Zeaxanthin and Eye Health

Clin Dermatol. 2009 Mar-Apr;27(2):195-201.

Lutein and zeaxanthin in eye and skin health.

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Less than 20 of the hundreds of carotenoids found in nature are found in the human body. These carotenoids are present in the body from the foods or dietary supplements that humans consume. The body does not synthesize them. Among the carotenoids present in the body, only lutein and its coexistent isomer, zeaxanthin, are found in that portion of the eye where light is focused by the lens, namely, the macula lutea. Numerous studies have shown that lutein and zeaxanthin may provide significant protection against the potential damage caused by light striking this portion of the retina. In the eye, lutein and zeaxanthin have been shown to filter high-energy wavelengths of visible light and act as antioxidants to protect against the formation of reactive oxygen species and subsequent free radicals. Human studies have demonstrated that lutein and zeaxanthin are present in the skin, and animal studies have provided evidence of significant efficacy against light-induced skin damage, especially the ultraviolet wavelengths. Little was known about the protective effects of these carotenoids in human skin until recently. This article reviews the scientific literature pertaining to the effects that lutein and zeaxanthin exhibit in the human eye and skin.

Publication Types:

- Review

PMID: 19168000 [PubMed - indexed for MEDLINE]

Curr Eye Res. 2009 Apr;34(4):311-8.

Zeaxanthin, a retinal carotenoid, protects retinal cells against oxidative stress.

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PURPOSE: To investigate whether zeaxanthin, the predominant carotenoid pigment of the macular pigments in human retina, provides neuroprotection against retinal cell damage. METHODS: We used in vitro cultured retinal ganglion cells (RGCs), specifically RGC-5, an E1A virus-transformed rat cell line. Cell damage was induced either by a 24-hr exposure to hydrogen peroxide (H2O2) or by serum deprivation. Cell viability was measured using the tetrazolium salt, WST-8. The scavenging capacity of zeaxanthin for H2O2, superoxide anion radical (O2.-), and hydroxyl radical (HO.) was measured using a radical scavenging capacity assay with CM-H2DCFDA, a reactive oxygen species (ROS)-sensitive probe. RESULTS: When added to RGC-5 cell cultures, 0.1, 10, and 1 microM zeaxanthin scavenged the free radicals induced by H2O2, O2.-, and HO., respectively. In addition, pretreatment with 1 microM zeaxanthin permitted scavenging of staurosporine-induced intracellular radicals. Zeaxanthin also inhibited the neurotoxicity induced by H2O2 or serum deprivation and scavenged the intracellular radicals induced by H2O2 or serum deprivation. CONCLUSIONS: Our results suggest that zeaxanthin provides effective protection against oxidative stress-induced retinal cell damage.

PMID: 19373580 [PubMed - in process

J Ocul Biol Dis Infor. 2008 Mar;1(1):12-18.

Macular and serum carotenoid concentrations in patients with malabsorption syndromes.

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The carotenoids lutein and zeaxanthin are believed to protect the human macula by absorbing blue light and quenching free radicals. Intestinal malabsorption syndromes such as celiac and Crohn's disease are known to cause deficiencies of lipid-soluble nutrients. We hypothesized that subjects with nutrient malabsorption syndromes will demonstrate lower carotenoid levels in the macula and blood, and that these lower levels may correlate with early-onset maculopathy. Resonance Raman spectrographic (RRS) measurements of macular carotenoid levels were collected from subjects with and without a history of malabsorption syndromes. Carotenoids were extracted from serum and analyzed by high performance liquid chromatography (HPLC). Subjects with malabsorption (n=22) had 37% lower levels of macular carotenoids on average versus controls (n=25, $P<0.001$). Malabsorption was not associated with decreased serum carotenoid levels. Convincing signs of early maculopathy were not observed. We conclude that intestinal malabsorption results in lower macular carotenoid levels.

PMID: 19081745 [PubMed]

PMCID: PMC2600549

Ophthalmic Epidemiol. 2008 Nov-Dec;15(6):389-401.

Carotenoids and co-antioxidants in age-related maculopathy: design and methods.

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Age-related macular degeneration (AMD), is the leading cause of blind registration in the Western World among individuals 65 years or older. Early AMD, a clinical state without overt functional loss, is said to be present clinically when yellowish deposits known as drusen and/or alterations of fundus pigmentation are seen in the macular retina. Although the etiopathogenesis of AMD remains uncertain, there is a growing body of evidence in support of the view that cumulative oxidative damage plays a causal role. Appropriate dietary antioxidant supplementation is likely to be beneficial in maintaining visual function in patients with AMD, and preventing or delaying the progression of early AMD to late AMD. The Carotenoids in Age-Related Maculopathy (CARMA) Study is a randomized and double-masked clinical trial of antioxidant supplementation versus placebo in 433 participants with either early AMD features of sufficient severity in at least one eye or any level of AMD in one eye with late AMD (neovascular AMD or central geographic atrophy) in the fellow eye. The aim of the CARMA Study is to investigate whether lutein and zeaxanthin, in combination with co-antioxidants (vitamin C, E, and zinc), has a beneficial effect on visual function and/or prevention of progression from early to late stages of disease. The primary outcome is improved or preserved distance visual acuity at 12 months. Secondary outcomes include improved or preserved interferometric acuity, contrast sensitivity, shape discrimination ability, and change in AMD severity as monitored by fundus photography. This article outlines the CARMA Study design and methodology, including its rationale.

Publication Types:

- Comparative Study
- Research Support, Non-U.S. Gov't
- Review

PMID: 19065432 [PubMed - indexed for MEDLINE]

Nutr Rev. 2008 Dec;66(12):695-702.

Possible role for dietary lutein and zeaxanthin in visual development.

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The possibility that the macular carotenoids, lutein (L), and zeaxanthin (Z), could retard age-related changes in the eye and prevent the eye diseases that result from such changes (namely, cataract and macular degeneration) has been carefully studied. A role for the carotenoids very early in life, however, has received far less attention. Nevertheless, an influence on visual development is likely. Retinal L and Z, for instance, would influence the development of the visual system if they 1) altered input during a critical/sensitive period of visual development and/or 2) influenced maturation and/or 3) protected the retina during a period when it was particularly vulnerable. The available evidence indicates that the pigments may play a role in all three of these areas.

Publication Types:

- Review

PMID: 19019038 [PubMed - indexed for MEDLINE]

Arch Ophthalmol. 2008 Oct;126(10):1396-403.

Sunlight exposure, antioxidants, and age-related macular degeneration.

Fletcher AE, **Bentham GC**, **Agnew M**, **Young IS**, **Augood C**, **Chakravarthy U**, **de Jong PT**, **Rahu M**, **Seland J**, **Soubrane G**, **Tomazzoli L**, **Topouzis F**, **Vingerling JR**, **Vioque J**.

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OBJECTIVE: To examine the association of sunlight exposure and antioxidant level with age-related macular degeneration (AMD). METHODS: Four thousand seven hundred fifty-three participants aged 65 years or older in the European Eye Study underwent fundus photography, were interviewed for adult lifetime sunlight exposure, and gave blood for antioxidant analysis. Blue light exposure was estimated by combining meteorologic and questionnaire data. RESULTS: Data on sunlight exposure and antioxidants were available in 101 individuals with neovascular AMD, 2182 with early AMD, and 2117 controls. No association was found between blue light exposure and neovascular or early AMD. Significant associations were found between blue light exposure and neovascular AMD in individuals in the quartile of lowest antioxidant level-vitamin C, zeaxanthin, vitamin E, and dietary zinc-with an odds ratio of about 1.4 for 1 standard deviation unit increase in blue light exposure. Higher odds ratios for blue light were observed with combined low antioxidant levels, especially vitamin C, zeaxanthin, and vitamin E (odds ratio, 3.7; 95% confidence interval, 1.6-8.9), which were also associated with early stages of AMD. CONCLUSIONS: Although it is not possible to establish causality between sunlight exposure and neovascular AMD, our results suggest that people in the general population should use ocular protection and follow dietary recommendations for the key antioxidant nutrients.

Publication Types:

- Research Support, Non-U.S. Gov't

PMID: 18852418 [PubMed - indexed for MEDLINE]

Med Monatsschr Pharm. 2008 Aug;31(8):299-308.

[Lutein and eye health--current state of discussion]

[Article in German]

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Due to increased life expectancy the number of people with age-related diseases like age-related macular degeneration (AMD) will grow. Currently AMD is incurable and only a few therapeutic strategies are available. Therefore prevention becomes more important. Protective effects related to eye health are discussed for the two carotenoids lutein and zeaxanthin. Meanwhile both substances are offered as food supplements to a great extent. Both carotenoids lutein and zeaxanthin are accumulated in the retina, especially in the macula lutea. They are able to absorb blue light, which damages photoreceptors and pigmentary epithelium. Due to their antioxidative properties they can reduce changes in membrane permeability via quenching reactive oxygen species and free radicals. Research studies suppose lutein and zeaxanthin may contribute to improvement of vision in patients with AMD and other eye diseases. Based on the scientific rationale, these carotenoids may be effective in the prevention of age-related eye diseases. However, this issue has to be examined in a differentiated way.

Publication Types:

- English Abstract
- Review

PMID: 18754570 [PubMed - indexed for MEDLINE]

Vopr Pitan. 2008;77(3):34-8.

[Light-absorbing and antiradical properties of a product with lutein and zeaxanthin in vitro and kinetics of carotinoids at single oral administration on rats]

[Article in Russian]

Karlina MV, **Pozharitskaia ON**, **Kosman VM**, **Shikov AN**, **Makarov VG**.

Light-absorbing and antiradical properties of the new product on a basis of lutein and zeaxanthin for correction of eye diseases in model system of initiated oxidation of isopropylbenzene were investigated. It is shown, that the product is the effective light-absorbing agent and inhibitor of free-radical oxidation in vitro. In experiments on animals (rat) the pharmacokinetics of the product was investigated at single oral administration. A simple, specific and sensitive RP-HPLC method for the determination of lutein in rat plasma was developed, which was applied to pharmacokinetic investigation in rats after oral administration of lutein at dose 20 mg/kg. It was established, that the peak plasma levels was achieved to 2 hour and the mean elimination half life was 2,4 hours.

Publication Types:

- English Abstract

PMID: 18669329 [PubMed - indexed for MEDLINE]

Nutr Rev. 2008 Aug;66(8):465-72.

Phytochemicals and age-related eye diseases.

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Cataracts, glaucoma, and age-related macular degeneration (AMD) are common causes of blindness in the elderly population of the United States. Additional risk factors include obesity, smoking, and inadequate antioxidant status. Phytochemicals, as antioxidants and anti-inflammatory agents, may help prevent or delay the progression of these eye diseases. Observational and clinical trials support the safety of higher intakes of the phytochemicals lutein and zeaxanthin and their association with reducing risks of cataracts in healthy postmenopausal women and improving clinical features of AMD in patients. Additional phytochemicals of emerging interest, like green tea catechins, anthocyanins, resveratrol, and Ginkgo biloba, shown to ameliorate ocular oxidative stress, deserve more attention in future clinical trials.

Publication Types:

- Review

PMID: 18667008 [PubMed - indexed for MEDLINE]

Exp Eye Res. 2001 Mar;72(3):215-23.

Identification and quantitation of carotenoids and their metabolites in the tissues of the human eye.

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There is increasing evidence that the macular pigment carotenoids, lutein and zeaxanthin, may play an important role in the prevention of age-related macular degeneration, cataract, and other blinding disorders. Although it is well known that the retina and lens are enriched in these carotenoids, relatively little is known about carotenoid levels in the uveal tract and in other ocular tissues. Also, the oxidative metabolism and physiological functions of the ocular carotenoids are not fully understood. Thus, we have set out to identify and quantify the complete spectrum of dietary carotenoids and their oxidative metabolites in a systematic manner in all tissues of the human eye in order to gain better insight into their ocular physiology.Human donor eyes were dissected, and carotenoid extracts from ocular tissues [retinal pigment epithelium/choroid (RPE/choroid), macula, peripheral retina, ciliary body, iris, lens, vitreous, cornea, and sclera] were analysed by high-performance liquid chromatography (HPLC). Carotenoids were identified and quantified by comparing their chromatographic and spectral profiles with those of authentic standards.Nearly all ocular structures examined with the exception of vitreous, cornea, and sclera had quantifiable levels of dietary (3R,3'R,6'R)-lutein, zeaxanthin, their geometrical (E / Z) isomers, as well as their metabolites, (3R,3'S,6'R)-lutein (3'-epilutein) and 3-hydroxy-beta,epsilon-caroten-3'-one. In addition, human ciliary body revealed the presence of monohydroxycarotenoids and hydrocarbon carotenoids, while only the latter group was detected in human RPE/choroid. Uveal structures (iris, ciliary body, and RPE/choroid) account for approximately 50% of the eye's total carotenoids and approximately 30% of the lutein and zeaxanthin. In the iris, these pigments are likely to play a role in filtering out phototoxic short-wavelength visible light, while they are more likely to act as antioxidants in the ciliary body. Both mechanisms, light screening and antioxidant, may be operative in the RPE/choroid in addition to a possible function of this tissue in the transport of dihydroxycarotenoids from the circulating blood to the retina. This report lends further support for the critical role of lutein, zeaxanthin, and other ocular carotenoids in protecting the eye from light-induced oxidative damage and aging.

PMID: 11180970 [PubMed - indexed for MEDLINE]

Invest Ophthalmol Vis Sci. 2000 Apr;41(5):1200-9.

Lutein and zeaxanthin concentrations in rod outer segment membranes from perifoveal and peripheral human retina.

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PURPOSE: In addition to acting as an optical filter, macular (carotenoid) pigment has been hypothesized to function as an antioxidant in the human retina by inhibiting the peroxidation of long-chain polyunsaturated fatty acids. However, at its location of highest density in the inner (prereceptoral) layers of the foveal retina, a specific requirement for antioxidant protection would not be predicted. The purpose of this study was to determine whether lutein and zeaxanthin, the major carotenoids comprising the macular pigment, are present in rod outer segment (ROS) membranes where the concentration of long-chain polyunsaturated fatty acids, and susceptibility to oxidation, is highest. METHODS: Retinas from human donor eyes were dissected to obtain two regions: an annular ring of 1.5- to 4-mm eccentricity representing the area centralis excluding the fovea (perifoveal retina) and the remaining retina outside this region (peripheral retina). ROS and residual (ROS-depleted) retinal membranes were isolated from these regions by differential centrifugation and their purity checked by polyacrylamide gel electrophoresis and fatty acid analysis. Lutein and zeaxanthin were analyzed by high-performance liquid chromatography and their concentrations expressed relative to membrane protein. Preparation of membranes and analysis of carotenoids were performed in parallel on bovine retinas for comparison to a nonprimate species. Carotenoid concentrations were also determined for retinal pigment epithelium harvested from human eyes. RESULTS: ROS membranes prepared from perifoveal and peripheral regions of human retina were found to be of high purity as indicated by the presence of a dense opsin band on protein gels. Fatty acid analysis of human ROS membranes showed a characteristic enrichment of docosahexaenoic acid relative to residual membranes. Membranes prepared from bovine retinas had protein profiles and fatty acid composition similar to those from human retinas. Carotenoid analysis showed that lutein and zeaxanthin were present in ROS and residual human retinal membranes. The combined concentration of lutein plus zeaxanthin was 70% higher in human ROS than in residual membranes. Lutein plus zeaxanthin in human ROS membranes was 2.7 times more concentrated in the perifoveal than the peripheral retinal region. Lutein and zeaxanthin were consistently detected in human retinal pigment epithelium at relatively low concentrations. CONCLUSIONS: The presence of lutein and zeaxanthin in human ROS membranes raises the possibility that they function as antioxidants in this cell compartment. The finding of a higher concentration of these carotenoids in ROS of the perifoveal retina lends support to their proposed protective role in age-related macular degeneration.

PMID: 10752961 [PubMed - indexed for MEDLINE]

Exp Eye Res. 2000 Sep;71(3):239-45.

Lutein and zeaxanthin in the eyes, serum and diet of human subjects.

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Inverse associations have been reported between the incidence of advanced, neovascular, age-related macular degeneration (AMD) and the combined lutein (L) and zeaxanthin (Z) intake in the diet, and L and Z concentration in the blood serum. We suggest that persons with high levels of L and Z in either the diet or serum would probably have, in addition, relatively high densities of these carotenoids in the macula, the so-called 'macular pigment'. Several lines of evidence point to a potential protective effect by the macular pigment against AMD. In this study we examined the relationship between dietary intake of L and Z using a food frequency questionnaire; concentration of L and Z in the serum, determined by high-performance liquid chromatography, and macular pigment optical density, obtained by flicker photometry. Nineteen subjects participated. We also analysed the serum and retinas, as autopsy samples, from 23 tissue donors in order to obtain the concentration of L and Z in these tissues. The results reveal positive, though weak, associations between dietary intake of L and Z and serum concentration of L and Z, and between serum concentration of L and Z and macular pigment density. We estimate that approximately half of the variability in the subjects' serum concentration of L and Z can be explained by their dietary intake of L and Z, and about one third of the variability in their macular pigment density can be attributed to their serum concentration of L and Z. These results, together with the reported associations between risk of AMD and dietary and serum L and Z, support the hypothesis that low concentrations of macular pigment may be associated with an increased risk of AMD. Copyright 2000 Academic Press.

Publication Types:

- Research Support, Non-U.S. Gov't
- Research Support, U.S. Gov't, P.H.S.

PMID: 10973733 [PubMed - indexed for MEDLINE]

Invest Ophthalmol Vis Sci. 1997 Aug;38(9):1802-11.

Identification of lutein and zeaxanthin oxidation products in human and monkey retinas.

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PURPOSE: To characterize fully all the major and minor carotenoids and their metabolites in human retina and probe for the presence of the oxidative metabolites of lutein and zeaxanthin. METHODS: Carotenoids of a composite of 58 pairs of human retinas and a monkey retina were elucidated by comparing their high-performance liquid chromatography (HPLC)-ultraviolet/visible absorption spectrophotometry (UV/Vis)-mass spectrometry (MS) profile with those of authentic standards prepared by organic synthesis. RESULTS: In addition to lutein and zeaxanthin, several oxidation products of these compounds were present in the extracts from human retina. A major carotenoid resulting from direct oxidation of lutein was identified as 3-hydroxy-beta, epsilon-caroten-3'-one. Minor carotenoids were identified as: 3'-epilutein, epsilon,epsilon-carotene-3,3'-diol, epsilon,epsilon-carotene-3,3'-dione, 3'-hydroxy-epsilon,epsilon-caroten-3-one, and 2,6-cyclolycopene-1,5-diol. Several of the geometric isomers of lutein and zeaxanthin were also detected at low concentrations. These were as follows: 9-cis-lutein, 9'-cislutein, 13-cis-lutein, 13'-cis-lutein, 9-cis-zeaxanthin, and 13-cis-zeaxanthin. Similar results were also obtained from HPLC analysis of a freshly dissected monkey retina. CONCLUSIONS: Lutein, zeaxanthin, 3'-epilutein, and 3-hydroxy-beta,epsilon-caroten-3'-one in human retina may be interconverted through a series of oxidation-reduction reactions similar to our earlier proposed metabolic transformation of these compounds in humans. The presence of the direct oxidation product of lutein and 3'-epilutein (metabolite of lutein and zeaxanthin) in human retina suggests that lutein and zeaxanthin may act as antioxidants to protect the macula against short-wavelength visible light. The proposed oxidative-reductive pathways for lutein and zeaxanthin in human retina, may therefore play an important role in prevention of age-related macular degeneration and cataracts.

PMID: 9286269 [PubMed - indexed for MEDLINE]

Invest Ophthalmol Vis Sci. 1997 Aug;38(9):1795-801.

Dietary modification of human macular pigment density.

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PURPOSE: The retinal carotenoids lutein (L) and zeaxanthin (Z) that form the macular pigment (MP) may help to prevent neovascular age-related macular degeneration. The purpose of this study was to determine whether MP density in the retina could be raised by increasing dietary intake of L and Z from foods. METHODS: Macular pigment was measured psychophysically for 13 subjects. Serum concentrations of L, Z, and beta-carotene were measured by high-performance liquid chromatography. Eleven subjects modified their usual daily diets by adding 60 g of spinach (10.8 mg L, 0.3 mg Z, 5 mg beta-carotene) and ten also added 150 g of corn (0.3 mg Z, 0.4 mg L); two other subjects were given only corn. Dietary modification lasted up to 15 weeks. RESULTS: For the subjects fed spinach or spinach and corn, three types of responses to dietary modification were identified: Eight "retinal responders" had increases in serum L (mean, 33%; SD, 22%) and in MP density (mean, 19%; SD, 11%); two "retinal nonresponders" showed substantial increases in serum L (mean, 31%) but not in MP density (mean, -11%); one "serum and retinal nonresponder" showed no changes in serum L, Z, or beta-carotene and no change in MP density. For the two subjects given only corn, serum L changed little (+11%, -6%), but in one subject serum Z increased (70%) and MP density increased (25%). CONCLUSIONS: Increases in MP density were obtained within 4 weeks of dietary modification for most, but not all, subjects. When MP density increased with dietary modification, it remained elevated for at least several months after resuming an unmodified diet. Augmentation of MP for both experimental and clinical investigation appears to be feasible for many persons.

Publication Types:

- Research Support, Non-U.S. Gov't
- Research Support, U.S. Gov't, Non-P.H.S.
- Research Support, U.S. Gov't, P.H.S.

PMID: 9286268 [PubMed - indexed for MEDLINE]

Optom Vis Sci. 1997 Jul;74(7):499-504.

Density of the human crystalline lens is related to the macular pigment carotenoids, lutein and zeaxanthin.

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PURPOSE: Although oxidative stress may play an important role in the development of age-related cataract, the degree of protection reported for antioxidant vitamins and carotenoids has been inconsistent across studies. These varied results may be due in part to the lack of good biomarkers for measuring the long-term nutritional status of the eye. The present experiments investigated the relationship between retinal carotenoids (i.e., macular pigment), used as a long-term measure of tissue carotenoids, and lens optical density, used as an indicator of lens health. METHODS: Macular pigment (460 nm) and lens (440, 500, and 550 nm) optical density were measured psychophysically in the same individuals. Groups of younger subjects--7 females (ages 24 to 36 years), and 5 males (ages 24 to 31 years)--were compared with older subjects--23 older females (ages 55 to 78 years), and 16 older males (ages 48 to 82 years). RESULTS: Lens density (440 nm) increased as a function of age ($r = 0.65$, $p < 0.001$), as expected. For the oldest group, a significant inverse relationship ($y = 1.53-0.83x$, $r = -0.47$, $p < 0.001$) was found between macular pigment density (440 nm) and lens density (440 nm). No relationship was found for the youngest group ($p < 0.42$). CONCLUSIONS: The main finding of this study was an age-dependent, inverse relationship between macular pigment density and lens density. Macular pigment is composed of lutein and zeaxanthin, the only two carotenoids that have been identified in the human lens. Thus, an inverse relationship between these two variables suggests that lutein and zeaxanthin, or other dietary factors with which they are correlated, may retard age-related increases in lens density.

Publication Types:

- Comparative Study
- Research Support, Non-U.S. Gov't
- Research Support, U.S. Gov't, P.H.S.

PMID: 9293517 [PubMed - indexed for MEDLINE]

Am J Clin Nutr. 1995 Dec;62(6 Suppl):1448S-1461S.

Evidence for protection against age-related macular degeneration by carotenoids and antioxidant vitamins.

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Epidemiologic data indicate that individuals with low plasma concentrations of carotenoids and antioxidant vitamins and those who smoke cigarettes are at increased risk for age-related macular degeneration (AMD). Laboratory data show that carotenoids and antioxidant vitamins help to protect the retina from oxidative damage initiated in part by absorption of light. Primate retinas accumulate two carotenoids, lutein and zeaxanthin, as the macular pigment, which is most dense at the center of the fovea and declines rapidly in more peripheral regions. The retina also distributes alpha-tocopherol (vitamin E) in a nonuniform spatial pattern. The region of monkey retinas where carotenoids and vitamin E are both low corresponds with a locus where early signs of AMD often appear in humans. The combination of evidence suggests that carotenoids and antioxidant vitamins may help to retard some of the destructive processes in the retina and the retinal pigment epithelium that lead to age-related degeneration of the macula.

Publication Types:

- Research Support, Non-U.S. Gov't
- Research Support, U.S. Gov't, P.H.S.
- Review

PMID: 7495246 [PubMed - indexed for MEDLINE]

JAMA. 1994 Nov 9;272(18):1413-20.

Dietary carotenoids, vitamins A, C, and E, and advanced age-related macular degeneration. Eye Disease Case-Control Study Group.

Seddon JM, **Ajani UA**, **Sperduto RD**, **Hiller R**, **Blair N**, **Burton TC**, **Farber MD**, **Gragoudas ES**, **Haller J**, **Miller DT**, **et al**.

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OBJECTIVE--To evaluate the relationships between dietary intake of carotenoids and vitamins A, C, and E and the risk of neovascular age-related macular degeneration (AMD), the leading cause of irreversible blindness among adults. DESIGN--The multicenter Eye Disease Case-Control Study. SETTING--Five ophthalmology centers in the United States. PATIENTS--A total of 356 case subjects who were diagnosed with the advanced stage of AMD within 1 year prior to their enrollment, aged 55 to 80 years, and residing near a participating clinical center. The 520 control subjects were from the same geographic areas as case subjects, had other ocular diseases, and were frequency-matched to cases according to age and sex. MAIN OUTCOME MEASURES--The relative risk for AMD was estimated according to dietary indicators of antioxidant status, controlling for smoking and other risk factors, by using multiple logistic-regression analyses. RESULTS--A higher dietary intake of carotenoids was associated with a lower risk for AMD. Adjusting for other risk factors for AMD, we found that those in the highest quintile of carotenoid intake had a 43% lower risk for AMD compared with those in the lowest quintile (odds ratio, 0.57; 95% confidence interval, 0.35 to 0.92; P for trend = .02). Among the specific carotenoids, lutein and zeaxanthin, which are primarily obtained from dark green, leafy vegetables, were most strongly associated with a reduced risk for AMD (P for trend = .001). Several food items rich in carotenoids were inversely associated with AMD. In particular, a higher frequency of intake of spinach or collard greens was associated with a substantially lower risk for AMD (P for trend < .001). The intake of preformed vitamin A (retinol) was not appreciably related to AMD. Neither vitamin E nor total vitamin C consumption was associated with a statistically significant reduced risk for AMD, although a possibly lower risk for AMD was suggested among those with higher intake of vitamin C, particularly from foods. CONCLUSION--Increasing the consumption of foods rich in certain carotenoids, in particular dark green, leafy vegetables, may decrease the risk of developing advanced or exudative AMD, the most visually disabling form of macular degeneration among older people. These findings support the need for further studies of this relationship.

Publication Types:

- Multicenter Study
- Research Support, Non-U.S. Gov't
- Research Support, U.S. Gov't, P.H.S.

PMID: 7933422 [PubMed - indexed for MEDLINE]

Anticancer Res. 2005 Nov-Dec;25(6B):3871-6.

The photoreceptor protector zeaxanthin induces cell death in neuroblastoma cells.

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BACKGROUND: The dietary carotenoid zeaxanthin protects against age-related eye disease by preventing apoptosis in photoreceptor cells. This study examined the effect of zeaxanthin on neuroblastoma cells in which apoptosis can be induced with lipid peroxidation products. Since zeaxanthin can inhibit lipid peroxidation and beta-carotene inhibits lipoxygenase (LOX) activity, it was of concern that zeaxanthin might inhibit apoptosis in these cancer cells. MATERIALS AND METHODS: Apoptosis-resistant CHP100 neuroblastoma cells were treated with zeaxanthin. Apoptosis was assessed via an immunoassay for histone-associated DNA fragments and cytofluorimetric analysis of apoptotic body formation. The effect of zeaxanthin on the activity of two model LOXs and LOX-mediated lipid peroxidation in liposomes was assessed. RESULTS: Zeaxanthin strongly induced apoptosis in neuroblastoma cells. Consistent with this finding, zeaxanthin did not inhibit LOX activity. CONCLUSION: Zeaxanthin is a remarkable dietary factor that is able to induce apoptosis in neuroblastoma cells while being able to prevent apoptosis in healthy cells.

PMID: 16309173 [PubMed - indexed for MEDLINE]

Invest Ophthalmol Vis Sci. 2002 Nov;43(11):3538-49.

Elevated retinal zeaxanthin and prevention of light-induced photoreceptor cell death in quail.

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PURPOSE: Inferential evidence indicates that macular pigments (lutein and zeaxanthin) protect photoreceptors and/or retard age-related macular degeneration. These experiments tested the hypothesis that retinal zeaxanthin prevents light-induced photoreceptor cell death. METHODS: Retinal damage was assessed in quail fed a carotenoid-deficient (C-) diet for 6 months. Groups of 16 birds (8 male, 8 female) were fed a C- diet supplemented with 35 mg 3R,3'R-zeaxanthin for 1, 3, or 7 days; one group was continued on C- diets. Half of each group was exposed to intermittent 3200-lux white light (10 1-hour intervals separated by 2 hours in dark). After 14 additional hours in the dark, one retina of each quail was collected for HPLC analysis, and the contralateral retina was embedded in paraffin for counts of apoptotic nuclei. RESULTS: After 7 days' supplementation, concentrations of zeaxanthin in serum, liver, and fat had increased by factors of 50.8, 43.2, and 6.5, respectively (all $P < 0.001$). In contrast, retinal zeaxanthin fluctuated significantly upward on day 3, but there was no net change on day 7. The number of apoptotic rods and cones in light-damaged eyes correlated significantly and inversely with zeaxanthin concentration in the contralateral retina ($r = -0.61$; $P < 0.0001$ and $r = -0.54$; $P < 0.002$), but not with serum zeaxanthin. Similar correlations were observed with retinal lutein, which correlated strongly with retinal zeaxanthin ($r = 0.95$; $P < 0.0001$). CONCLUSIONS: Retinal zeaxanthin dose dependently reduced light-induced photoreceptor apoptosis; elevated serum levels did not. These data provide the first experimental evidence that xanthophyll carotenoids protect photoreceptors in vivo.

Publication Types:

- Research Support, Non-U.S. Gov't

PMID: 12407166 [PubMed - indexed for MEDLINE]