



The Whole Body Benefits Of **Natural Astaxanthin**

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This e-book is underwritten by the Natural Algae Astaxanthin Association (NAXA), a trade association whose members are committed to the production and research of natural astaxanthin derived from *Haematococcus pluvialis* microalgae. NAXA promotes natural astaxanthin's health benefits while supporting public education, safety, product quality, and testing standards. For more information, please visit www.astaxanthin.org or email info@astaxanthin.org.

THE KING OF CAROTENOIDS

Carotenoids are a group of plant pigments responsible for all life on this planet. As an antioxidant, they serve a vital role in protecting plants during the process of photosynthesis. Without this protection, plant cells would be destroyed as they convert the sun's energy into chemical forms.

Some carotenoids, like beta-carotene, are best known for their capacity for being converted into vitamin A. While over 400 carotenoids have been characterized, only about 30–50 are believed to have vitamin A activity. In the past, the biological effects of carotenoids have been based on their corresponding vitamin A activity. However, considerable research now shows that many of the non-vitamin A carotenoids exhibit far greater health benefits. Examples include lycopene (found in tomatoes and watermelon), and lutein and zeaxanthin (peppers, squash and corn), and the most beneficial carotenoid of them all—astaxanthin.

Astaxanthin is known as the “King of Carotenoids.” It is given this title because of its unique benefits and action in promoting health and protecting against cellular damage, especially in the brain and vascular system.

In regards to general antioxidant effects in protecting cells, astaxanthin is more than 50 times more powerful than beta-carotene. There is also another big

advantage for astaxanthin that relates to its size and how it fits into cell membranes – it is considerably larger/longer than other popular carotenoids.” Its size and physical form allow it to be incorporated into cell membranes where it is able to span the entire thickness of the cell membrane. This allows astaxanthin to not only protect the inner and outer cell membrane from oxidative damage, but also to stabilize the cell membranes. No other carotenoids can produce this effect and that explains why the health benefits of astaxanthin are considerably greater than other carotenoids.

WHERE DOES ASTAXANTHIN COME FROM?

Natural astaxanthin is found in select plants and animals worldwide. Other natural sources of astaxanthin are bacteria and fungi. It is most prevalent in algae—specifically *Haematococcus pluvialis*—and the aquatic creatures that eat it such as salmon, crab, and crustaceans. The astaxanthin gives those marine animals their reddish color.



Haematococcus pluvialis is the Superior Source

Source	Astaxanthin Concentration (PPM)
Salmonids (Artificial Coloring)	5 PPM
Plankton	60 PPM
Krill	120 PPM
Arctic Shrimp	1,200 PPM
Genetically Mutated Pfaffia Yeast	10,000 PPM
<i>Haematococcus pluvialis</i>	50,000 PPM

However, these latter sources have only trace amounts of astaxanthin. For example, one ounce of wild sockeye salmon contains 1 mg of astaxanthin. Other seafood has even less. Humans and other mammals cannot synthesize astaxanthin, so this potent antioxidant must be consumed via a dietary supplement.

Natural astaxanthin produced from various commercial sources differ in many parameters such as chemical characteristics, bioavailability, and metabolism. Compared to all the other sources, *Haematococcus pluvialis*, a fresh water algae, is the richest source of astaxanthin in nature. It can accumulate up to 50 grams of astaxanthin per kilogram of dry biomass under environmental stress, such as elevated temperature or UV exposure.

The majority of safety and efficacy studies were conducted with astaxanthin derived from *Haematococcus pluvialis*—the primary natural source of astaxanthin for human consumption. It is also recognized by most regulatory authorities.

THE FULL-BODY BENEFITS OF ASTAXANTHIN

I. Inflammation Support

The body's inflammatory response is a crucial part of healthy immune function, but prolonged inflammation is often considered the root of a wide range of health problems. Astaxanthin's ability to travel throughout the body allows it to target a number of high-stress inflammatory areas: the joints, the heart, the brain, the eyes, and the skin.



“Astaxanthin, with its anti-inflammatory properties, can target a number of high-use, high-stress areas including joints.”

Astaxanthin works to support a balanced inflammatory response by suppressing different inflammatory mediators, according to research. These compounds are what potentiate inflammation. They include compounds like necrosis factor alpha (TNF-a), prostaglandin E-2 (PGE-2), interleukin 1B (IL-1b,) inducible nitric oxide (iNO), and nuclear factor kappa-B. These compounds are well known to researchers looking at the role of inflammation in chronic disease. Astaxanthin has been shown to inhibit

the formation or action of all of these inflammatory compounds as well as exert additional anti-inflammatory effects.^{1, 2, 3}

There are many practical applications of this anti-inflammatory effect. For example, during rigorous exercise, there is often a suppression of the immune response along with significant inflammation. Astaxanthin supplementation has been shown to prevent both.⁴ Anyone can benefit from these effects, but it is especially important for people who regularly engage in heavy endurance training, intense activities like weight lifting or cross-fit, and other high-intensity or long-duration forms of exercise.

Astaxanthin is also useful in supporting individuals experiencing chronic inflammation. This silent form of inflammation is now known to fuel such conditions as heart disease, diabetes, Alzheimer’s disease, and every other degenerative disorder. The most common test for silent inflammation involves measuring blood levels for C-reactive protein (CRP). High levels of CRP are considered by many researchers and physicians to be a leading indicator of heart disease, cancer, diabetes and many other life-threatening illnesses. CRP is produced in the liver and in the coronary arteries; the protein is then released into the bloodstream when the body is fighting inflammation.



First, let's answer the question, why does skin wrinkle? The main reason skin wrinkles is the cumulative effects of oxidative damage. This damage may be the result of exposure to the elements—sun, wind, and pollution all take their toll—but exposure to internal free radicals is also a major cause, as is normal aging.

"In double-blind, randomized controlled trials (RCTs), astaxanthin lowered oxidative stress in overweight and obese subjects and in smokers," one researcher concluded. "It blocked oxidative DNA damage, lowered C-reactive protein (CRP) and other inflammation biomarkers, and boosted immunity."⁵ These effects are not just limited to these subjects. Nearly everyone can take advantage of the benefits offered by astaxanthin supplementation.

II. Skin Health

Radiant, vibrant, and healthy looking skin has long been associated with good health. While most people try and improve the appearance of their skin from the outside alone, the real key to healthy skin is building it from the inside out. Astaxanthin can be an important part of that strategy.

People spend countless hours (and dollars) battling the ravages of time—or, more accurately, oxidative damage. This damage ultimately causes the collagen in our skin to become thinner and lose its ability to hold its shape. The net effect of these changes is the skin becomes thinner, less elastic and wrinkles form. To prevent this process from happening prematurely, we need to eat a diet rich in antioxidants and avoid exposure to environmental causes of free radical damage especially smoking cigarettes and excessive sun exposure. But, astaxanthin supplementation can also help.

A headlining study for astaxanthin's skin benefits was published in 2006.⁶ Forty-nine healthy women with an average age of 47 were divided into two groups—one given placebos and the other supplemented with 4 mg/day of natural astaxanthin.

At the end of six weeks, the reviews from the female subjects were stunning. In the self-assessment, over 50 percent of the subjects taking natural astaxanthin rated improvements in all areas. The dermatologist assessment found improvements in fine lines and wrinkles, elasticity and dryness. Before and after photos also confirmed the assessment.

Astaxanthin also works in tandem. In 2014, researchers explored the promising effects of combining dietary astaxanthin and collagen hydrolysate supplementation on people with moderately sun-damaged skin. Forty-four subjects were given astaxanthin (2 mg/day) combined with collagen hydrolysate (3 g/day) or a placebo for 12 weeks. The elasticity and hydration properties of facial skin were evaluated using noninvasive instruments. Also evaluated were the expression of new collagen fibers, inflammatory markers, and damage to skin cell DNA.

The astaxanthin group showed significant improvements in elasticity and water content of the facial skin after 12 weeks compared to placebo. In the supplement group, expression of new collagen was increased while markers of inflammation and cellular damage decreased compared to the placebo group.⁷ These results indicate that astaxanthin supplementation goes a very long way in supporting youthful-looking and vibrant facial skin.

Two other human clinical studies also proved the benefits of natural astaxanthin in promoting skin health. The first was a study involving 30 healthy female subjects for eight weeks. Significant improvements were observed by combining 6 mg per day oral supplementation and 2 ml (78.9 µM solution) per day topical application of natural astaxanthin. The astaxanthin showed improvements in skin wrinkles (crow's feet at week 8), age spot size (cheek at week 8), elasticity (crow's feet at week 8), skin texture (cheek at week 4), and the moisture content and overall health of the outer layer of skin (cheek in 10 dry skin subjects at week 8).

The second study, a randomized double-blind, placebo-controlled study, followed 36 healthy male subjects for six weeks. Crow's feet wrinkles and elasticity and the water content of the skin were improved after 6 mg of astaxanthin daily supplementation. Also, sebum oil level at the cheek zone showed strong tendencies for improvement, indicating a possible benefit in acne.

The researchers concluded, "These results suggest that astaxanthin derived from *Haematococcus pluvialis* may improve the condition of the skin in both women and men."⁸

Men do care about their skin. In 2014, CNBC reported that "total U.S. sales for the men's personal care market hit \$4.1 billion, up 6.7 percent from 2012 and 19



“...cyclists taking
astaxanthin demonstrated
significant improvement in
their power output.”

percent from 2009, making it one of the fastest-growing segments of the beauty industry.” However, to keep things in perspective, retail sales of beauty products for women reportedly reached \$38.1 billion in 2014.⁹

III. Sports Nutrition

A good portion of astaxanthin’s research has sports nutrition applications, either directly or indirectly. The benefits in reducing exercise-induced inflammation as well as supporting a healthy immune system response were mentioned previously. Those are direct effects. Improving skin health is a good example of indirect support—after all, many people exercise outdoors and astaxanthin can prevent sun damage. On top of the positive reviews astaxanthin receives from athletes,

there is a sizable, diverse body of sports-related research on astaxanthin. In a study sponsored by Gatorade®, competitive cyclists supplemented with a placebo or 4 mg of natural astaxanthin daily for four weeks. From the endurance athletes’—or any competitive athletes’—perspectives, the results were excellent. In a 20-kilometer cycling time trial, the performance of the subjects taking astaxanthin improved by five percent, while the subjects taking the placebo showed no improvement. Also, the cyclists taking astaxanthin demonstrated significant improvement in their power output — a 15% improvement in just four weeks.¹⁰ These results are particularly impressive since this study was done on a group of highly trained, competitive athletes.

While a mechanism of action was not identified, another study provided a clue. Three years later, researchers determined that giving Wistar rats 1 mg of astaxanthin per kg of body weight over 45 days, delayed their time to exhaustion by 29 percent in a swimming test.

Supplementation increased the antioxidant capacities and limited exercise-induced pro-oxidant effects in these animals thereby limiting oxidative stress and delayed exhaustion.¹¹

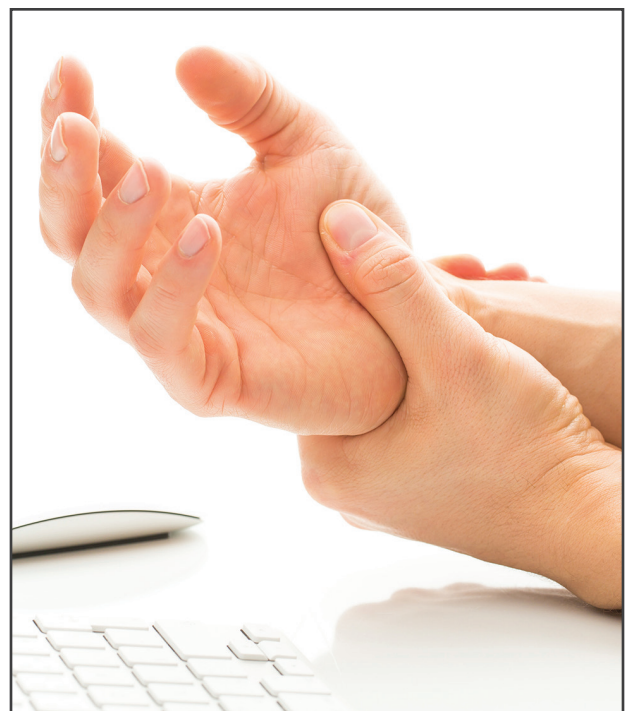
In a study conducted in Japan, astaxanthin's effect on lactic acid levels in the muscles was measured. Lactic acid is an unwanted byproduct of physical exertion; it deposits in the muscles and causes muscle fatigue, cramps, and burning during exercise. Reducing lactic acid levels increases endurance. The subjects were all 20-year-old men. The treatment group took 6 mg per day of astaxanthin for four weeks. Lactic acid levels for both groups were measured before running 1,200 meters and again two minutes after running. Subjects who took natural astaxanthin averaged 28.6 percent lower serum lactic acid after running 1,200 meters compared to the placebo group.¹² The significance of these findings are absolutely enormous for anyone wanting to clock a better time or go a little farther with their exercise.

IV. Joint and Tendon Health

The benefits of astaxanthin have no age limit. This statement is especially true when we look at astaxanthin's effect on joint health. A 2001 health survey involved 247 people between 20 and 87 years of age; 146 of them reported problems with muscle and joint soreness. After compiling the data, 88 percent of all participants who took astaxanthin reported improvement in muscle and joint soreness. In all cases, the more exercise an individual did, the more benefit.¹³

Athletes' joints and tendons take a pounding. So does everyone else's. Everyday tasks such as typing on computers, working in the yard, or simply picking up a scrap of paper, exact a considerable toll.

Consider the widespread effects of arthritis. According to the Centers



for Disease Control and Prevention, 40 percent of adults report it is “very difficult” or that they “cannot do” at least one of nine important daily functional activities. Almost eight million adults who reported an activity limitation due to their arthritis claim to have severe limitation in their ability to stoop, bend, or kneel; six million people cannot walk a quarter-mile.

The situation will only get worse. “By the year 2040, an estimated 78 million (26 percent of the projected total adult population) adults aged 18 years and older will have doctor-diagnosed arthritis, compared with the 52.5 million adults in 2010-2012. Two-thirds of those with arthritis will be women,” CDC predicts. “Also by 2040, an estimated 35 million adults (44 percent of adults with arthritis or 11 percent of all U.S. adults) will report arthritis-attributable activity limitations.”¹⁴

Astaxanthin might be able to help. Researchers divided 20 people who experienced wrist pain after overuse in the workplace. Thirteen participants received 4 mg of natural astaxanthin three times a day; the rest received a placebo. Those given natural astaxanthin reported a 27 percent reduction in daytime pain after four weeks and a 41 percent reduction after eight weeks. The duration of their daytime pain decreased by 21 percent after four weeks and 36 percent after eight weeks.¹⁵

“88 percent of respondents with sore muscles or joints found that astaxanthin reduced their discomfort.”

This research group also conducted another study involving everyday pain and astaxanthin’s role in affecting it. Fourteen subjects received astaxanthin and seven received a placebo. Pain and satisfaction with the ability to perform daily activities were measured at the beginning of the study, after four weeks, and finally after eight weeks of supplementation. Astaxanthin, according to its users, worked better with time: pain scores for the treatment group decreased by approximately 10 percent after four weeks, and by more than 35 percent after eight weeks. The subjects taking natural astaxanthin self-rated satisfaction scores improved by approximately 15 percent after four weeks and by over 40 percent after eight weeks.¹⁶

Regarding aches and pains, over 80 percent of people who specifically



Eye & Brain Health

- Crosses the blood-retinal and blood-brain barriers
- Protects eyes from light-induced damage
- Improves visual acuity
- Reduces eye strain and fatigue
- Lessens oxidative stress to the brain

mentioned osteoarthritis, rheumatoid arthritis, or back pain reported improvement after supplementing with astaxanthin.¹³

V. Eye and Brain Support

One major benefit of astaxanthin is that it readily crosses the blood-brain barrier as well as the blood-retinal barrier.

That means it easily can reach the inner sanctum of the eye and the brain, something other carotenoids simply cannot do. Astaxanthin is the King of Carotenoids for eye and brain health. Research overwhelmingly supports the power of astaxanthin's presence in the brain and eyes. Let's look at a practical application. Whether it's for work or fun, many of us are now tethered to a screen. Eye fatigue is a BIG issue for many of us.

In a double-blind study, after four weeks of natural astaxanthin supplementation (5 mg), investigators reported a 46 percent reduction in the number of subjects with eyestrain or fatigue.

Researchers also found higher accommodation amplitude (i.e., the adjustment in the lens that allows it to focus) in subjects who used visual display terminals.¹⁷ Another study found positive effects for eyestrain at 4 mg per day, but found a better result at 12 mg per day.¹⁸

A separate double-blind study divided 40 subjects into placebo and treatment groups. The treatment group received 6 mg of astaxanthin for four weeks. Three separate visual parameters had statistically significant benefits from astaxanthin supplementation—an optimum daily dose for eye fatigue at 6 mg was established.¹⁹ Two other studies confirmed that 6 mg per day of astaxanthin supplementation for four weeks can reduce eye soreness, dryness, tiredness, and blurred vision.^{20,21}

Research has unveiled some possibilities regarding astaxanthin's mechanism of action. Japanese researchers measured retinal capillary

blood flow in 18 volunteers who took oral astaxanthin—again 6 mg a day—for four weeks, compared with a placebo group. After four weeks of astaxanthin supplementation, retinal capillary blood flow was significantly higher in both eyes, but unchanged in the placebo group.²² Another study, this time in rats, determined that astaxanthin inhibited inflammation in the eye.²³

Beyond eyestrain, astaxanthin has shown—in animal and human studies—to improve visual acuity and depth perception in men,²⁴ display potent antioxidant effects in the prevention of cataracts in rats' eyes,²⁵ and protect the lens proteins in pigs.²⁶

Astaxanthin's impact on the brain boasts an ever-mounting pile of research, including human subjects. A study on a human neuroblastoma cell line showed that astaxanthin can protect from cell death. The researchers hypothesized that astaxanthin could be used for treating diseases such as Parkinson's.²⁷ A study on human cells found astaxanthin reduced brain cell death.²⁸ Finally, human brain cells endured neuronal cell damage through oxidation at Nagoya University in Japan. Significant protection was found in cells pre-treated with astaxanthin.²⁹

As for other research of note, researchers in Taiwan concluded

that astaxanthin could be used as a potent brain protector and as a therapy for early stages of Alzheimer's disease.³⁰ Astaxanthin, thanks to its intense antioxidant activity and unique effects on cell membranes, can protect against damage to the brain from insufficient oxygen delivery or ischemia.³¹ Pretreatment with astaxanthin five hours and again one hour before ischemia provided protection against brain damage³² and was revealed as a potent agent against neurodegenerative disorders like Parkinson's and Alzheimer disease.³³

VI. Cardiovascular Health

Like the brain, the heart is a complicated organ that demands a supplement with a multi-faceted approach. A quick look at the research behind astaxanthin and cardiovascular health reveals support on multiple levels, much like astaxanthin's role with the brain, skin, and eyes.



A study on adults with metabolic syndrome showed that astaxanthin supported healthy blood circulation by promoting arterial health.^{34, 35} Human participants supplemented with 6 mg of astaxanthin per day for only 10 days showed a significant improvement in blood flow.³⁶ Another study featuring rats fed astaxanthin may provide a clue. The animal subjects had decreased hardening of the arteries and the elastin bands in the aorta and decreased the size of the aerial ratio of coronary arteries.³⁷

Natural astaxanthin can help maintain normal blood lipids, LDL, HDL, and triglyceride levels.³⁸ A study showed that adults who took astaxanthin supplements had an improved lipid profile, namely decreased triglycerides and increased HDL cholesterol. Blood levels of the hormone adiponectin—which promotes insulin sensitivity along with healthy blood sugar and lipid levels—were also higher in those who took astaxanthin. Optimal results were found at 12 mg of astaxanthin per day.³⁹

The connection between astaxanthin and cardiovascular support is especially important when you consider the prevalence of cardiovascular disease in America. In 2011, 787,000 Americans died of cardiovascular disease, making it the number one killer in the United States. The direct and indirect costs of heart disease total more than \$320 billion.⁴⁰

NATURAL MATTERS

There is natural astaxanthin and synthetic astaxanthin. Really, the only similarity between them is the name. Natural astaxanthin—always from a natural source like *Haematococcus pluvialis* microalgae—is supported by years of safety data and nearly 100 clinical trials.

Synthetic astaxanthin is actually made from petrochemicals—what you put into your car's gas tank. To say that it is different chemically than natural astaxanthin is a gross understatement. Synthetic astaxanthin has been shown to be 20 to 50 times weaker in antioxidant strength than natural astaxanthin.

The synthetic form differs in its chemical structure from the natural form. Natural astaxanthin is more than 95 percent esterified. This means natural fatty acids are attached to one or both ends of the molecule. By contrast, synthetic astaxanthin is all free form, or unesterified. There is something wrong with this synthetic form as it is simply not absorbed or utilized in the same manner as nature intended.

Even the U.S. Food and Drug Administration (FDA) views synthetic versions of natural supplements to be different from the natural version itself, and takes the position that safety data on natural compounds does not apply to synthetics. Synthetic astaxanthin also has no peer-reviewed human

safety studies to its credit—and no documented health benefits.

Another warning: astaxanthin from genetically mutated yeast known as *Phaffia* has not established sufficient safety standards, so it is not allowed by the FDA for human consumption above 2 mg per day. Also, it is not recommended for long-term use or for children. And similar to synthetic astaxanthin, the *Phaffia*-sourced

astaxanthin is chemically different and non-esterified.

The only form of astaxanthin that has hundreds of medical research experiments showing health benefits—as well as extensive safety trials and 15 years of safe use in humans—is the natural astaxanthin from microalgae.

STARK DIFFERENCES BETWEEN NATURAL & SYNTHETIC FORMS OF ASTAXANTHIN

Natural Algal Astaxanthin

Years of safety data supporting multiple health conditions

Extensively published in almost 100 human clinical trials

Cultivated from natural algae as nature intended

Synthetic Astaxanthin

Not approved by the FDA as a human supplement

No known peer-reviewed human safety studies

Never proven to have any health benefits in human clinical trials

Synthesized from petrochemicals

Haematococcus ponds turn from green to red like fall leaves.

CHOOSING THE RIGHT ASTAXANTHIN PRODUCT

Obviously, you want to buy natural astaxanthin. After that, the rest comes down to awareness and good communication.



Only buy astaxanthin that lists *Haematococcus pluvialis* as the source on the label. Ask for documentation verifying the supply chain—from origin to delivery. If a company representative tells you its synthetic astaxanthin is just as good, walk away.



My recommendation is to make sure the material comes from a Natural Algae Astaxanthin Association (NAXA) member and look for the NAXA Verification Seal.



Ask for testing data. Only purchase astaxanthin that is tested using USP standards or other validated identity methods (e.g., Isomeric or chiral HPLC).



IN CONCLUSION

Because of its wide range of benefits supported in peer-reviewed clinical studies, spotless safety record, and its ability to act in a manner and reach areas that other antioxidants cannot, astaxanthin is more than the “King of Carotenoids.” Astaxanthin is the leader in a new natural products world defined by quality, safety, and research.



FREQUENTLY ASKED QUESTIONS

Q: Is supplementation with astaxanthin really necessary?

A: Yes. To get the amount of astaxanthin in a 4 mg supplement, you'd have to eat four ounces of wild sockeye salmon every day (which has the highest level of astaxanthin of any food).

Q: How much astaxanthin should I take daily?

A: If you are taking an astaxanthin nutritional supplement as part of your daily health maintenance regimen, 4 to 6 mg per day is recommended. However, for those with serious joint or tendon health problems—or who exercise/engage in physical activity daily—12 mg per day of astaxanthin is generally recommended. Talk with your healthcare provider before adding any supplement to your daily regimen.

Q: Do I need to take astaxanthin with food?

A: Astaxanthin is a fat-soluble carotenoid, so it works best when taken with food. The fat in a meal aids in the absorption of the antioxidant.

Q: Are there any side effects?

A: The only potential effect—if you want to call it that—arises when people take far above the recommended 4 to 12 mg per day. There may be a slight orange color in the palms of the hands and soles of the feet. It is just astaxanthin depositing in the skin, which may actually be healthful.

Q: Where I can learn more about research studies on astaxanthin?

A: Astaxanthin.org is a wonderful resource that is updated regularly.

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