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Novel Cancer-Related Understandings of Vitamin K Biology

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Description

Although vitamin K was first identified about a century ago as a dietary component necessary for the prevention of bleeding, new uses for this vitamin in a variety of physiological processes are now being recognised. Phylloquinone, generally known as vitamin K1, and menaquinone (MK or vitamin K2) are two naturally occurring compounds with vitamin K activity. Both of these chemicals serve as cofactors for a particular post-translational protein modification called -carboxylation. Target proteins' glutamate (Glu) and carboxyglutamate (Gla) residues are catalytically changed into one another during -carboxylation. These vitamin K-dependent proteins have the ability to bind calcium because of the presence of Gla residues (often called Gla proteins). The function of various liver-derived pro- and anticoagulant proteins that regulate the balance between effective clotting activity and pathological thrombosis depends on vitamin K-dependent -carboxylation. Although the function of vitamin K in coagulation is widely recognised, it is now understood that not all Gla proteins play this role [1].

Examples include proteins that are -carboxylated and control the equilibrium between healthy and unhealthy calcification, as well as other proteins involved in glucose metabolism and cell signalling. It is intriguing to note that human malignancies and tumor-derived cell lines have Gla proteins and the enzymes that make them, but nothing is known about how -carboxylation affects the functions of these proteins in tumours. The presence of the tumour proteins gamma-glutamyl carboxylase (GGCX), vitamin K epoxide reductase (VKOR), and Gla strongly suggests that vitamin K status may be important for cancer treatment or prevention. There is some evidence from observational studies that dietary vitamin K intake can lower cancer incidence or death, although the results are not totally reliable. The idea that vitamin K supplements help slow down cancer growth and/or progression is supported by a few small randomised trials, but more extensive research is necessary. It is important to highlight that the physiological functions of K vitamins are now understood to extend beyond -carboxylation. K2 specifically affects cancer cells through non-canonical modes of action, such as disruption of electron transport and induction of apoptosis. Furthermore, it is becoming more widely acknowledged that the two forms of vitamin K behave differently in terms of metabolism, tissue uptake, and absorption [2].

An overview of vitamin K biology is given in this review, with a focus on recently found metabolic pathways and methods of action that may be relevant to human cancer. Comprehensive knowledge of the role of vitamin K in health and disease is crucial given the growing interest in the idea of "tailored nutrition." The term "vitamin K" refers to a group of substances that are necessary for the post-translational modification known as -carboxylation of proteins, which is important for the best possible blood coagulation. Phylloquinone (PK, vitamin K1) and different menaquinones generated from bacteria are naturally occurring compounds that facilitate -carboxylation (MKs, vitamin K2 family). These compounds differ in their aliphatic side chains but have a common core (the functional naphthoquinone ring). The K2 family has an unsaturated aliphatic side chain with a variable number of prenyl units (from 4 to 14), whereas PK has a phytyl side chain with four prenyl units. K2 exists in its most prevalent tissue form, MK4, which has four prenyl units. PK is the main dietary source of vitamin K and is plentiful in dark-green leafy vegetables and plant oils. Long-chain MKs are more abundant in a variety of Asian cuisines like Natto (fermented soybeans), which reflects the particular bacterial species utilised for fermentation [3, 4].

Although PK and MK4 activities have received extensive research, the long-chain bacterially produced MKs have received less attention, in part due to their considerable structural variety and low levels of accumulation in tissues other than the liver of mammals. The biological importance of long-chain MKs with regard to vitamin K physiology is unknown because long-chain MKs are easily converted into MK4 in tissues, despite the data suggesting that long-chain MKs are generated by gut microorganisms. Because they are lipid soluble, K vitamins are absorbed along with dietary fats, and the presence of bile salts increases their bioavailability [5].

Conclusion

Through the lymphatic system, they are integrated into micelles and discharged as chylomicrons into the systemic circulation. It's interesting to note that MK4 is the main form found in mammalian tissues, regardless of food intake (PK or different MKs). Studies on mice show that dietary PK, MK4, MK7, and MK9 all function as precursors to tissue MK4. The build-up of MK4 in tissues can be explained by the enzyme UBIAD1 (UBIA prenyltransferase domain-containing protein 1) that converts PK to MK4. The liver, kidney, fat, reproductive organs, bone, and pancreas are particularly enriched in MK4. Despite the fact that MK4 build-up is significant in many. Extrahepatic organs is still unclear, however local pools may promote the production of carboxylated proteins or have other biological effects, as discussed below.

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