soluble vitamins, Vitamin E is also highly concentrated in meats such as liver and fat. All of the functions of Vitamin E are not known, but it plays a role in the formation of cell membranes, cell respiration, and in the metabolism of fats. It is an antioxidant and protects various hormones from oxidation.

Deficiencies of Vitamin E will cause cell damage and death in skeletal muscle, heart, testes, liver, and nerves. It is essential in keeping the cells of these organs alive and functioning. Vitamin E deficiencies have been well documented in both dogs and cats. The 'Brown Bowel Syndrome' is the condition usually used to describe a dog or cat suffering from inadequate Vitamin E. These animals have affected bowels which ulcerate, hemorrhage, and degenerate. In addition, the cells of the eyes and testes can also be affected.

There is no experimental evidence to support the popular belief that Vitamin E in excess will help increase the stamina in breeding dogs or cats. Vitamin E is occasionally supplemented for this reason, but it is ineffective.

There are no known Vitamin E toxicities in the dog and cat. Fed even at huge levels, no interruption of bodily functions has been demonstrated. Recommendations on the daily dose are highly variable depending on the source. Further research is necessary to discover other possible functions of Vitamin E.

Vitamin K

Vitamin K is the last of the fat soluble vitamins. From a nutritional standpoint, it is important, but its understanding is of prime significance in the treatment of one of the most common toxicities encountered in animals - rat and mouse poisoning.

The discovery of Vitamin K by Henrik Dam in 1929, won him the Nobel Prize. Vitamin K exists in three forms. Vitamin K1 is found in green plants; Vitamin K2 is high in fish meal and can be synthesized by the bacteria in the intestine; Vitamin K3, also known as menadione, is a synthetic precursor of the others. Vitamin K3 is the form most utilized as a supplement. Since the bacteria in the intestine can manufacture Vitamin K, it is not needed in high levels in food supplements.

Vitamin K is essential for normal blood functions. Without Vitamin K, blood cannot clot. Most rat and mouse poisons (e.g.; Warfarin, D-Con) kill rats and mice by eliminating their ability to clot blood, hence, the rodents internally hemorrhage to death. Contained within the poison is the active ingredient coumarin or a derivative. It is the coumarin that binds to and depletes the body of active Vitamin K. Without Vitamin K the blood cannot clot and the rodents die. Unfortunately, dogs and cats also enjoy rat and mouse poison. The results are the same. The pet will begin hemorrhaging, usually within the intestinal tract. If the amount ingested is large (1 packet), then death may follow. If you suspect a pet has ingested this poison, induce vomiting at once and call your veterinarian. Veterinary treatment will be the administration of Vitamin K1, either as an injectable or tablet. If instituted early, the patient's life can generally be saved.

The actual dietary requirement for Vitamin K is unclear. Since bacteria within the intestines manufacture Vitamin K, the exact amounts produced are unknown. Dietary Vitamin K is found in green leafy plants and vegetables.

Vitamin K deficiencies in pets have not been documented except in instances of Warfarin toxicosis (rat poison). Likewise, Vitamin K toxicity due to oversupplementation has not been reported in animals.

Summary

Of the four fat soluble vitamins, only A and D seem to have a potential toxicity, and this only experimentally. We do not believe that in today's foods and supplements it would be possible to have a vitamin toxicosis. Well demonstrated, however, are the disorders relating to a lack of these vitamins. They are absolutely essential to life. Also understood is the fact that growing animals have much greater requirements than adults. In addition, influences such as lactation, pregnancy, and exercise will all increase the need.

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