Vitamin K[1]

Vitamin K was identified in the early 1930s when it was shown to be essential for normal blood coagulation. Phylloquinone (2-methyl-3-phytyl-1,4-naphthoquinone) found in green plants is the major source of the vitamin. Large amounts of menaquinones with lengthy side chains are also synthesized in the lower bowel by anaerobic bacteria, but only small amounts are absorbed. The metabolic role of vitamin K is as a substrate for an enzyme, the vitamin K-dependent carboxylase, that converts specific glutamic acid residues of a limited number of proteins to Gla[2] residues by the addition of a CO_2. This modification was first identified in the procoagulant protein prothrombin and subsequently in other plasma procoagulants. A small number of Gla-containing proteins have also been discovered in proteins other than those involved in blood coagulation and their role in skeletal and tissue calcification is an active area of research. Gla-containing proteins have also been found in fish, snake and snail venoms, and invertebrates.

Deficiencies: Due to poor maternal-placental transfer of vitamin K, infants are born vitamin K-deficient. Widespread, routine prophylaxis at birth prevents the vitamin K-deficient bleeding that can otherwise occur within the first few months of life. In contrast, vitamin K deficiency is rare among adults and is limited to those with disorders of fat digestion and absorption. Routine use of extremely high doses of vitamin E has also been attributed to vitamin K deficiency among patients taking oral anticoagulant drugs. Low intakes of vitamin K have been associated with osteoporotic fracture risk. However, clinical trial data do not support a beneficial role for high vitamin K intakes in slowing progression of age-related bone loss.

DRI: The current DRI for vitamin K are Adequate Intakes as data that would be needed to calculate an Estimated Average Requirement and subsequently a RDA were determined to be insufficient to set an Estimated Average Requirement. The Adequate Intakes utilized was based on the median intakes of vitamin K calculated from the 1994 NHANES III data and these values are (μg/d) 2.0 for infants 0–6 mo, 2.5 for infants 7–12 mo, 30 for 1–3 y, 55 for 4–8 y, 60 for 9–13 y, 75 for 14–18 y, 120 for males 19 to >70 y, and 90 for females 19 to >70 y. There are no changes in recommendations for pregnancy or lactation. Increased consumption of vitamin K is not toxic and there is no upper limit for vitamin K within the current DRI.

Food sources: Vitamin K in the form of phylloquinone is found in all green vegetables, and spinach, broccoli, kale, and collards contain >200 μg/100 g. Substantial amounts are present in other commonly consumed green vegetables and over 100 μg/100 g are present in soybean oil and canola oil. A small amount of fat is needed for the absorption of vitamin K from vegetable sources. The bioavailability of vitamin K from vegetables is low, probably <10%, for commonly consumed vegetables, although the vitamin K present in oils is substantially more available. The amounts and forms of vitamin K consumed in various populations are closely related to the type of food consumed. The consumption of vitamin K in The Netherlands and China is substantially higher, and in Great Britain is somewhat lower than in the US. Small amounts of menaquinones are present in some cheeses and certain fermented foods.

Recent research: Mammals have the ability to convert dietary phylloquinone into MK-4 in specific tissues. The brain and reproductive organs are particularly rich in MK-4. Menaquinones with long side chains have also been reported to convert to MK-4. All vitamin K forms share a common role as a substrate for the vitamin K-dependent carboxylase, so this tissue-specific conversion suggests that MK-4 has functions unrelated to the classical cofactor role of vitamin K. Preliminary cell and animal studies suggest unique roles for MK-4 in regulation of inflammation, oxidative stress, and apoptosis. Recently, UBIAD1 was identified as the enzyme catalyzing the steps required to form MK-4. The exact mechanism by which vitamin K forms are converted to MK-4 and the tissue localization(s) for this conversion is an active area of research. Although vitamin K has long been attributed with a role in regulation of soft tissue calcification through Gla-containing proteins, such as Matrix Gla Protein, the data to support this in humans are limited. Current research is focused on patient populations at risk of vitamin K deficiency and abnormal calcification, such as those with chronic kidney disease. Well-designed clinical trials evaluating the effects of

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vitamin K supplementation on cardiovascular diseases are required.

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Additional Information

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