

LUTEIN AND ZEAXANTHIN SUPPLEMENTATION AND VISUAL PERFORMANCE UNDER GLARING LIGHT

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KEY CONCLUSIONS

- *Daily supplementation with 10 mg FloraGLO® Lutein and 2 mg of OPTISHARP® Zeaxanthin showed increases in macular pigment optical density (MPOD) after as early as two months and continued to increase over six months.*
- *Glare disability improved within subjects in direct relation to the increase in MPOD.*
- *The time required to recover from photostress decreased after supplementation and the improvement also showed a direct relationship with increased MPOD.*

This is a summary of:

Stringham, JM, and BR Hammond. Macular pigment and visual performance under glare conditions. *Optometry and Vision Science* 85: 82-88, 2008.

INTRODUCTION

Lutein and zeaxanthin are the only carotenoids that are deposited in significant quantities into the human macula, the small, highly sensitive area of the retina responsible for central vision (1). As such, these carotenoids are termed macular pigments and give the macula a distinctive yellow color. The ability of the macular pigments to filter low wavelength visible light, as measured in macular pigment optical density (MPOD), has become an interesting biomarker in that there are indications that MPOD levels are related to both macular health and certain visual function measurements (6, 9).

There is presently a large body of research indicating that nutritional status, particularly in regard to lutein/zeaxanthin intake, may play a role in lowering the risk of age-related macular degeneration (7), which is the most common cause of blindness in the elderly of the Western world (3). One mechanism of this protection may come from the characteristic antioxidant nature of the carotenoids. However, it is likely that protection may also be due to the fact that the absorption spectrum of lutein and zeaxanthin overlaps with the so-called blue-light hazard function: the short wavelength visible light with the highest potential to cause tissue damage (4). Thus, the macular pigment may be also filtering harmful light before it can cause oxidative stress.

The Stringham and Hammond study summarized here demonstrates that this mechanism of filtering blue-light may enable the macular pigment to provide benefits to visual health beyond protection from retinal degeneration (8). The study indicates that an increased MPOD helps reduce glare disability and helps shorten the time it takes to recover from direct illumination from bright light.

STUDY DESIGN

In the present study, 40 healthy subjects participated: 23 women and 17 men with ages ranging from 17 to 41 years (mean age of 23.9). The study group was diverse in regard to race and iris color. The diets of the subjects were supplemented with a daily dose of 10 mg FloraGLO Lutein and 2 mg OPTISHARP Zeaxanthin over a course of six months. Both of these ingredients were formulated into beadlets using Actilease® technology by DSM Nutritional Products. This delivery system, along with the non-esterified nature of the

carotenoids, ensured absorption of the nutrients by the digestive system.

At five time points during the study (baseline, 1, 2, 4, and 6 months after starting supplementation), three main endpoints were measured: MPOD, glare disability and photostress recovery.

METHODS AND RESULTS

Macular Pigment Optical Density

All but two of the forty subjects responded to lutein/zeaxanthin supplementation with increased MPOD over the course of the study. Specifically, MPOD is a measurement of the macular ability to absorb (i.e., filter) blue light. Lutein and zeaxanthin maximally absorb at approximately 446 nm of light; it is in this blue light range that the effects of glare are generally concentrated on.

In the present study, MPOD was measured using heterochromatic flicker photometry. Each subject is presented stimuli that flicker between a test wavelength of deep blue light (458 nm) and a reference wavelength of yellow light (570 nm). The subject adjusts the radiance of the test stimulus until equal luminance between the two stimuli is achieved (known as a “null-flicker”). The optical density corresponds to the level of maximum radiance of blue light that can be tolerated while maintaining a null-flicker with the yellow light. By varying the spatial pattern of the test (blue light) stimulus, this optical density can be measured over a spatial distribution of the retina. Subtracting the radiance measure from the periphery of the macula from that of the center of the macula gives the macular pigment optical density (MPOD).

Most subjects showed increases in MPOD at some point after the 1 month evaluation. The average increase in MPOD was 12% at two months of supplementation, 24% at four months and 39% at six months in relation to baseline MPOD values (see **Figure 1**). The baseline MPOD varied considerably among subjects (from 0.08 to 1.04 OD units measured at 30' eccentricity) and in order to determine any possible effects on baseline MPOD to lutein/zeaxanthin supplementation, the researchers stratified subjects into three groups: low, middle and high MPOD (0-0.25, 0.26-0.50, and > 0.50, respectively). All three groups showed a response to supplementation and none showed a sign of a plateau in MPOD increases at six months. Looking at the average MPODs, the middle group showed the most pronounced absolute increase after six months (0.39 to 0.60) and the low group had the highest percentage increase (0.18 to 0.32; 78%). The high group increased from a baseline of 0.67 to 0.78 at six months.

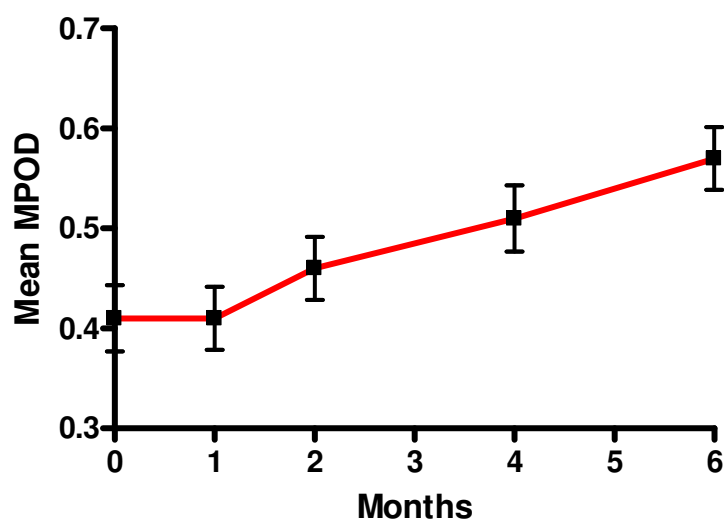


Figure 1. MPOD Response to Lutein/Zeaxanthin Supplementation. Mean MPOD (460 nm at 0.50° eccentricity) is plotted over 6 months of supplementation with a daily dose of 10 mg FloraGLO Lutein and 2 mg OPTISHARP Zeaxanthin. Error bars indicate ± 1 SD from the mean.

Veiling Glare

Glare disability was measured by determining how much veiling glare a subject could tolerate. To determine this, a subject is shown two stimuli: a test target consisting of a centrally located grating disk and an annular (donut-shaped) stimulus that is concentric with the test target and is spatially wide enough to ensure minimal direct absorption by macular pigment. The initial intensity of the annulus is set to a level below which the test stimulus would be veiled. The subject then increases the intensity of the annulus to the level at which the test target is no longer visible. This intensity level is the veiling glare tolerance for the subject.

The results of this study showed a significant increase in veiling glare tolerance starting at the 4 month time point ($t = 8.7$; $p = 0.002$) with a further increase at six months ($t = 15.7$; $p < 0.0001$). Significantly, this decreased glare disability coincided with an increase in MPOD. Not only was there a rise in veiled glare tolerance as mean MPOD increased, but the two subjects that did not respond to lutein/zeaxanthin supplementation also failed to show any increases in veiling glare tolerance from baseline.

Photostress Recovery

To determine photostress recovery time (the time it takes for vision to recover from direct exposure bright light, also called glare recovery), subjects were again shown two stimuli. The test stimulus was identical to stimulus shown to determine glare disability: a centrally located grating disk. The photostress stimulus was a bright white disk. The subject is first shown the test stimulus for 30 seconds, the photostress beam is then presented for five seconds using a shutter, and the subject then indicates when the grating can be perceived again. This time lapse, measured with a stopwatch, was used to determine the photostress recovery time.

In this study, the photostress recovery times improved significantly over baseline at the four-month time point ($t = 3.85$, $p = 0.05$) and much more so at the six-month time point ($t = 12.06$, $p = 0.0003$). The average recovery time decreased 5 seconds compared to baseline after six months of lutein/zeaxanthin supplementation. Moreover, over the entire course of the study, decreases in the photostress recovery time showed a strong, linear correspondence to increases in MPOD ($r = -0.988$, $p = 0.012$).

Lastly, it was found that neither sex, age, diet or iris color showed any direct relation with the results of the visual performance analyses.

CONCLUSIONS AND DISCUSSION

In a previous study, Stringham and Hammond showed that across different subjects there was a strong relationship between MPOD and both glare disability and photostress recovery (9). A positive difference of 0.16 in MPOD between different subjects corresponded to the ability to tolerate glare from an annular stimulus that was approximately 0.16 log units more intense. This MPOD increase also related to a 3 second decrease in photostress recovery time.

The present study showed that an MPOD *increase within the same subject* resulted in a statistically significant reduction in glare disability and photostress recovery time. It was possible to show this intra-subject relationship because the subjects responded dramatically to lutein/zeaxanthin supplementation. After six months of daily supplementation with 10 mg FloraGLO Lutein and 2 mg OPTISHARP Zeaxanthin, MPOD increased an average of 39%. Moreover, the response to supplementation occurred whether subjects had low or high baseline MPODs at the start of the study and the response did not appear to plateau at any point during the supplementation.

Previous studies have shown that an increase in MPOD, as a result of lutein supplementation, can result in improvements in visual performance. In a placebo-controlled study, Richer *et al.* tested veterans (average age of 65 years) with early stage AMD and found that supplementation (10 mg FloraGLO Lutein daily) corresponded to increases in MPOD and various visual function improvements (for instance, they were able to read more letters on a Snellen eye chart) (6)(1). Olmedilla showed in a placebo-controlled study that cataract patients who were supplemented for 2 years with lutein exhibited reductions in glare sensitivity (5). However, while one should not discount the possible palliative benefits of lutein supplementation for those with AMD or cataracts, the Stringham and Hammond study is striking in that the positive effects of lutein/zeaxanthin supplementation and the concomitant increase in MPOD resulted in visual performance improvements among a non-elderly population with good eye health. This indicates that the improvements can be directly tied to optical factors, in particular the blue-light filtering capacity of the macula, as opposed to biological factors such as the disease state of the subjects. For instance, an optical phenomenon known as chromatic aberration, in which shorter wavelengths of visible (blue) light is out of focus while the middle wavelengths of visible light are in focus, is thought to be attenuated by the filtering capacity of the macula. Also, if a background image contains more



short wavelength light than a central target, a yellow filter such as the macular pigment will help absorb more of the background than the target, resulting in a higher contrast and better visibility of the target (10).

There appears to be specific mechanisms in place in human health to accumulate lutein and zeaxanthin into the macula (2). As the authors note in the discussion on this study, it is unlikely that this mechanism evolved exclusively as protection from eye diseases that generally manifest after reproductive age. This study tested younger subjects and the ability to handle glare may be one way in which lutein and zeaxanthin deposition in the macula may provide a selective advantage.

The authors concluded from their results that:

- “It seems likely that our results are both large enough and sufficiently general to be meaningful in real life.”
- “MP would be likely to confer a selective advantage earlier in life. Effects of MP on glare would clearly manifest early as our data on younger subjects show.”

Glare is a situation that is encountered frequently in everyday life. Many light sources, including the sun and headlights, contain a significant amount of the short wavelength visible light that may be absorbed by the macular pigment. In essence, the macular pigment can be thought of as a filter for those wavelengths and as such, in regular lighting, it can help in contrast enhancement: the ability to distinguish a target from its surrounding. Studies such as this one are showing that a diet that is high in the macular carotenoids, lutein and zeaxanthin, including from supplementation, is important in maintaining an increased MPOD. Increased MPOD may be instrumental for improved visual performance in younger and older healthy individuals.

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