



Fat-Soluble Vitamins *the Good and the Bad*

What are Fat-Soluble Vitamins?

Vitamins are essential micronutrients your body needs to function and maintain good health. They can be categorized into two groups: water-soluble (B-complex and C vitamins) and fat-soluble (vitamin A, D, E and K). Because of their lipophilic (“fat-like”) nature, fat-soluble vitamins are absorbed through the lymphatic system (as opposed to the small intestine) and bile is required to digest them.

Diseases that impair fat absorption can lead to the deficiency of these vitamins. Unlike water-soluble vitamins that need regular replacement, the fat-soluble vitamins can be stored in the body for longer periods of time. Fat soluble vitamins are stored in the liver, adipose (fat) tissue and skeletal muscle. As a result, with a balanced diet the chance of a deficiency is low. However, fat-soluble vitamins are more likely to cause toxicity due to overdose.

Environmental Exposure Leads to Oxidative Damage

Oxygen is a reactive oxidant in our body and is essential in energy production. However, excess oxygen-derived reactive species can cause damage to tissues, *i.e.*, oxidative damage. Many environmental toxins, such as iron and copper, can induce excess formation of such reactive oxygen species. The primary targets of the oxidative damage are the unsaturated lipids in the lipid membrane of the cell. Since they are enriched in the membrane, fat-soluble antioxidants, mostly vitamins, are at the frontline of defense for our body against oxidative damage.



Vitamin A

Vitamin A has many functions within the body. It plays an important role in vision by helping the eyes adjust to light changes. Furthermore, it can regulate bone growth, mucous membrane development and immune system response. Dietary sources of

vitamin A include plants such as carrots and sweet potatoes, fish oil, eggs and dairy products. Liver is rich in vitamin A. Deficiencies are rare in the United States but are much more prevalent in regions of Africa and Southeast Asia where they affect millions of people. Symptoms such as night blindness, dry skin, decreased resistance to infections, and faulty tooth and bone development may indicate vitamin A deficiency.

The Good: Vitamin A as Antioxidant

Vitamin A is known as one of the most effective natural products in quenching reactive oxygen species generated by light, which could cause oxidative damage to tissues. Vitamin A is also a good antioxidant against free radicals that can also lead to the formation of reactive oxygen species under low oxygen conditions.

The Bad: Vitamin A as Pro-oxidant

Vitamin A undergoes spontaneous oxidation easily, particularly under high oxygen conditions. In tissues with high oxygen levels such as the skin, eyes, and lungs, vitamin A acts as a pro-oxidant, which means that it actually accelerates oxidative damage in these tissues. Not surprisingly, in controlled clinical trials, vitamin A produced an increase in mortality from lung cancer.

Pathological Effects of Vitamin A Overdosing

Overdose of vitamin A can increase the risk of birth defects. Concerns have been raised over excessive consumption of liver by pregnant women. Vitamin A poisoning is characterized by vomiting, brittle bones, fatigue, joint pain, increased calcium levels, dry skin and swelling. These diseases can be caused by taking too many supplements or consistently eating concentrated sources of vitamin A. A harmless example would be eating a lot of carrots which can turn your skin bright yellow.

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Vitamin D

Vitamin D is made in the skin by the ultraviolet (UV) in sunlight. Vitamin D is important for the absorption of calcium in the body. Calcium is essential for healthy teeth and bones, blood clotting and muscular function. A diet deficient in Vitamin D combined with inadequate sun exposure can lead to diseases such as rickets, a childhood illness characterized by weak and deformed long bones, and muscle weakness.

The Good: Antioxidant and Reduced Risk of Cancer

Vitamin D₃ is an effective antioxidant toward the metal Zinc and Zinc-induced oxidative stress in the central nervous system. Studies have also shown that high intake of vitamin D may reduce the risk of certain types of cancer, such as colorectal and possibly breast and prostate cancer.

The Bad: Vitamin D Synthesis and UV Damage

Since vitamin D is made by exposure to UV, levels of vitamin D are dependent on sunlight exposure. However, UV exposure can also cause oxidative damage to skin. This happens because the oxygen level is high in skin and UV can lead to the formation of reactive oxygen radicals. Getting vitamin D from fish liver and fish oil, eggs, fortified milk and supplements can be an option.



Vitamin E

The Good: Vitamin E is Nature's Most Potent Antioxidant

Vitamin E has many functions, most notably as an anti-oxidant. Because vitamin E is soluble in the lipid membrane of the cell, it can prevent oxidation of polyunsaturated fatty acids and cholesterol. Vitamin E can work together with vitamin C to achieve a synergistic antioxidant effect.

It is also claimed that vitamin E decreases heart disease, cancer, dementia and contributes to living a longer life. However, studies using vitamin E have

shown no significant decreases in these diseases. Studies have also shown that taking more than the recommended amount of supplements is not beneficial to the body.

The Bad: Vitamin E as a Pro-Oxidant in LDL

Within LDL, the so-called "bad cholesterol", high levels of vitamin E can actually act as a pro-oxidant, promoting oxidative damage to LDL. However, synergistic action with vitamin C can prevent such harmful pro-oxidant activity.



Vitamin K

Vitamin K was initially discovered in green plants and fishmeal as a cure for excess bleeding. For example, Vitamin K₁, the most prevalent form, is found at high concentrations in green leafy vegetables such as spinach, collard greens and kale. Because Vitamin K helps with blood clotting, a deficiency increases spontaneous hemorrhaging.

Vitamin K is used routinely during pregnancy to prevent bleeding during childbirth. It also helps strengthen bones and prevent fractures, prevents prostate and liver cancer, and stops the buildup of calcium in blood vessels.

Antioxidant Activity

Vitamin K itself is not a good antioxidant. One intermediate in the vitamin K metabolic cycle could be a potent antioxidant, but its level is very low. So generally, vitamin K is not known as an antioxidant.

The Bad: Toxicity

There is no known toxicity associated with high doses of Vitamin K₁ or K₂, but a synthetic form of vitamin K (K₃, banned in the US from over-the-counter sale) can cause allergic reactions, hemolytic anemia, and toxicity in liver cells.

Where to Learn More:

Fat Soluble Vitamins: A,E,D and K <http://www.ext.colostate.edu/pubs/foodnut/09315.html>

Medline Plus, National Library of Medicine: Vitamins

<http://www.nlm.nih.gov/medlineplus/vitamins.html>



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