

ROLE OF VITAMIN A IN HEALTH AND ILLNESS

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Annotation. Vitamin A is an essential substance for human well-being and survival. It plays a crucial role in many physiological processes, including growth and differentiation of target tissues, reproduction, proper functioning of the retina and modulation of the immune system. Vitamin A deficiency leads to increased risk of severe infections, numerous diseases and pathological conditions, including disorders of vision, bones, epithelial tissue and immunity. It remains one of the main causes of preventable blindness in children. Nonetheless, excessive intake of vitamin A can also cause serious health problems.

Key words: vitamin A, retinol, fat soluble vitamin, vitamin A deficiency.

РОЛЬ ВИТАМИНА А В ЗДОРОВЬЕ И ЗАБОЛЕВАНИЯХ

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Аннотация. Витамин А является жизненно необходимым веществом для поддержания здоровья и жизнедеятельности человека. Он играет

ключевую роль во многих физиологических процессах, включая рост и дифференциацию тканей, репродуктивную функцию, нормальное функционирование сетчатки глаза и регуляцию иммунной системы. Дефицит витамина А повышает риск тяжёлых инфекций, различных заболеваний и патологических состояний, в том числе нарушений зрения, развития костной ткани, состояния эпителиальных тканей и иммунной защиты организма. Он остаётся одной из ведущих причин предотвратимой слепоты у детей. В то же время чрезмерное потребление витамина А может вызывать серьёзные неблагоприятные последствия для здоровья.

Ключевые слова: витамин А, ретинол, жирорастворимый витамин, дефицит витамина А.

Introduction. Vitamin A is a name of the group of chemical substances – retinoids (i.e., retinol, retinal, retinoic acid), fat-soluble compounds that are essential for human body. They cannot be produced and have to be provided as a part of the diet. In the animal origin food, vitamin A is present in ester form – mostly as retinyl palmitate, which is converted in the human body to alcohol – retinol. In plant-based diet, it is present in form of β -carotene, β -cryptoxanthin and other pro-vitamin A carotenoids [1]. These substances are less efficient in vitamin A generation process. It is accepted that 6 mg of β -carotene is required to produce 1 mg of retinal during enzymatic cleavage. However several years ago it has been stated that this conversion is even less efficient and it requires not 6 but, 12 molecules of β -carotene to produce 1 molecule of vitamin A [2]. Then again this process may be either more or less productive for different sources and types of pro-vitamin A carotenoids [3–5]. Serum concentrations of vitamin A have to stay in equilibrium, for it takes part the cellular differentiation and growth, and at high serum level it exert its toxic effects. Moreover, vitamin A plays a crucial role in vision, immune system function, maintenance of epithelial tissues and reproduction. Nevertheless, lack of vitamin A persists to be one of the most

prevalent micronutrient deficiencies and a significant contributor to the global burden of disease, especially in the resourceconstrained countries [6].

Absorption, transport and storage. Efficiency of absorption, processing and storage of preformed vitamin A varies from 70% – 90%. For carotenoids, the bioavailability range is wider and oscillates between 35% – 88% [7, 8]. Crucial for improving the absorption of vitamin A in vulnerable populations is the knowledge that the presence of dietary fat enhances absorption of both pro-vitamin A carotenoids and preformed vitamin A. Up to 80% of vitamin A in the body is stored in the liver, mainly in the stellate cells, and mostly as retinyl esters. A part of retinol esters from chylomicra is uptaken by spleen, lung and adrenal gland to maintain concentration. Lesser amounts of retinyl esters can be found in kidney and intestine. An undervalued role in retinol storing is played by adipose tissue, which can also gather β -carotenoids. Vitamin A occurs in cis- and trans- geometric isomeric forms , and interconversion between them readily takes place in the body. All-trans retinoic acid is the ligand of nuclear receptors, such as retinoic acid receptors (RARs), and 11-cisretinal is required in the visual cycle. Retinol is transported from the liver to the tissues as a complex with retinol-binding protein (RBP), which is synthesized primarily in hepatocytes. This stability of complex retinol: RBP in plasma is enhanced by its binding to transthyretin. RBP is a negative acute-phase reactant; therefore, serum retinol concentrations are decreased during inflammation and infection.

Table 1.

Selected sources of vitamin A

Food	Sweet potatoes	Beef liver	Spinach	Carrots	Mangos	Apricots
Vitamin A (IU)	28,058	22,175	11,458	9,189	2,240	1,261
Food	Broccoli	Ice	Ricotta	Tomato	Cereal fortified	Milk with added

		cream	cheese	juice	with vitamin A	vitamin A
Vitami n A (IU)	1,208	1,014	945	821	500	500

Fortifying food with vitamin A is socially acceptable and does not require big changes in food habits. The most common and approved types of food for fortification are margarines and oils. They have two big advantages, namely they prevent vitamin A from oxidation during storage and are at low price. Nevertheless, there are many different types of fortified food [3]. Cooking improves the bioavailability of carotenoids. The situation is different for fortified food where processing, storage and preparation may cause big losses of vitamin A. Preformed retinol tends to be a major source of vitamin A in developed countries, while in developing countries most demand is covered by pro-vitamin A carotenoids.

Functions. Nowadays, knowledge about vitamin A properties, metabolism, functions, roles and epigenetic gene regulation is still evolving. The main function of vitamin A is its role in the vision cycle: 11-cis retinal binds to opsin and forms rhodopsin, which is able to absorb light within the visible spectrum. When 11-cis retinal is hit by a photon, it isomerizes via intermediate species to all-trans retinal, and rapidly releases opsin. This is the initial step of vision. Light-induced hyperpolarization of the rod membrane is amplified by the excited intermediate form of rhodopsin, resulting in the generation of impulses in optic nerves. Retinoic acid is proven to be promoting the proliferation and regulation of the apoptosis of thymocytes. It also takes part in development, proliferation and differentiation of thymic epithelium. Retinoic acid may play a role in negative selection for T cells.

Vitamin A has regulatory and promoting effects in the immune system. It is valuable enhancer of immunity against numerous infectious diseases and pathologies. Both T cell-mediated and antibody-dependent immune responses are affected by this vitamin, which is relevant in the process of synthesis of

immunoglobulins, mostly IgA class. Retinoids also have repressive activity on IgE; therefore, they may ameliorate allergic diseases mediated by IgE. [10] Another mechanism of action of vitamin A on immune system regulation is the induction of differentiation of naive T cells into T-reg cells through enhancement of Foxp3 gene expression and inhibition of IL-17 expression. Retinoic acid in in vitro conditions inhibits the growth of *M. tuberculosis*. It also reduces its survival rate, making them easier to be lysed when engulfed by macrophages.

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