The Effects of Lutein and Nutrition on Eye Health

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Abstract

Background. Eye health is a crucial element in an individual's quality of life, given the essential function of vision in everyday life. The main focus of this issue is on the relevance of nutrients, specifically Lutein, one of several types of Xanthophyll Carotenoids found in high concentrations in the macula of the human retina. Since the human body is unable to synthesize lutein on its own, the only way to obtain this substance is through food consumption.[1]

Methods. This study was conducted as a systematic literature review to collect and analyze relevant research on lutein and its nutrients in the context of eye health. The main focus was on studies that discussed the effects of lutein on age-related eye diseases. The literature examined came from various academic databases, including PubMed, Google Scholar, and leading scientific journals in the fields of nutrition and ophthalmology.

Discussion. This study focuses insight into lutein, a carotenoid with high potential for improving human health, notably in the prevention of degenerative disorders.

Conclusion. Lutein is essential for preserving eye health, particularly in the prevention of age-related macular degeneration. Adequate lutein consumption from foods such as green vegetables and egg yolks is advantageous, whereas lutein supplementation is safe but should

be used with caution in people with reduced absorption. More research is needed in order to comprehend the processes and long-term effects of lutein in eye health.
Keywords. Lutein, Eye Health, Nutrition

Introduction

Eye health is a crucial element in an individual's quality of life, given the essential function of vision in everyday life. As the world's population ages, eye health issues including macular degeneration, cataracts, and retinopathy become more prevalent. To prevent and treat these issues, the emphasis is on the role of diet, particularly lutein, in preserving eye health. In addition to lutein, a diet high in vitamins C, E, and zinc enhances eye health. Buscemi et al. (2018) pointed out that combining numerous nutrients in a well-balanced diet can improve lutein's effectiveness in maintaining eye health. As a result, it is important to understand how lutein and other nutrients interact to preserve eye health, and how this might be incorporated into a daily diet.[1]

Lutein is one of several types of Xanthophyll Carotenoids found in high concentrations in the macula of the human retina. Since the human body is unable to synthesize lutein on its own, the only way to obtain this substance is through food consumption.. Lutein is a natural compound found in abundance in egg yolks and dark green leafy vegetables, such as spinach and kale.2 Several studies, both basic and clinical, have shown that lutein has significant anti-oxidative and anti-inflammatory properties for eye health. These studies indicate that lutein may provide beneficial protective effects and potentially reduce the risk of various eye diseases.[4]

Methods

This study adopted a systematic literature review to gather and assess important research on lutein and its nutrients in the context of eye health. The primary focus was on research into the impact of lutein on age-related eye disorders. The material reviewed comes from a variety of academic databases, including PubMed, Google Scholar, and top scientific journals in nutrition and ophthalmology.

Discussion

The majority of the study in the field of eye health has centered on lutein (L), a carotenoid with excellent antioxidant properties when evaluated in vitro. This study reveals that lutein may help to reduce the risk of a variety of age-related disorders, which are growing

increasingly widespread among the elderly. Lutein is a kind of xanthophyll, a vital oxygenated carotenoid, and all mammals, including humans, acquire it through their diet because their bodies are unable to produce carotenoids naturally.[5]

The structure of lutein (L) is similar to other carotenoids, consisting of 40 carbon atoms organized into eight isoprene units. However, there is a significant chemical difference with functional implications, namely the presence of two oxygen atoms in its structure. This makes lutein a polar carotenoid classified as a xanthophyll, which is a type of oxygenated carotenoid. Together with zeaxanthin (Z), lutein is the major carotenoid found in the human macula, and the two are often referred to as macular pigment (MP).[1, 2, 3]

Lutein mainly accumulates in the inner plexiform layer and in the Henle fiber layer, and can also be found in Müller cells. In addition, lutein has been detected in the peripheral region of the fovea, although its concentration decreases in the central area of the fovea where zeaxanthin is more prevalent, with a lutein to zeaxanthin ratio of approximately 2:1. Interestingly, the levels of this carotenoid decrease significantly—up to a hundredfold—as one moves away from the macula.[7]

Lutein is naturally present in large amounts in a variety of food sources, including fruits, cereals, and vegetables, and is also found in egg yolk. The bioavailability of lutein from egg yolk is higher than that from other food sources. Lutein intake is highly dependent on vegetable consumption, so intake levels can vary by dietary pattern, with estimates ranging from 0.67 mg/day to over 20 mg/day. In individuals following a Western diet, the average daily lutein intake is estimated to be around 1.7 mg/day. Meanwhile, in countries with a Mediterranean diet rich in fruits and vegetables, lutein intake has been reported to range from 1.07 to 2.9 mg/day, indicating significant variability between countries. In the Korean population, the average lutein intake is estimated to be around 3 mg/day. Interestingly, countries in the Pacific region report the highest lutein intakes, with individuals consuming diets very rich in fruits and vegetables, peaking at around 25 mg/day in the Fiji Islands.[8]

The distribution of lutein and zeaxanthin varies between different types of food. In green vegetables, the ratio of lutein to zeaxanthin has been reported to range from 12 to 63, with kale having the highest ratio. In contrast, in orange-yellow fruits and vegetables, this ratio is much lower, ranging from 0.1 to 1.4. In addition, small amounts of lutein and zeaxanthin are also found in bread made from modern wheat varieties.[8,9]

Compared with plant sources, egg yolk is considered a better source of lutein and zeaxanthin, because the fat content in eggs increases the bioavailability of carotenoids. The carotenoid content in egg yolk is highly dependent on the type of feed given to the chicken,

which usually contains esterified forms of lutein and zeaxanthin, as well as small amounts of lycopene and β-carotene.[6]

Before they can exert their nutritional effects, carotenoids must be absorbed and transported into the body circulation. Therefore, it is important to understand the processes of carotenoid release, absorption, transport, and accumulation in the eye in order to assess their health benefits. In general, carotenoids are hydrophobic, meaning they are soluble in fat but not in the aqueous medium of the human digestive system. However, due to the presence of hydroxyl groups, lutein and zeaxanthin are more polar than hydrocarbon carotenoids such as β-carotene and lycopene, giving them different properties in absorption and transport.[8,9]

In a balanced diet, lutein (L) intake is usually sufficient, so supplementation is not necessary. However, in cases of impaired absorption or chronic disease, supplementation should be considered with caution. Several studies have been conducted to determine a safe upper limit for daily supplementation and to identify possible side effects of long-term lutein use. To date, no studies have reported toxicity with either acute or chronic lutein supplementation. [8,9]

Animal studies and in vitro testing clearly show that lutein is safe for use, as no mutagenic or teratogenic effects have been found. However, it should be noted that Beta-Carotene Oxygenase 2-deficient mice exhibit pathological accumulation of carotenoids, as well as significant increases in oxidative stress and mitochondrial dysfunction. This suggests that excessive carotenoid supplementation may cause toxicity under certain conditions. Furthermore, neither epidemiological nor interventional studies have found toxic effects associated with lutein, further supporting its safety when consumed in recommended amounts.[10,11]

Conclusion

Lutein is a xanthophyll that is primarily synthesized by plants, but humans cannot produce it on their own. It is highly concentrated in the macula and has a variety of properties, including anti-inflammatory, antioxidant, and blue light filtering effects. Due to its protective properties and relatively high safety profile, lutein is often considered by many researchers as a potential alternative or additional therapy for various eye diseases. As a powerful antioxidant, lutein is supported by numerous studies showing its benefits for eye health. In addition, lutein also has positive effects on other tissues, especially the brain, which are associated with improved cognitive performance.

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