



Lutein and Zeaxanthin

Can athletes benefit from supplementation?

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Physiology

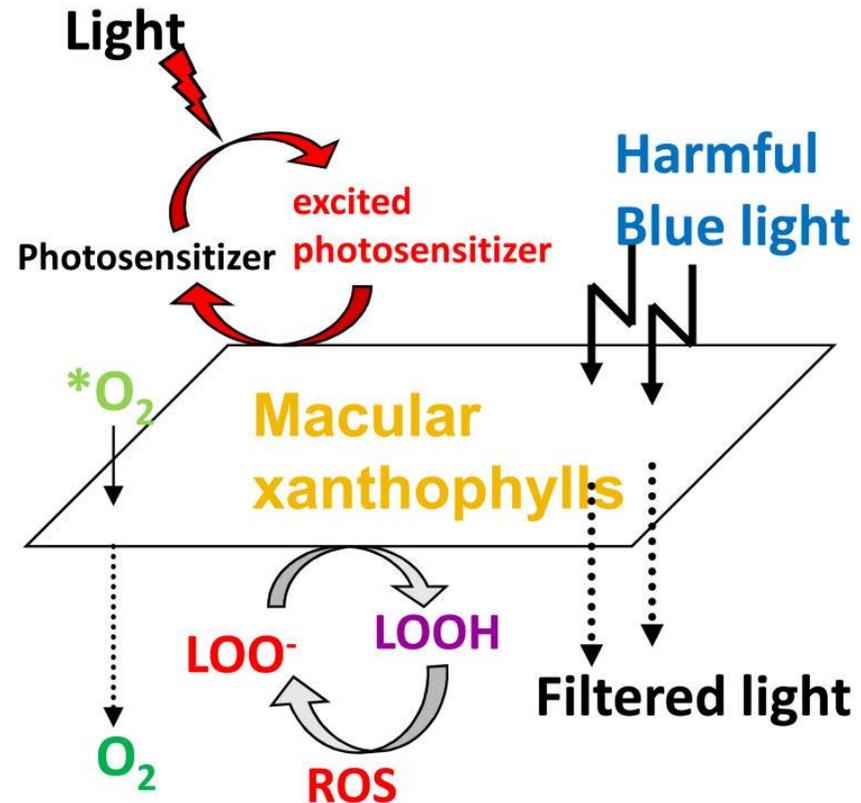
- ▶ Lutein (L) and Zeaxanthin (Z) are xanthophylls, a subclass of carotenoids that are the yellow-orange pigments found predominantly in green leafy vegetables and orange or yellow fruits and vegetables.¹
- ▶ The macula, functional center of the retina, contains the highest concentrations of L and Z as well as meso-zeaxanthin (MZ), which is rarely found in the diet, and made from the conversion of L within the eye.¹
- ▶ L and Z exist in the diet in their ester forms. Hydrolysis occurs in the gut to release the free form, incorporates into micelles and ultimately gets absorbed by enterocytes.¹ They are fat soluble, so their absorption is enhanced by dietary fat.
- ▶ Plasma lipoproteins are primarily responsible for delivering L and Z to the retina where Xanthophyll Binding Proteins (XBP's) help incorporate them into the macula.²

Physiology

- ▶ L and Z have peak absorbance at 460 nm in the macula which is in the blue light range (400-500 nm). Blue light has been shown to cause damage to the photoreceptor cells which cannot be repaired. L and Z act as a filter, blocking up to 40% of the blue light waves before they can cause damage to photoreceptors.^{2, 3}
- ▶ L and Z reside in lipid membranes of cones and rods increasing their rigidity, but also reducing their vulnerability to oxidative damage by Reactive Oxygen Species (ROS).¹
- ▶ L and Z neutralize radicals, specifically singlet oxygen species, by absorbing and releasing excess energy harmlessly through a series of reactions.¹

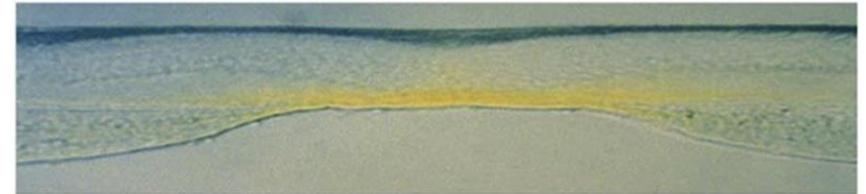
Physiology

Protective roles of lutein and zeaxanthin, as an absorber of harmful light and as an antioxidant reacting with reactive oxygen species (ROS). $*O_2$, singlet oxygen; LOO^- , lipid peroxy radicals; $LOOH$, lipid peroxides.¹

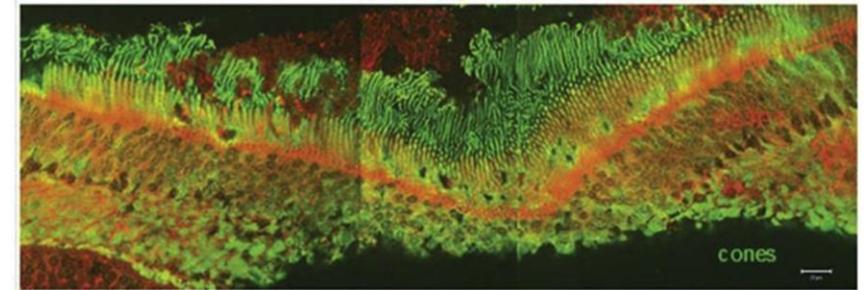


Xanthophylls in the Retina

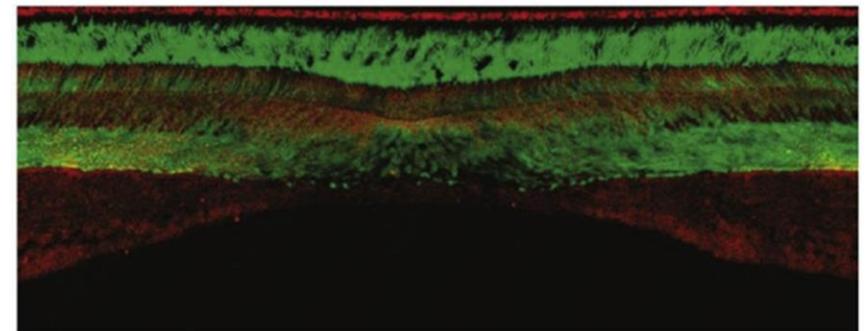
The retinal distribution of macular pigment carotenoids and their binding proteins. (a) Vertical section (vitreous side down) through a monkey fovea showing the distribution of the yellow macular carotenoids. Image courtesy of Dr. Max Snodderly. (b) GSTP1 labeling of foveal cones in the macula of a 3-year-old monkey. This montage shows strongest labeling by antibody against GSTP1 (red) over the myoid and ellipsoid regions of cones identified by monoclonal antibody (7G6, green). (c) A low-magnification view of a near-foveal retina section in which N-62 StAR (red) identifies StARD3, an anti-cone arrestin monoclonal antibody (7G6, green) identifies monkey cones. The sections in (b) and (c) have the same orientation as in (a). Images courtesy of Dr. Jeanne M. Frederick.¹



(a)



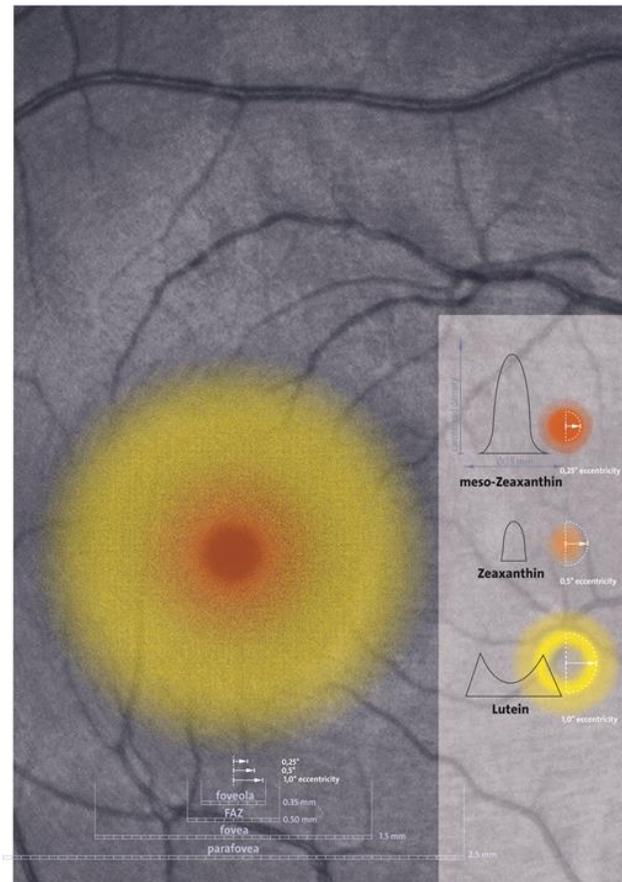
(b)



(c)

Visualization of the Retina

Distribution of macula pigments (MPs) constituent carotenoids presented in scale onto a photograph of a healthy human retina. Figure courtesy of John Nolan, Robert Kuchling, and Kristiane Nöbel.⁴



Definitions

- ▶ **Photostress recovery** is the amount of time required for the macula to return to its normal level of function after being exposed to a bright light source
- ▶ **Disability glare** is the loss of retinal image contrast as a result of intraocular light scatter, or straylight, a reduction of visual acuity caused by light elsewhere in the field of vision
- ▶ **Chromatic contrast** refers to the occurrence of differences in chromaticity (saturated, hue-full color) in a visual percept (scene, image, stimulus). It may consist in differences across space (**spatial chromatic contrast**) or in changes of chromaticity across time (**temporal chromatic contrast**)

Health Claims of Lutein and Zeaxanthin

- ▶ It can prevent or slow the progression of eye related diseases such as Age-Related Macular Degeneration (AMD), cataract formation and retinitis pigmentosa.^{5,6,7}
- ▶ It maintains normal vision.
There was insufficient evidence to establish a cause-and-effect relationship between the consumption of lutein and maintenance of normal vision as of 2006.^{8,9}
This health claim was denied by the FDA in the US in 2006 and EU soon after using the US guidelines.^{8,9}
- ▶ It promotes chromatic contrast and recovery from photostress.
Studies show that increasing macular pigment optical density (MPOD) leads to improved visual performance.^{10,11} The most current research is suggesting this is true, however, there are other possible explanations for these results. Further investigation is ongoing.

Safety of Lutein and Zeaxanthin

- ▶ In a 90-day study in Wistar rats, L and Z were studied for acute, subchronic toxicity and mutagenic effects, L and Z showed No-Observed-Adverse-Effect Level (NOAEL) at doses up to 400 mg/kg/day.¹²
- ▶ In Cynomolgus monkeys, L or Z, at dose levels of either 0.2 or 20 mg/Kg/day for 1 year, did not induce any toxic effects as evidenced by necropsy and histopathology.¹³
- ▶ The Observed Safety Level (OSL) risk assessment method indicates that at intakes of up to 20 mg/day of L is safe.¹² There are no reports of toxicity from taking supplemental forms, either synthetic or natural, in doses of up to 20 mg/day.¹⁴
- ▶ In 2001, the FDA designated L and Z as GRAS, Generally Recognized As Safe.⁸

Negative Effects

- ▶ To date, there have been no reported adverse effects on vision or the body on supplementation of L 20 mg/day¹⁴
- ▶ There are no known toxic side effects of taking too much L or Z. People who eat large amounts of carrots or yellow and green citrus fruits can develop a harmless yellowing of the skin called carotenemia and this can happen with overconsumption of any carotenoid.

How does Lutein and Zeaxanthin Affect Performance?

- ▶ Increased MPOD can aid with:
 - photostress recovery¹⁵
 - recovering from excess light stimulation such as glare¹⁵
 - enhance chromatic contrast¹⁵
- ▶ Visual Processing Speed is enhanced in healthy subjects supplemented with 20 mg Z/day or 26 mg Z + 8 mg L + 190 mg mixed omega-3 fatty acids/day.¹⁶
- ▶ Healthy subjects who supplemented for 1 year with 10 mg L, 2 mg Z, and 10 mg MZ had increased contrast sensitivity.¹⁷ If you are a batter or even an outfielder, tennis player, golfer, then that extra sharpness in contrast, your photosensors recovering a few milliseconds quicker from bright light and having crisper vision, like wearing internal sunglasses, can positively impact performance.^{15,16,17,18}
- ▶ Increases in MPOD lead to significant improvements in photostress recovery (PSR) times and disability glare (DG) thresholds.^{10,15} Increases in MPOD produce more consistent steady-state visual performance in bright light conditions.¹⁵ The mechanism for this effect may involve both the optical filtering and biochemical (antioxidant) properties of MP.¹⁵
- ▶ Variations in MPOD have immediate effects on visual function. As with many species, intraocular yellow filters in humans appear to improve many aspects of the visual stimulus by absorbing vision distorting short-wave light.¹⁰ Daily supplementation with L+Z resulted in significant increases in serum levels and MPOD and improvements in chromatic contrast and recovery from photostress.^{4,15,17}

Supplements

- ▶ EyePromise® Zeaxanthin + Lutein¹⁹

This product has the highest available level of dietary zeaxanthin of any carotenoid supplement, according to the company. Each softgel capsule contains 10 mg L from marigold extract and 10 mg Z from paprika extract.

- ▶ EyePromise® Screen Shield™ Pro²⁰

This product contains 7 mg L from marigold extract, 14 mg Z from paprika extract.

- ▶ This brand's supplements are third party certified by NSF International Certified for Sport®
- ▶ L and Z are permissible as they are considered vitamin A derivatives.²¹

Dosing and Supplement Brands



\$38.95 Per Bottle
2 month supply



\$35.95 Per Bottle
1 month supply

Would you recommend to an Athlete?

- ▶ Main Facts: Carotenoids, such as the xanthophylls L and Z, are a natural defense mechanism against the effects of damaging blue light (400 -500 nm) which outdoor athletes are exposed to in higher amounts than the general population. L and Z are components of the retina, the light sensing portion of the eye, and are concentrated in the macula, the central focusing region of the retina.
- ▶ Mechanism: L and Z absorb damaging ROS limiting their destructiveness in the eye. This prevents oxidative damage to the macula, retina and other components of the eye such as the lens.
- ▶ Recommendation: L and Z can be a beneficial supplement for a diet lacking in dark leafy greens, and yellow and orange fruits and vegetables since research indicates an improvement in eye health. Supplementation of 10-20 mg/day of L and/or 2-10 mg/day of Z can slow or possibly prevent deterioration of macula related diseases and aid in recovery from sun glare, excess light input and enhance contrast sensitivity. Athletes with a family history of eye disease or who have inadequate intakes of dark leafy greens, or yellow and orange fruits and vegetables, should consider a supplement as there appears to be no adverse effects or toxicity to supplementing at the recommended dosage or up to 30mg/day.

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