



## Vitamin K - description, benefits, effects on the body and the best sources

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**Abstract.** The article discusses the main properties of vitamin K and its effect on the human body. A systematic review of modern specialized literature and relevant scientific data was carried out. The best natural sources of vitamin K are indicated. The use of vitamin K in various types of medicine and the effectiveness of its use in various diseases are considered. The potentially adverse effects of vitamin K on the human body under certain medical conditions and diseases are analyzed separately.

**Keywords:** vitamin K, vitamin K, benefit, harm, beneficial properties, contraindications

The international name is 2-methyl-1,4-naphthoquinone, menaquinone, phyloquinone.

### Discovery history

Vitamin K was discovered by accident in 1929 during experiments on sterol metabolism, and was immediately associated with blood clotting. In the following decade, the major K vitamins, **phyloquinone** and **menaquinone**, were isolated and fully characterized. In the early 1940s, the first vitamin K antagonists were discovered and crystallized with one of its derivatives, warfarin, which is still widely used in modern clinical settings.

However, significant advances in our understanding of the mechanisms of action of vitamin K occurred in the 1970s with the discovery of  $\gamma$ -carboxyglutamic acid (Gla), a new amino acid common to all vitamin K proteins. This discovery not only served as a basis for understanding early findings about prothrombin, but also led to the discovery of vitamin K-dependent proteins (VCPs) that are not involved in hemostasis. The 1970s also marked an important breakthrough with regard to our understanding of the vitamin K cycle. The 1990s and 2000s were marked by important epidemiological and interventional studies focusing on the translational effects of vitamin K, especially in bone and cardiovascular diseases <sup>[2]</sup>.

### Foods rich in vitamin K

Product	Vitamin K content ( $\mu\text{g}/100 \text{ g}$ ) <sup>[3]</sup>
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dried thyme	1714.5
Parsley	1640
Chard	830
Dried marjoram	621.7
Spinach (fresh)	482.9
Basil	414.8
curly cabbage	389.6
goose liver	369
fresh coriander	310
mustard leaves	257.5
Chicory	231
green onion	207
Brussels sprouts	177
lettuce	126.3
Rucola	108.6
beef liver	106
Broccoli (fresh)	101.6
White cabbage	76
Black Eyed Peas	43
Asparagus	41.6
Kiwi	40.3
Chicken meat	35.7
Cashew nuts	34.1
Prunes	26.1
Green pea	24.8
Iceberg lettuce	24.1
Avocado	21
Blueberry	19.8
Blueberry	19.3
Pomegranate	16.4
Cucumber	16.4
Dried dates	15.6
Grape	14.6
Red currants	eleven

See also [Top 100 Natural Sources of Vitamin K](#).

### Daily requirement for a vitamin

To date, there is little data on what the body's daily requirement for vitamin K is. The European Food Committee recommends an intake of 1 µg of vitamin K per 1 kg of body weight per day. In some European countries - Germany, Austria and Switzerland - it is recommended to take 70 micrograms of vitamin per day for men and 60 kg for women. The American Council on Nutrition in 2001 approved the following requirements for vitamin K: <sup>[1]</sup>

Age	Recommended amount, men (mcg/day)	Recommended amount, women (mcg/day)
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0-6 months	2.0 µg	2.0 µg
7-12 months	2.5 mcg	2.5 mcg
1-3 years	30 mcg	30 mcg
4-8 years old	55 mcg	55 mcg
9-13 years old	60 mcg	60 mcg
14-18 years old	75 mcg	75 mcg
19 years and older	120 mcg	90 mcg
Pregnancy, 18 years and under		75mcg
Pregnancy, 19 years and older		90 mcg
Lactating, 18 years and under		75 mcg
Lactating, 19 years and older		90 mcg

### The need for a vitamin increases:

- **in newborns** : due to poor transfer of vitamin K through the placenta, infants are often born with low levels of vitamin K in the body. This is quite dangerous, as the newborn may bleed, which is sometimes fatal. Therefore, pediatricians recommend administering vitamin K intramuscularly after birth. Strictly according to the recommendation and under the supervision of the attending physician.
- **people with gastrointestinal problems** and poor digestibility .
- **when taking antibiotics** : antibiotics can destroy bacteria that help absorb vitamin K <sup>[4]</sup> .

### Chemical and physical properties

Vitamin K is a general name for a whole family of compounds with a common chemical structure of 2-methyl-1,4-naphthoquinone. It is a fat-soluble vitamin that is naturally present in some foods and is available as a dietary supplement. These compounds include the phyloquinone ( **vitamin K1** ) and the menaquinone series ( **vitamin K2** ). Phyloquinone is present primarily in green leafy vegetables and is the main dietary form of vitamin K. Menaquinones , which are predominantly of bacterial origin, are present in moderate amounts in a variety of animals and fermented foods. Almost all menaquinones , in particular the long chain menaquinones , are also produced by bacteria in the human gut <sup>[4]</sup> . Like other fat-soluble vitamins, vitamin K is soluble in oil and fat, is not completely eliminated from the body with fluids, and is also partially deposited in the fatty tissues of the body.

Vitamin K is insoluble in water and slightly soluble in methanol. Less resistant to acids, air and moisture. Sensitive to sunlight. Boiling point - 142.5 ° C. Odorless, has a light yellow color, in the form of an oily liquid or crystals <sup>[5]</sup> .

### Useful properties and effects on the body

The body needs vitamin K to produce **prothrombin** , a protein and blood clotting factor that is also important for bone metabolism. Vitamin K1, or **phyloquinone** , comes from plants. It is the main form of dietary vitamin K. A lesser source is vitamin K2 or **menaquinone** , which is found in some animal tissues and fermented foods.

### Metabolism in the body

Vitamin K functions as a coenzyme for vitamin K-dependent carboxylase, an enzyme essential for the synthesis of proteins involved in blood clotting and bone metabolism, and a variety of other physiological functions. Prothrombin (clotting factor II) is a vitamin K-dependent plasma protein that is directly involved in blood clotting. Like dietary lipids and other fat-soluble vitamins, ingested

vitamin K enters micelles through the action of bile and pancreatic enzymes and is taken up by enterocytes in the small intestine. From there, vitamin K is incorporated into complex proteins, secreted into the lymphatic capillaries, and transported to the liver. Vitamin K is present in the liver and other body tissues, including the brain, heart, pancreas, and bones.

In its circulation in the body, vitamin K is carried mainly into lipoproteins. Compared to other fat-soluble vitamins, very little vitamin K circulates in the blood. Vitamin K is rapidly metabolized and excreted from the body. Based on measurements of phylloquinone, the body retains only about 30-40% of the oral physiological dose, while about 20% is excreted in the urine and 40% to 50% in the faeces through the bile. This rapid metabolism explains the relatively low tissue levels of vitamin K compared to other fat-soluble vitamins.

menaquinones are present in the colon. While the amount of vitamin K the body receives in this way is unclear, experts believe that these menaquinones meet at least some of the body's need for vitamin K. [4].

### Vitamin K Benefits

- **Bone Health Benefits** : There is evidence of a relationship between low vitamin K intake and the development of osteoporosis. Several studies have shown that vitamin K contributes to the development of strong bones, improves their density and reduces the risk of fractures;
- **maintaining cognitive health** : Elevated blood levels of vitamin K have been associated with improved episodic memory in the elderly. In one study, healthy people over 70 with the highest blood levels of vitamin K1 had the highest verbal episodic memory performance;
- **Heart Aid** : Vitamin K may help lower blood pressure by preventing arterial mineralization. This allows the heart to pump blood freely through the vessels. Mineralization usually occurs with age and is an important risk factor for heart disease. Sufficient intake of vitamin K has also been shown to reduce the risk of stroke.

### Healthy Food Combinations with Vitamin K

Vitamin K, like other fat-soluble vitamins, is useful to combine with the "right" fats. Mono- and polyunsaturated fats have significant health benefits and help the body absorb a certain group of vitamins, including vitamin K, which is key to bone formation and blood clotting. Examples of correct combinations in this case would be [8]:

- chard or broccoli or kale stewed in olive oil with ginger or garlic butter;
- roasted Brussels sprouts with almonds;
- it is considered correct to add parsley to salads and other dishes, because one handful of parsley is quite capable of providing the body's daily need for vitamin K.

**It should be noted that vitamin K is readily available from food, and is also produced in some quantities by the human body. Following a proper diet, which includes a variety of fruits, vegetables, herbs, as well as the correct ratio of proteins, fats and carbohydrates, should provide the body with a sufficient amount of most of the nutrients. Vitamin supplements should be prescribed by a doctor if there are certain medical indications.**

### Interaction with other elements

Vitamin K interacts extensively with vitamin D. Optimal levels of vitamin K in the body can prevent some of the side effects of excess vitamin D, and normal levels of both vitamins reduce the risk of hip fractures and improve overall health. In addition, the interaction of these vitamins improves insulin

levels, blood pressure and reduces the risk of atherosclerosis. Together with vitamin D, calcium is also involved in these processes.

Vitamin A toxicity can impair the synthesis of vitamin K<sub>2</sub> by intestinal bacteria in the liver. In addition, high doses of vitamin E and its metabolites can also interfere with vitamin K activity and intestinal absorption <sup>[7]</sup>.

### Application in official medicine

In traditional medicine, vitamin K is considered effective in such cases:

- to prevent bleeding in neonates with low vitamin K levels; for this, the vitamin is administered orally or as an injection.
- treating and preventing bleeding in people who have low levels of a protein called prothrombin; vitamin K is taken orally or intravenously.
- with a genetic disease called insufficiency of blood clotting factors that depend on vitamin K; taking the vitamin orally or intravenously helps prevent bleeding.
- to reverse the effects of taking too much warfarin ; effectiveness is achieved when taking the vitamin simultaneously with the drug, stabilizing the process of blood clotting <sup>[9]</sup>.

In pharmacology, vitamin K is found in the form of capsules, drops, and injections. May be available alone or as part of a multivitamin - especially together with vitamin D. For bleeding caused by diseases such as hypothermia, 2.5 - 25 mg of vitamin K<sub>1</sub> is usually prescribed. To prevent bleeding when taking too many anticoagulants, take 1 to 5 mg of vitamin K. In Japan, menaquinone-4 (MK-4) is recommended for the prevention of osteoporosis. **It should be remembered that these are general recommendations, and when taking any medications, including vitamins, it is necessary to consult your doctor** <sup>[10]</sup>.

### In folk medicine

Traditional medicine considers vitamin K as a remedy for frequent bleeding, hepatitis, cirrhosis of the liver, stomach or duodenal ulcers, as well as bleeding in the uterus. Folk healers consider green leafy vegetables, cabbage, pumpkin, beets, liver, egg yolk, as well as some medicinal plants - rowan berries, shepherd's purse, nettle, yarrow and water pepper to be the main sources of the vitamin.

To strengthen blood vessels, as well as to maintain the overall immunity of the body, it is advised to use a decoction of rose hips and black currants, nettle leaves and lingonberries. Such a decoction is taken in the winter season, for 1 month, before meals.

rich in vitamin K and are often used in folk medicine to stop bleeding, as an analgesic and sedative. Take in the form of decoctions, tinctures, poultices and compresses. Plantain leaf tincture lowers blood pressure, helps with coughs and respiratory diseases. Shepherd's purse has long been considered an astringent and is often used in folk medicine to stop internal and uterine bleeding. The plant is used as a decoction or infusion. Also, to stop uterine and other bleeding, tinctures and decoctions of nettle leaves, which are rich in vitamin K, are used. Sometimes yarrow is added to nettle leaves to increase blood clotting <sup>[11]</sup>.

### Latest Scientific Research on Vitamin K

- In the largest and most modern study of its kind, researchers at the University of Surrey have found a link between diet and effective osteoarthritis treatment. After reviewing 68 existing studies in this area, the researchers found that a low daily dose of fish oil can reduce pain in

patients with osteoarthritis and help improve their cardiovascular health. The essential fatty acids in fish oil reduce inflammation in the joints, helping to relieve pain.

The researchers also found that reducing body weight in obese patients and introducing an exercise regimen also improves osteoarthritis. Obesity not only increases stress on the joints, but can also lead to systemic inflammation in the body. Introducing more vitamin K-containing foods, such as kale, spinach, and parsley, has also been found to have a positive effect on patients with osteoarthritis. Vitamin K is essential for vitamin K-dependent proteins found in bones and cartilage. Insufficient intake of vitamin K negatively affects protein function, slowing down the growth and repair of bones and increasing the risk of developing osteoarthritis [12].

- A study published in the American Journal of High Blood Pressure indicates that high levels of inactive Gla protein (which is normally activated by vitamin K) may indicate an increased risk of cardiovascular disease. This conclusion was made after measuring the level of this protein in people on dialysis. There is growing evidence that vitamin K, traditionally considered essential for bone health, also plays a role in the functioning of the cardiovascular system. Strengthening bones, calcium, in addition, contributes to the contraction and relaxation of blood vessels. If vascular calcification occurs, then calcium from the bones passes into the vessels, as a result of which the bones become weaker and the vessels less elastic. The only natural inhibitor of vascular calcification is the active matrix Gla -protein, which provides the process of calcium attachment to blood cells instead of vessel walls. And this protein is activated precisely with the help of vitamin K. Despite the lack of clinical results, inactive circulating Gla -protein is widely considered an indicator of the risk of developing cardiovascular diseases [13].
- Insufficient vitamin K intake in adolescents is associated with heart disease. In a study of 766 healthy teenagers, those who consumed the least amount of vitamin K1, found in spinach, kale, iceberg lettuce and olive oil, were 3.3 times more likely to have an unhealthy enlargement of the heart's main pumping chamber. Vitamin K1, or phylloquinone, is the most common form of vitamin K in the US diet. "Teens who don't eat green leafy vegetables may face serious future health problems," says Dr. Norman . Pollock, a bone biologist at the Georgia Prevention Institute at Augusta University (Georgia, USA), author of the study. About 10 percent of adolescents already had some degree of left ventricular hypertrophy, Pollock and colleagues report. Usually mild ventricular changes are more common in adults whose hearts are overworked due to persistent high blood pressure. Unlike other muscles, a larger heart is not considered healthy and can become inefficient.

The scientists believe they have conducted a first-of-its-kind study of the associations between vitamin K and heart structure and function in young adults. Although there is a need to continue to study this problem, the evidence suggests that already at an early age it is necessary to ensure sufficient levels of vitamin K intake in order to avoid the occurrence of further health problems [14].

### Use in cosmetology

Traditionally, vitamin K is considered one of the key beauty vitamins, along with vitamins A, C and E. It is often used at a five percent concentration in skin care products for stretch marks, scars, rosacea and rosacea due to its ability to improve blood vessels and stop bleeding. There is an opinion that vitamin K is also able to cope with dark circles under the eyes. Research shows that vitamin K can help fight the signs of aging as well. A 2007 study shows that people with vitamin K malabsorption had pronounced premature wrinkles.

Vitamin K is also useful for use in body care products. Research published in the Journal of Vascular Research shows that vitamin K may help prevent the occurrence of varicose veins. It activates a special protein necessary to prevent calcification of the vein walls - the cause of varicose veins <sup>[15]</sup>.

In industrial cosmetics, only one form of this vitamin is used - phytonadione. It is a blood coagulation factor, stabilizes the state of blood vessels and capillaries. Vitamin K is also used during the rehabilitation period after plastic surgery, laser procedures, peelings.

There are many recipes for natural face masks that include ingredients that contain vitamin K. Such products are parsley, dill, spinach, pumpkin, berries. Such masks often include other vitamins, such as A, E, C, B6, to achieve the best effect on the skin. Vitamin K, in particular, is able to give the skin a fresher look, smooth out fine wrinkles, get rid of dark circles and reduce the visibility of blood vessels.

1. A very effective recipe for puffiness and rejuvenation is a mask with honey, lemon juice, coconut milk and kale. This mask is applied to the face in the morning, several times a week for 8 minutes. In order to prepare the mask, you need to squeeze the juice of a lemon wedge (so that you get one teaspoon), rinse the kale (a handful) and mix all the ingredients (1 teaspoon of honey and a tablespoon of coconut milk). Next, you can grind all the ingredients in a blender, or if you prefer a thicker structure, chop the cabbage in a blender and add all the other ingredients by hand. The finished mask can be placed in a glass jar and stored in the refrigerator for a week <sup>[16]</sup>.
2. A nourishing, refreshing and softening mask is a mask with banana, honey and avocado. Banana is rich in vitamins and minerals such as vitamin B6, magnesium, vitamin C, potassium, biotin and fiber. Avocados are rich in omega-3s, fiber, vitamin K, copper, folic acid, and vitamin E. They help protect the skin from UV rays. Honey is a natural antibacterial, antifungal and antiseptic agent. Together, these ingredients are a storehouse of beneficial substances for the skin. In order to prepare the mask, you need to mash a banana and avocado, then add 1 teaspoon of honey. Apply to cleansed skin, leave for 10 minutes, rinse with warm water <sup>[17]</sup>.
3. Famous beautician Ildi Pekar shares his favorite recipe for a homemade mask for redness and inflammation: the composition includes parsley, apple cider vinegar and yogurt. Grind a handful of parsley in a blender, add two teaspoons of organic unfiltered apple cider vinegar and three tablespoons of natural yogurt. Apply the mixture on cleansed skin for 15 minutes, then rinse with warm water. Such a mask will not only reduce redness due to the vitamin K contained in parsley, but will also have a slight whitening effect.
4. For radiant, hydrated and tightened skin, it is advised to use a mask of cucumber and natural yogurt. Cucumber contains vitamins C and K, which are antioxidants, moisturize the skin and fight dark circles. Natural yogurt exfoliates the skin, removes dead cells, moisturizes and gives a natural glow. To prepare the mask, grind the cucumber in a blender and mix with 1 tablespoon of natural yogurt. Leave on the skin for 15 minutes, then rinse with cool water <sup>[19]</sup>.

## **Vitamin K for hair**

There is a scientific opinion that a lack of vitamin K2 in the body can lead to hair loss. It helps the regeneration and restoration of hair follicles. In addition, vitamin K, as noted earlier, activates a special protein in the body that regulates the circulation of calcium and prevents the deposition of calcium on the walls of blood vessels. Proper blood circulation in the scalp directly affects the speed and quality of follicle growth. In addition, calcium is responsible for the regulation of the hormone testosterone, which, if not produced, can cause baldness in both men and women. Therefore, it is recommended to include foods rich in vitamin K2 in the diet - fermented soybeans, mature cheese, kefir, sauerkraut, egg yolk, meat <sup>[20]</sup>.

## Use in animal husbandry

Since its discovery, vitamin K has been known to play an important role in the blood clotting process. More recent studies have shown that vitamin K is also important in calcium metabolism. Vitamin K is an essential nutrient for all animals, although not all sources are safe.

Poultry, especially broilers and turkeys, are more likely to develop signs of vitamin K deficiency than other animal species, which can be explained by their short digestive tract and fast food passage. Ruminants such as cattle and sheep do not appear to require a dietary source of vitamin K due to microbial synthesis of this vitamin in the rumen, one of the stomach compartments of these animals. Because horses are herbivores, their vitamin K requirements can be met from sources present in plants and from microbial synthesis in the gut.

The various sources of vitamin K accepted for use in animal feed are broadly labeled as vitamin K actives. There are two main vitamin K actives, menadione and menadione bransulfite complex. These two compounds are also widely used in other types of pet food, as dietitians often include vitamin K actives in formulas to prevent deficiency. Even though plant sources contain fairly high amounts of vitamin K, very little is known about the actual bioavailability of the vitamin from these sources. According to NRC publication, Vitamin Tolerances of Animals (1987), vitamin K does not result in toxicity when high amounts of phyloquinone, the natural form of vitamin K are consumed. It is also noted that menadione, a synthetic vitamin K commonly used in animal feed, can be added to levels up to 1,000 times the amount, consumed with food, without any adverse effects in animals, with the exception of horses. Injection of these compounds has caused adverse effects in horses, and it is not clear if these effects will also occur when vitamin K actives are added to the diet. Vitamin K and the active substances of vitamin K play an important role in providing essential nutrients to the diet of animals.

## In crop production

In recent decades, interest in the physiological function of vitamin K in plant metabolism has grown significantly. In addition to its well-known relevance in photosynthesis, it is increasingly likely that phyloquinone may also play an important role in other parts of the plant. Several studies, for example, suggest that vitamin K is involved in the transport chain that carries electrons across plasma membranes, and the possibility that this molecule helps maintain the correct oxidation state of some important proteins embedded in the cell membrane. The presence of various types of quinones reductase in the liquid content of the cell may also lead to the suggestion that the vitamin may be associated with other enzymatic pools from the cell membrane. To date, new and deeper research is still being conducted to understand and elucidate all the mechanisms in which phyloquinone is involved. <sup>[22]</sup>

## Contraindications and warnings

Vitamin K is more stable during food processing than other vitamins. Some naturally occurring vitamin K can be found in oils that are resistant to heat and moisture during cooking. Vitamin is less stable when exposed to acids, alkalis, light and oxidizing agents. Freezing can reduce vitamin K levels in foods. It is sometimes added to food as a preservative to control fermentation <sup>[23]</sup>.

## Signs of shortage

Current evidence indicates that vitamin K deficiency is not common in healthy adults, as the vitamin is widely distributed in foods. Those most often at risk of developing a deficiency are those taking anticoagulants, patients with significant liver damage and poor absorption of fat from food, and



newborn infants. Vitamin K deficiency leads to bleeding disorders, usually demonstrated by laboratory tests of the rate of clotting.

### Symptoms include:

- easy bruising and bleeding;
- bleeding from the nose, gums;
- blood in urine and stool;
- heavy menstrual bleeding;
- severe intracranial bleeding in infants <sup>[1]</sup>.

For healthy people, there are no known risks associated with high doses of vitamin K1 ( phylloquinone ) or vitamin K2 ( menaquinone ).

### Interaction with drugs

Vitamin K can have serious and potentially dangerous interactions with anticoagulants such as **warfarin** , as well as **phenprocoumon** , **acenocoumarol** , and **thioclomarol** , which are commonly used in some European countries. These drugs interfere with the activity of vitamin K, leading to the depletion of vitamin K clotting factors.

Antibiotics can destroy vitamin K-producing bacteria in the gut, potentially lowering vitamin K levels.

sequestrants , which are used to lower cholesterol levels by preventing bile acid reabsorption , may also reduce the absorption of vitamin K and other fat-soluble vitamins, although the clinical significance of this effect is not clear. A similar effect may have drugs for weight loss, which inhibit the absorption of fat, respectively, and fat-soluble vitamins <sup>[4]</sup>.

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