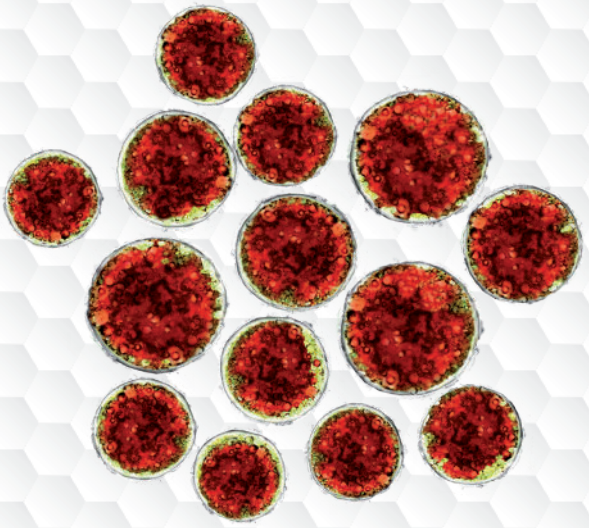
Natural Astaxanthin

The positive effects of algae-based astaxanthin on your immune system



Executive Summary

A supplementary diet with natural astaxanthin, derived from the microalgae *Haematococcus pluvialis,* has proven several positive effects on the complex network of the human immune system. Studies show that astaxanthin enhances immune response, increases antibody production and reduces oxidative stress as well as inflammation. The ability of astaxanthin to span the entire lipid bilayer of the cell membrane offers a superior protection from inside, which also distinguishes astaxanthin from other antioxidants.

Benefits of natural astaxanthin for the human immune system:

- Increases B and T cell profileration
- Increases natural killer cell activity
- Reduces C-Reactive protein which plays a major role in innate immunity
- Enhances inhibitory effects in activated macrophages
- Improves sIgA response and prevents inflammation induced by physical training

Introduction

The human immune system is a highly complex and a sensitive network within the organism. It protects the human being against infections with bacteria, viruses or other external invaders. The immune system includes numerous organs – e.g., bone marrow, thymus, spleen, tonsils, lymph nodes etc. – as well as special blood cells.

The intestine is closely associated with the immune system and contains 70 percent of the body's immune cells. Therefore, a balanced diet is a key factor in maintaining a general well-being and a good performance of our immune system.

External stress, be it environmental pollution, stress at work, an insufficient or poor diet, can reduce the activity of the immune system and make a person more susceptible to diseases. Also, with increasing age, the effectiveness of the human immune system may decrease.

In the following, recent studies are presented on the potential benefits of an astaxanthin-supplemented diet to support the human immune system.

What is the power of natural astaxanthin

Astaxanthin is a naturally occurring pigment that gives the reddish color to marine organisms such as crabs, shrimps and salmons. Chemically, astaxanthin belongs to the carotenoid group, specifically to the xanthophylls. In natural surroundings, it can be found in photosynthetic organisms like bacteria, algae and yeasts. The highest concentrations of natural astaxanthin can be accumulated from the sweet water microalga *Haematococcus pluvialis*. Due to its unique molecular structure, astaxanthin contains both lipophilic and hydrophilic properties, and it can combine with cell membranes from inside and outside.[1]

Natural astaxanthin has great anti-inflammatory effects. Furthermore, it is considered to be the most powerful antioxidant and highly effective at counteracting reactive oxygen species (ROS). It neutralizes harmful free radicals in a way that does not harm somatic cells. Unlike other antioxidants, astaxanthin does not become a pro-oxidant which can harm the body. Compared to other well-established synthetic or natural antioxidants, natural astaxanthin has been proven to be significantly more effective.

Therefore, it is also called the "diamond of radical scavengers" (for details, see our dossier "Natural astaxanthin – nature's most powerful antioxidant"). Natural astaxanthin is classified as a novel food in the European Union and was considered safe by the United States Food and Drug Administration (FDA) with GRAS (generally recognized as safe) status. Numerous scientific studies have demonstrated the positive effects of natural astaxanthin on human health.

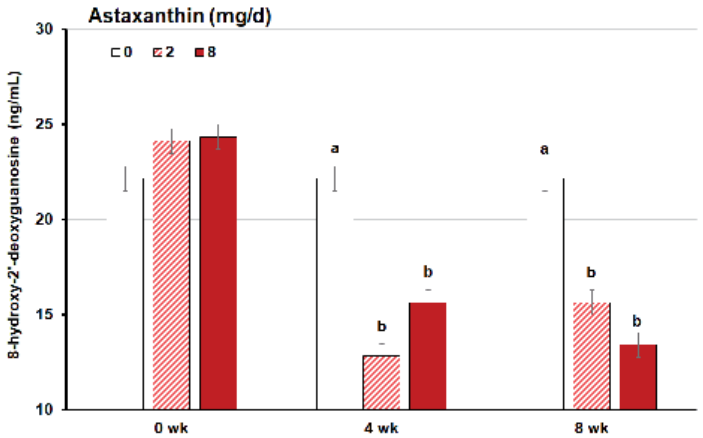
The in-vivo study by *Park et al.* in 2010 indicates several positive effects of natural astaxanthin on the immune system.[2] This randomized double-blind, placebo-controlled study comprised 42 healthy female participants with an average age of 21.5 years.

Each morning, the subjects received a dose of 0.2 or 8mg astaxanthin in 1 capsule over a period of 8 weeks.

Improvement of immune response

The immune response was measured by checking the reproduction rate of T and B cells as well as the activity of natural killer cells (NK cells) which are types of white blood cells (lymphocytes).

These cells are responsible for defending the human body against outside and inside threats such as viruses or bacteria (T/B cells) and tumors (NK cell). The populations of T and B cells were higher in the group with 8mg compared to the control group and the group with 2mg.



Prevention of oxidative damage

Oxidative stress is an imbalance between production and accumulation of reactive oxygen species (ROS), also known as free radicals. Although ROS are vital for several functions of the human body, an imbalance can cause irreversible DNA damage, respectively cancer.[3]

Park et al. tested the effect of astaxanthin on oxidative damage to DNA by using a DNA biomarker (plasma 8-OHdG). The biomarker concentration was significantly lower in both astaxanthin groups compared to the control group (figure 1).

Figure 1: Concentrations of plasma 8-OHdG in human subjects fed 0.2 or 8 mg astaxanthin daily over 8 wk.[1]
a, b Different letters represent significant treatment differences ($P < 0.05$) as analysed by protected LSD test. Values are means ± overall standard error.

Enhancement of inflammatory status

Inflammation is a biological response by the human immune system that can be triggered by a variety of factors (pathogens, toxic compounds or damaged cells), potentially leading to tissue damage or diseases in human organs.[4]

Park et al. measured the inflammatory status by using C-reactive protein in plasma as a biomarker. The concentration of the biomarker was significantly lower in both groups in week 4 and was still lower compared to the control group in week 8 (figure 2).

In their study from 2015, *Baralic et al.* investigated the effect of astaxanthin on the production of antibodies and oxidative stress in the human body. In this randomized double-blind, placebo-controlled study, 40 male football players participated and received one capsule of 4mg astaxanthin after each meal for 90 days.[5]

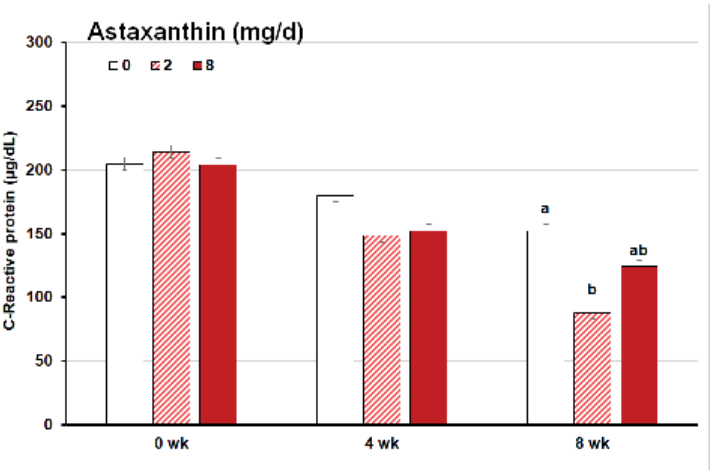


Figure 2: Plasma concentration of plasma C-reactive protein in human subjects given 0.2 or 8mg astaxanthin daily over 8 weeks.[2]
a, b: different letters represent significant treatment differences ($P<0.05$) as analyzed by protected LSD test. Values are means ± overall standard error.

Increase in immunoglobulin A (sIgA):

Immunoglobulin A is a major serum immunoglobulin and the predominant antibody class in the external secretions that bathe mucosal surfaces. It plays a key role in immune protection[6] and especially in the defense against respiratory pathogens like influenza. A recent study also suggests a correlation of salivary IgA levels and COVID-19 disease severity.[7]

Baralic et al. revealed a significant increase in sIgA concentration in the astaxanthin group compared to the control group (figure 3).

Furthermore, this study also shows positive effects of astaxanthin supplementation compared to the control group with a decrease in prooxidant-antioxidant balance.

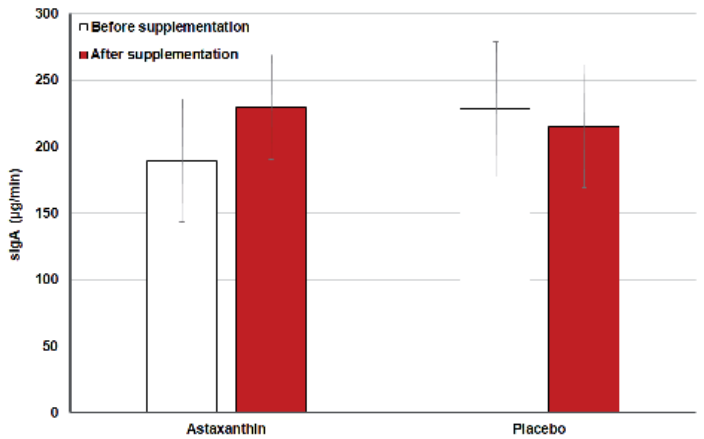


Figure 3: Salivary IgA concentration in soccer players at baseline and after 90 days of astaxanthin supplementation.[5]
Values are presented as mean ± SE. The difference compared to the results at baseline was significant at 0.05 (+).

Several in-vitro and non-human studies also indicate positive response by astaxanthin on the immune system:

In 2011, *Chew et al.* showed that astaxanthin enhances the immune defense in dogs.[8] Hence, astaxanthin supplementation improves the natural killer cell cytotoxic activity, increases the population of B-cells, decreases concentration of C-reactive proteins and heightens the DTH response.

An in-vitro study by *Jyonouchi et al.* in 1993 showed that astaxanthin increases antibody production in mouse splenocytes[9] Another study by *Jyonouchi et al.* in 1995 demonstrated that enhanced immunoglobulin production in human blood cells could be attributed to astaxanthin.[10] In 2000, *Bennedsen et al.* proved the positive influence of astaxanthin on the decrease of bacterial load and gastric inflammation in mice.[11]

Support of COVID-19 treatment

SARS-CoV-2 is a highly contagious and potentially fatal virus which caused the coronavirus pandemic in 2019/2020. *Talukdar et al.* point out that *"accumulating evidence suggest that excessive reactive inflammation, oxidation and an exaggerated immune response very likely contribute to its pathology, leading to a violent immune response cytokine storm and subsequent progression to life threatening acute respiratory distress syndrome (ARDS)/acute lung injury (ALI)."*[12]

Astaxanthin is a safety-proven, well-known potent antioxidant and has also shown anti-inflammatory effects. *Fakhri et al.* recommend astaxanthin as "*a promising candidate to combat COVID-19*" due to its anti-inflammatory, anti-oxidative and anti-apoptotic effects.[13]

In their study from 2020, *Varadhachary et al.* point out a correlation of immunoglobulin A levels and COVID-19 disease severity. Since (sIgA) plays an important role in fending off respiratory pathogens, astaxanthin with its ability to increase sIgA levels might be helpful in preventing a severe course of disease. For these reasons, the authors suggest that natural astaxanthin might be a helpful therapeutic agent against COVID-19 infections.[7]

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About BDI-BioLife Science GmbH

BDI-BioLife Science (BLS) specializes in the development of innovative technologies to produce high-quality algal materials for the life sciences industry.
State-of-the-art in-house research facilities as well as years of cooperation with renowned universities create the basis for BDI's chief knowledge in algal research. Our department of product development turns ideas into finished formulations and supports you along the way from the raw material to the white label product. At the cultivation plant located at the Ökopark in Hartberg/ Austria, BDI-BioLife Science produces algae with the specially developed, closed algae cultivation process to produce natural astaxanthin, tailor-made for the cosmetics (AstaCos®) and food supplement (astafit®) industries.

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