24. UNLOCKING THE SHIELD: EXAMINING RETINAL PROTECTION VIA MACULAR CAROTENOIDS' ANTIOXIDANT CAPACITY

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Introduction. The human retina, crucial for vision, is highly susceptible to oxidative damage due to its exposure to light and high metabolic activity. Three macular xanthophylls (MXs) – zeaxanthin (Z), lutein (L), and meso-zeaxanthin (MZ) – accumulate in the macula and play a pivotal role in the antioxidant defense system within the human retina. They mitigate oxidative damage, thereby preventing or slowing the progression of retinal diseases such as age-related macular degeneration, a leading cause of irreversible vision loss.

Aim of study. To explore the role of macular carotenoids in protecting the retina by examining their antioxidant functions and to analyze their physical and chemical actions as antioxidants, elucidating their specific contribution, considering the four photoprotective mechanisms of MXs.

Methods and materials. The study comprehensively analyzed 30 scientific articles published in the last decade out of a selection of 73. The following databases were used: PubMed, ScienceDirect, and NCBI to ensure a reliable groundwork for interpreting results. Articles lacking in relevance were ousted.

Results. The distinctive chemical structures of macular carotenoids define their properties. Various roles of MXs in providing photoprotection were outlined, encompassing physical and chemical antioxidant actions: blue-light filtration by absorbing 40–90% of incident short-wavelength, reactive oxygen species (ROS) interception, chain-breaking action, and quenching of excited triplet state of photosensitizers and singlet oxygen. While chemical quenching deactivates only a small fraction of singlet oxygen because it utilizes MXs and disrupts their original structure, the efficiency of MXs in physically quenching singlet oxygen is notably higher. The selective distribution of Z at the foveal center indicates its superior antioxidant capacity over L, with a ratio of Z/L at 2.4/1, compared to 1/2 in the periphery. This difference is attributed to the increased exposure to intense light and elevated metabolic activity in the central region. However, the combined administration of antioxidants proves to be more effective in preventing oxidative stress (OS) than their separate use.

Conclusion. MXs exhibit a dual nature of antioxidant properties, chemical and physical, that contribute to their effectiveness in safeguarding against oxidative damage. Maintaining the structural integrity of these compounds enhances protection. Given the vulnerability of the retina to ROS due to its structure and location, as well as the impact of aging on OS, MXs are emerging as promising agents both in the prevention and treatment of various retinal degenerative diseases. Thus, understanding their antioxidant capacities becomes imperative in outlining strategies to maintain retinal health via appropriate dietary intake and supplementation.