

Vitamins as Key Modulators in Hair Growth Dynamics

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ABSTRACT

Vitamins play a fundamental role in the regulation and promotion of hair growth, with vitamins A, B7, C, D, and E being particularly crucial in this process. These essential nutrients not only stimulate active phases of hair growth but also offer protection against various forms of damage. Despite challenges in utilizing these vitamins as supplements for alopecia treatment, their substantial potential in addressing and preventing hair-related issues is noteworthy, particularly in the context of nutritional deficiencies. Given the significant influence of these vitamins, this study centers on exploring their modulating impact on hair growth.

Keywords: Vitamins; Supplements; Hair Growth; Hair Cycle; Alopecia

Abbreviations: WNT; Wingless/Integrated; WNT7A: Wingless-Type MMTV Integration Site Family Member 7A; BMP4: Bone Morphogenetic Protein 4; ALDH1A2: Aldehyde Dehydrogenase 1 Family Member A2; CRABP2: Cellular Retinoic Acid Binding Protein 2; CYP26B1: Cytochrome P450 Family 26 Subfamily B Member 1; IGF-1: Insulin-Like Growth Factor 1; PI3K: Phosphoinositide 3-Kinases; VDR: Vitamin D Receptor; LEF1: Lymphoid Enhancer-Binding Factor 1

Introduction

The hair cycle consists of four distinct phases: anagen, which is the phase of active growth; catagen, a regression stage; telogen, the resting period; and exogen, where hair shedding occurs [1]. Alopecia, characterized by abnormal hair loss, stems from an imbalance in these phases. One of the fundamental causes of this imbalance may be caused by malnutrition, specifically deficiency of certain vitamins [2]. Currently, it has been proven that vitamins obtained through diet or supplements play a significant role in promoting hair growth and preventing hair loss, highlighting the importance of an adequate nutritional balance to maintain hair health [2,3]. Vitamin A is key for hair cell development, as it promotes sebum production, moisturizing the scalp, and supporting cell growth. It also serves as an antioxidant, safeguarding hair, and scalp from damage by free radicals [2-4]. Biotin, also known as vitamin B7 or H, enhances keratin infrastructure, crucial for the health of hair, skin, and nails, thereby contributing to

stronger, healthier hair. Vitamin C plays a pivotal role in collagen synthesis, is vital for hair structure, and provides antioxidant protection to hair cells [2,3,5]. Vitamin D positively impacts hair follicles by prolonging the anagen phase of the hair cycle, promoting hair growth [2,3,6]. Vitamin E, known for its antioxidant properties, protects hair follicle cells from oxidative stress and boosts blood circulation in the scalp, which is essential for healthy hair growth [2,3,7]. Lack of these vitamins in the diet can lead to weakness, brittleness, dullness, texture changes and, in severe cases, significant shedding, underscoring the importance of proper nutrition [2,3,8].

Hair Growth Modulating Vitamins

Various vitamins have been examined in several biological models, including cell lines, murine and human studies, demonstrating their significant impact as key modulators of hair growth, as illustrated in Table 1. Recent studies demonstrate that vitamins exert a regulatory effect on the hair growth cycle, as illustrated in Figure 1 [9-17].

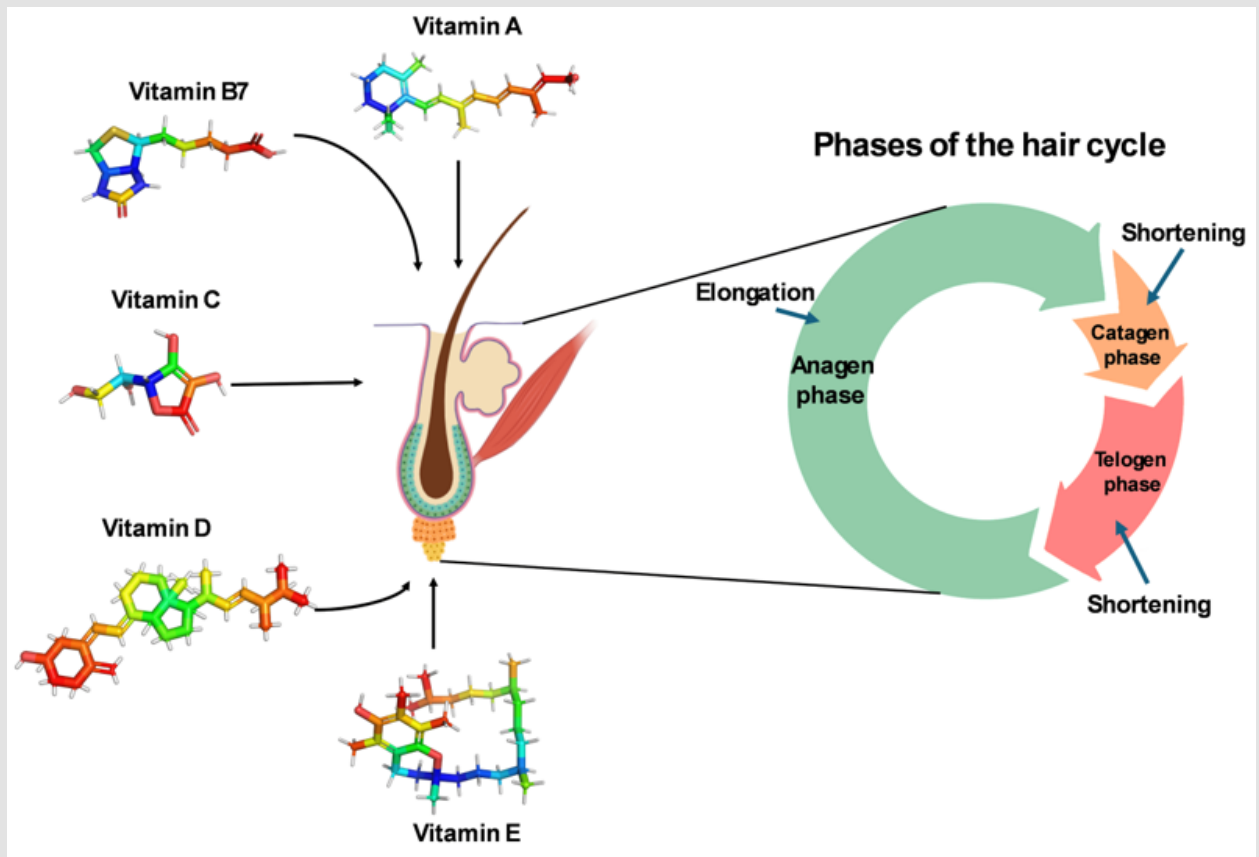


Figure 1: Influence of vitamins on hair growth cycle. This diagram illustrates the proposed impact of vitamins A, B7, C, D, and E on the hair growth cycle. The vitamins are depicted as contributors to the modulation of the hair cycle, specifically by extending the duration of the anagen phase and shortening the catagen and telogen phases. This modulation promotes hair growth and may lead to improved hair health.

Table 1: Biological effect of vitamins on hair growth.

Vitamins	Biological Model	Molecular Pathways Involved	Biological Effect	References
Vitamin A	C3H/HeJ Mouse	Increases WNT/ β -Catenin signaling and WNT7A levels	Activation of hair follicle stem cells, inducing the development and growth phase of the hair cycle	[9]
Vitamin A	C57BL/6 Mice	Increases WNT7A expression, reduced BMP4 and modulated ALDH1A2, CRABP2, and CYP26B1	Accelerates growth phase and hair growth induction	[10]
Vitamin B7	Humans	Not determined, but suggests modulation of fatty acid synthesis, branched-chain amino acid catabolism, and gluconeogenesis	Accelerates growth phase and hair growth induction	[11]
Vitamin B7	Humans	Not determined, but suggests modulation of carboxylase enzymes by functioning as a cofactor	Vitamin B7 deficiencies lead to hair fragility, alteration of the follicular cycle, hair loss	[12]
Ascorbic Acid 2-Phosphate (Asc 2-P), a Vitamin C derivative	Human and C57BL/6 mouse hair follicles	Induces IGF-1 expression	Induces proliferation of dermal papilla cells in culture, and in C57BL/6 mice induced an earlier transition from telogen to anagen and increased the number of follicles	[13]
Ascorbic Acid 2-Phosphate	Dermal papilla cells and human keratinocytes	Induces IGF-1 and PI3K signaling	Stimulates the proliferation of both cell lineages	[14]

Vitamin D	Vitamin D receptor null mouse	Null expression of VDR	Absence of the receptor, shortening of the anagen phase and increased catagen, leading to alopecia	[15]
Vitamin D	Humans	Not determined, but suggests modulation of the Wnt/ β -Catenin pathway	Hair Regeneration	[16]
Tocopherols (Vitamin E family)	Humans	Not determined, but suggests modulation of antioxidant pathways and apoptosis	Hair Regeneration	[7]
Vitamin E	C57BL/6 mice	Increases Wnt/ β -catenin signaling, and expression of Cyclin D1 and LEF 1	Induces hair growth, promote the anagen phase, and increase the number of follicles	[17]

Perspectives

The use of vitamin supplements for the treatment of alopecia faces key challenges, including the need for more clinical evidence to substantiate their efficacy, variability in individual responses, potential interactions, side effects, and a limited comprehension of the underlying molecular mechanisms. Despite these limitations, supplements hold substantial promise as integral components of a comprehensive approach to treating alopecia, particularly when nutritional deficiency is a contributing factor. They may also play a role in the prevention and long-term management of hair health.

Conclusion

Vitamins play a crucial role as modulators of hair growth, highlighting their potential to promote hair regeneration, prevent alterations, and combat hair loss. Therefore, they emerge as fundamental components in the treatment of alopecia.

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Declaration of Competing Interest

The authors declared that there is no conflict of interest.

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