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Tomatoes as a Novel Source of Vitamin D

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Abstract

Vitamin D deficiency is a prevalent global health concern associated with increased risks of various diseases, including cancer, neurocognitive decline, and mortality. Traditional dietary sources of vitamin D are limited, particularly for individuals following plant-based diets. To address this, we have to engineer tomatoes to accumulate provitamin D3, offering a biofortified food source. This innovation holds promise for supplement production from surplus plant material. Additionally, studies have highlighted the crucial role of vitamin D in preventing deficiency diseases and its association with immune function, inflammation, and disease risks. We review relevant studies exploring the impact of vitamin D on conditions such as colon cancer, cognitive decline, depression, Parkinson's disease, and dementia. Our findings underscore the importance of addressing vitamin D insufficiency through innovative approaches.

Introduction

Vitamin D deficiency is a significant global health concern, contributing to elevated risks of various ailments such as cancer, neurocognitive decline, and overall mortality. While many foods lack sufficient amounts of vitamin D, plant sources are particularly inadequate. To address this issue, we have to utilize genome editing techniques to enhance the accumulation of provitamin D3 in tomatoes. By modifying a duplicated segment of phytosterol biosynthesis in Solanaceous plants, we can engineer tomatoes to serve as a biofortified source of this essential nutrient. Furthermore, this innovation opens the door to producing supplements from surplus plant material, providing an additional avenue for addressing deficiencies.

Vitamin D plays a crucial role in preventing diseases related to skeletal development and also functions as a precursor to steroid hormones that participate in signaling within various organs, including the brain. Deficiencies in vitamin D not only affect immune function and inflammation but also elevate the risk of micronutrient deficiencies, cancer, neurodegenerative disorders like Parkinson's disease, depression, cognitive decline, dementia, and even impact the severity of COVID-19 infections. While humans can synthesize vitamin D from 7-dehydrocholesterol (provitamin D3) upon exposure to ultraviolet B (UVB) light, dietary intake remains a primary source (Fig.1). However, inadequate dietary availability has led to approximately one billion individuals worldwide experiencing vitamin D insufficiency, with numbers on the rise. Therefore, the development of a new plant-based source of vitamin D is crucial, especially for individuals following plant-rich, vegetarian, or vegan diets, to address the increasing demand for mitigating vitamin D insufficiency.

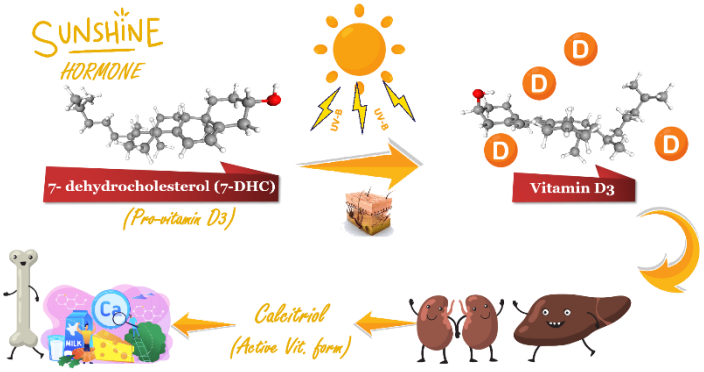

Fig. 1. Synthesis of vitamin D from 7-dehydrocholesterol (provitamin D3) upon exposure to ultraviolet B (UVB) light in human body.

Case Studies:

- **Study on Rickets:** Early research by McCollum et al. (1922) demonstrated the significance of vitamin D in bone growth and calcium deposition. Their experiments with rats showed that certain fats, such as cod liver oil and coconut oil,

stimulated calcium deposition in bones, highlighting the presence of substances beyond fat-soluble A involved in bone metabolism.

- **Colon Cancer Risk:** Garland and Garland (2005) proposed a protective role of vitamin D against colon cancer based on geographical patterns of colon cancer mortality and solar radiation exposure. Their hypothesis was supported by observations of reduced mortality rates in areas with higher sunlight exposure and the potential protective effect of vitamin D-fortified milk.
- **Cognitive Decline:** Llewellyn et al. (2014) conducted population-based studies revealing an association between low vitamin D levels and increased risk of cognitive decline in elderly individuals over a six-year period. These findings suggest a potential causal relationship between vitamin D deficiency and cognitive impairment.
- **Depression:** Anglin et al. (2013) conducted a meta-analysis indicating lower vitamin D levels in individuals with depression compared to controls. The study suggested a potential link between vitamin D deficiency and depression, emphasizing the need for randomized controlled trials to explore this association further.
- **Parkinson's Disease:** Zhou et al. (2019) conducted a systematic review and meta-analysis, revealing an association between vitamin D insufficiency and an increased risk of Parkinson's disease. However, vitamin D supplementation showed no significant improvement in motor function for patients with Parkinson's disease.

Conclusion

Vitamin D deficiency poses significant health risks globally, contributing to various diseases and conditions. Use of innovative approach of engineering tomatoes to accumulate provitamin D3 offers a sustainable solution to address dietary insufficiencies. Furthermore, a review of relevant studies underscores the crucial role of vitamin D in preventing deficiency diseases and mitigating the risks of cancer, neurocognitive decline, depression, and other ailments. Moving forward, it is imperative to continue exploring innovative strategies to combat vitamin D insufficiency and its associated health implications.

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