

Eye Health and Astaxanthin

Other carotenoids have begun to attain a certain level of fame for having beneficial properties for the eyes. There is no doubt that lutein and zeaxanthin are wonderful products to support and protect the eyes, and there is credible evidence that they can help prevent age related macular degeneration and other degenerative conditions. But due to Natural Astaxanthin's superior antioxidant and anti-inflammatory properties, indications are that it will prove to be superior to all other nutraceuticals for eye and brain health.

Scientists believe that something may cause people's internal antioxidant defense system to malfunction or wear out as we age. Our bodies may lose the ability to produce high levels of the antioxidants that are normally produced internally such as superoxide dismutase, catalase and glutathione peroxidase. Also, our bodies are now subjected to unprecedented levels of oxidation caused by environmental factors such as pollution, containments, processed food and the high levels of stress in modern life. All of these lead to an assault on our vital organs as we age, particularly our brains and eyes.

The eye, in particular is now subjected to much higher levels of oxidation than our ancestors' experienced. The depletion of the ozone layer is causing more intense sunlight than ever before, which directly affects the eyes and skin. Excessive exposure to sunlight and to the highly oxygenated environment cause free radicals to be generated in the eye. A condition called "ischemia" which is a type of blockage that deprives the eye of nutrition and oxygen is a common cause of increased oxidation in the eye. Another cause of increased oxidation in the eye happens when the ischemic blockages are removed. The reoxygenation of the tissue after blockage is called "reperfusion," and the end result is another attack on the eye's normal oxidative balance. Even normal enzymatic processes cause increased generation of free radicals and singlet oxygen such as hydrogen peroxide, superoxide and hydroxyl in the eyes.

Free radicals and singlet oxygen oxidize the polyunsaturated fatty acids in the retina which leads to functional impairment of the retinal cell membranes, causing temporary and permanent damage to the retinal cells. Once the retina is damaged, it cannot be replaced. Antioxidants that can reach the inner eye by crossing the blood-brain and blood-retinal barriers are essential because they protect the eye from these damaging conditions.

The carotenoids lutein and zeaxanthin are normally found in the eyes. Astaxanthin is not. Some groundbreaking work was done by Dr. Mark Tso of the University of Illinois on Astaxanthin's benefits on the eyes. Dr. Tso was the first person who proved that Astaxanthin could cross the blood-brain and blood-retinal barriers. He took laboratory rats and tested their eyes for Astaxanthin. As expected, he did not find any present. Then he fed the rats Astaxanthin and retested, this time finding Astaxanthin present in the retina. He proved that Astaxanthin could cross first the blood-brain barrier and get into the brain, and then once in the brain it could reach the retina and the macula by crossing through the blood-retinal barrier.

Through an extensive series of tests, Dr. Tso went on to prove that Astaxanthin has many protective properties once it reaches the eyes. Among the many benefits that Dr. Tso found include Astaxanthin's ability to protect the eye from:

- Light-induced damage
- Photoreceptor cell damage
- Ganglion cell damage
- Neuronal damage
- Inflammatory damage

Just as with Astaxanthin's anti-inflammatory properties which are a very diverse group of pathways that combat inflammation, the eye-protective properties of Astaxanthin are similar: Astaxanthin protects the eyes through various pathways rather than through just one (Tso, et al, 1996). We see a pattern emerging in which Astaxanthin attacks different problems in a multitude of ways. Perhaps someday researchers will discover that, similar to the case with single pathway anti-inflammatories like Vioxx which have dangerous side effects, this multiple pathway "shotgun" approach to eye health is also the safest and most natural.

Since Dr. Tso's groundbreaking work, other scientists have found further benefits for the eyes when using Natural Astaxanthin. For example, **eye fatigue** is a serious problem in many of today's occupations. Working for long periods at visual display terminals reportedly induces various visual problems such as **eye strain, blurring and diplopia** (a disorder of vision in which two images of a single object are seen because of unequal action of the eye muscles – also called **double vision**). In a double blind study performed in Japan, after four weeks of supplementation with 5 mg of Astaxanthin per day (extracted from Haematococcus algae meal) the authors reported a 46% reduction in the number of eye strain subjects. They also found higher accommodation amplitude (the adjustment in the lens of the eye that allows it to focus) in subjects who used visual display terminals. The mechanism of action is still not understood, but it's most likely due to Astaxanthin's potent antioxidant properties (Nagaki, et al, 2002). Additional research in the area of eye fatigue has been carried out. In fact, there are now nine different positive human clinical studies that have been published in this area.

Two different dosage levels were tested for eye fatigue by a group led by Dr. Nakamura in 2004. They found positive effects at 4 mg per day, but found a better result at 12 mg per day (Nakamura, et al, 2004).

Another group of Japanese researchers found similar results in another human clinical study. This double blind study was done to evaluate Astaxanthin's effect on eye fatigue and visual accommodation. Forty subjects were divided into placebo and treatment groups, with the treatment group receiving 6 mg of Astaxanthin for four weeks. The results were that three separate visual parameters were found to have statistically significant benefits from Astaxanthin supplementation. This research established an optimum daily dose for eye fatigue at 6 mg per day (Nitta, et al, 2005).

Additional studies have validated this work, showing that 6 mg per day of Natural Astaxanthin supplementation for four weeks can reduce eye soreness, dryness, tiredness and blurred vision (Shiratori, et al, 2005 and Nagaki, et al, 2006).

Astaxanthin may work in a preventative role for eye fatigue as compared to a curative one that has already been established. The other studies referenced above all centered on the use of Astaxanthin to cure eye fatigue. A clinical study was done on subjects whose eyes were healthy, with no signs of fatigue or strain. Both the treatment and the placebo groups were subjected to heavy visual stimuli to induce eye fatigue, and it was found that the treatment group recovered more quickly. This clearly indicates that Natural Astaxanthin may serve to prevent eye fatigue from occurring in healthy people (Takahashi and Kajita, 2005).

It is very important to have sufficient blood flow to the eyes and the retina. A human clinical study examined the ability of Astaxanthin to improve retinal capillary blood flow. Eighteen subjects were given 6 mg per day of Natural Astaxanthin and another eighteen people were given a placebo. After four weeks it was found that the treatment group had improved retinal capillary blood flow as compared to the placebo group (Yasunori, N, 2005).

The mechanisms of action thought to enable Astaxanthin to reduce or prevent eye fatigue are diverse. Of course, Astaxanthin's role as an antioxidant and anti-inflammatory must play a part. A study conducted at the Hokkaido University Graduate School of Medicine determined that Astaxanthin inhibited inflammation in the eye by blocking nitric oxide synthase (Ohgami, et al, 2003). Astaxanthin was also found to have potent antioxidant effects in the prevention of cataracts in rats' eyes (Wu, et al, 2002). In addition, the increased blood flow to the retina surely plays a part. The final, yet very significant mechanism is improved accommodation amplitude. By enabling the lens to more easily adjust, the ability of the eye to focus is improved.

Another, very different type of human study on Natural Astaxanthin's effects on the eyes has also yielded positive results. This study was done in Japan with subjects comprised of twenty year old men. The treatment group was given 6 mg of Natural Astaxanthin per day for four weeks. Different visual parameters were measured, with statistically significant improvement found in two different parameters for **visual acuity (the ability to see detail)**. The greatest enhancement was seen in **depth perception** which improved by 46% in the group supplementing with Natural Astaxanthin (Sawaki, et al, 2002).

Of course, along with the human clinical trials there are also pre-clinical animal studies and in-vitro experiments on Astaxanthin and eye health. One such study took the lens from the eyes of pigs and tested the ability of Astaxanthin to protect them from induced oxidative damage. This experiment found that Astaxanthin was capable of protecting the lens proteins from oxidative damage. In fact, Astaxanthin performed better than the antioxidant glutathione which is produced by the pig's own body (Wu, et al, 2006).

A study done in rats was very helpful in that it measured the effect of Astaxanthin on three important inflammatory markers in the uvea (the middle layer of the eye including the iris). Inflammation in the uvea was induced, after which nitric oxide, tumor necrosis factor alpha and prostaglandin E-2 were measured. The rats that had been injected with Astaxanthin had lower levels of all three inflammatory markers. The researchers concluded that Astaxanthin is effective in reducing ocular inflammation (Suzuki, et al, 2005). A previous study done on inflammation of the eye of rats yielded similar results, but also demonstrated that the effects of Astaxanthin worked in a dose-

dependent fashion. Additionally, this study proved these anti-inflammatory mechanisms in-vitro (Ohgami, et al, 2003).

While there is still a great deal more research that can be done on the effects of Astaxanthin on eye health, the current studies all point to one clear conclusion: Astaxanthin has great benefits for the eyes, and in fact, may be the best choice for eye health among all nutraceutical products.

References

- Nagaki, et al. (2006). "The supplementation effect of astaxanthin on accommodation and asthenopia." *Journal of Clinical Therapeutics & Medicines*. 22(1):41-54.
- Nagaki, Y., Hayasaka, S., Yamada, T., Hayasaka, Y., Sanada, M., Uonomi, T. (2002). "Effects of Astaxanthin on accommodation, critical flicker fusion, and pattern visual evoked potential in visual display terminal workers." *Journal of Traditional Medicines*. 19(5):170-173.
- Nakamura, et al. (2004). "Changes in Visual Function Following Peroral Astaxanthin." *Japanese Journal of Clinical Ophthalmology*. 58(6):1051-1054.
- Nitta, T., Ogami, K., Shiratori, K. (2005). "The effects of Astaxanthin on Accommodation and Asthenopia—Dose Finding Study in Healthy Volunteers." *Clinical Medicine*. 21(5):543-556.
- Ohgami, K., Shiratori, K., Kotake, S., Nishida, T., Mizuki, N., Yazawa, K., Ohno, S. (2003). "Effects of astaxanthin on lipopolysaccharide-induced inflammation in vitro and in vivo." *Investigative Ophthalmology and Visual Science*. 44(6):2694-701.
- Sawaki, K., Yoshigi, H., Aoki, K., Koikawa, N., Azumane, A., Kaneko, K., Yamaguchi, M. (2002). "Sports Performance Benefits from Taking Natural Astaxanthin Characterized by Visual Acuity and Muscle Fatigue Improvements in Humans." *Journal of Clinical Therapeutics & Medicines*. 18(9):73-88.
- Shiratori, K., Ogami, K., Nitta, T. (2005). "The effects of Astaxanthin on Accommodation and Asthenopia—Efficacy Identification Study in Healthy Volunteers." *Clinical Medicine*. 21(6):637-650.
- Suzuki, Y., Ohgami, K., Shiratori, K., Jin, X., Ilieva, I., Koyama, Y., Yazawa, K., Yoshida, K., Kase, S., Ohno, S. (2006). "Suppressive effects of astaxanthin against rat endotoxin-induced uveitis by inhibiting the NF-kappaB signaling pathway." *Experimental Eye Research*. 82(2):275-81.
- Takahashi, J., Kajita. (2005). "Effects of astaxanthin on accommodative recovery." *Journal of Clinical Therapeutics & Medicines*. 21(4):431-436.
- Tso, M., Lam, T. (1996) "Method of Retarding and Ameliorating Central Nervous System and Eye Damage." U.S. Patent #5527533.
- Wu, T., Liao, J., Hou, W., Huang, F., Maher, T., Hu, C. (2006). "Astaxanthin protects against oxidative stress and calcium-induced porcine lens protein degradation." *Journal Agriculture Food Chemistry*. 54, 6:2418-23.

Wu, T, et al. (2002). "An astaxanthin-containing algal extract attenuates selenite-induced nuclear cataract formation in rat pups." *Experimental Biology*, 2002.

Yasunori, N, et al. (2005). "The effect of astaxanthin on retinal capillary blood flow in normal volunteers." *J. Clin. Ther. Med.* 21(5):537-542.