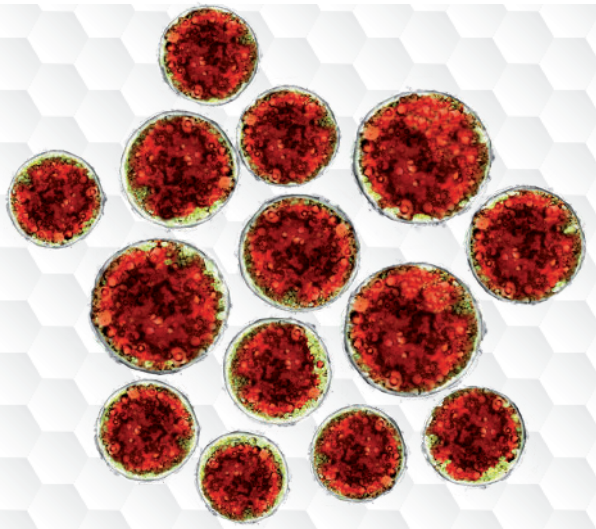
Natural Astaxanthin

The positive effects of algae-based astaxanthin on your cognitive health



Executive Summary

Numerous studies indicate that natural astaxanthin as nutritional supplementation could be a helpful therapeutic agent for the human brain. Due to its anti-inflammatory and antioxidative effects as well as its capability to cross the blood-brain barrier, astaxanthin might be helpful to prevent age-related diseases. In addition, astaxanthin could be supportive to human's everyday life by reducing mental fatigue on stressful days.

Benefits of natural astaxanthin for human cognitive health:

- Prevents dementia by improving the erythrocyte antioxidant status and decreases POOLH levels
- Improves cognitive function in healthy, aged individuals
- Improves higher brain function, including cognition, attention, memory, information processing and resultant behavior in older persons

Introduction

Our brain is the key control center of our body. It processes bodily information, controls our internal organs, generates our thoughts and emotions, stores and enables recall of memories and controls movements. Because the brain plays such a vital role, it has an excellent defense system and a specialized immune system that monitors the presence of invaders or the development of internal injuries. Furthermore, it is well-protected by the blood-brain barrier which prevents harmful substances from entering. Nevertheless, this cognitive organ remains vulnerable to attacks and damages by free radicals, especially for people over 50 years of age. As we age, the brain's natural antioxidant enzymes gradually lose their effectiveness. In fact, excessive and prolonged oxidative stress and chronic inflammation in the brain have been linked to the development and progression of neurodegenerative diseases such as Alzheimer's and Parkinson's disease as well as cerebrovascular diseases such as ischemic stroke and vascular dementia.
Brain health plays a critical role in almost everything the human body needs. For these reasons, neurologists and medical experts have begun to carefully pay attention to the preventive and therapeutic benefits of micronutrients on brain health. A number of clinical and experimental studies suggest that natural astaxanthin supplementation may play a role in maintaining and supporting brain and cognitive health. In the following, recent studies and papers are presented dealing with potential benefits of an astaxanthin-enriched supplementary diet for the human brain.

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.

Prevention of dementia

Phospholipid hydroperoxides (PLOOH) accumulate abnormally in the erythrocytes of dementia patients, while dietary xanthophylls (polar carotenoids such as astaxanthin) are hypothesized to prevent that increase. In a study by *Nakamura et al.* a randomized, double-blind, placebo-controlled human trial was carried out to assess the efficacy of a 12-week astaxanthin supplementation (6 or 12 mg/d) on both astaxanthin and PLOOH levels in the erythrocytes of 30 middle-aged and senior subjects (50 to 69 years).

After 12 weeks of treatment, erythrocyte astaxanthin concentrations were higher in both groups with 6 and 12mg astaxanthin than in the placebo group. In contrast, erythrocyte PLOOH concentrations were lower in the astaxanthin groups than in the placebo group (figure 1). To conclude, levels of PLOOH in the blood plasma were significantly lower after astaxanthin treatment (figure 2). It can be suggested that astaxanthin supplementation results in an improved erythrocyte antioxidant status and decreased PLOOH levels, which may contribute to the prevention of dementia.[2]

In 2014, *Zanotta et al.* carried out a prospective cohort, noncomparative, multicenter trial on 104 human participants diagnosed with mild cognitive impairment. Over 60 days, the subjects were given one tablet containing extracts of Bacopa monnieri (Bacosides), Phosphatidylserine, Vitamin E and 2mg of astaxanthin. To test the impact of the supplementation, the subjects had to undergo the Alzheimer's Disease Assessment Scale-cognitive subscale (ADAS-cog) test as well as the clock-drawing test at the beginning and the end of the study. The results showed significant improvements in both tests after a 60-day supplementation compared to the beginning of the study. The study authors therefore conclude that "*dietary supplementation with the tested compound shows potential for counteracting cognitive impairment in subjects with mild cognitive impairment.*"[3]

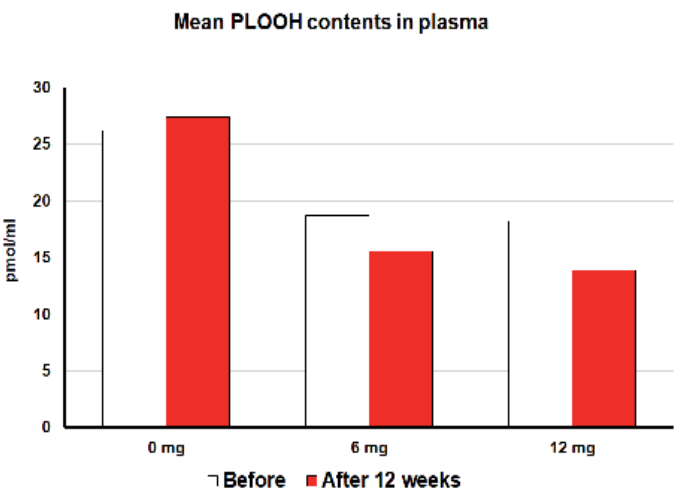


Figure 1: Changes in phospholipid hydroperoxides content in plasma before and after 12 weeks of astaxanthin administration. $p<0,05$[2]

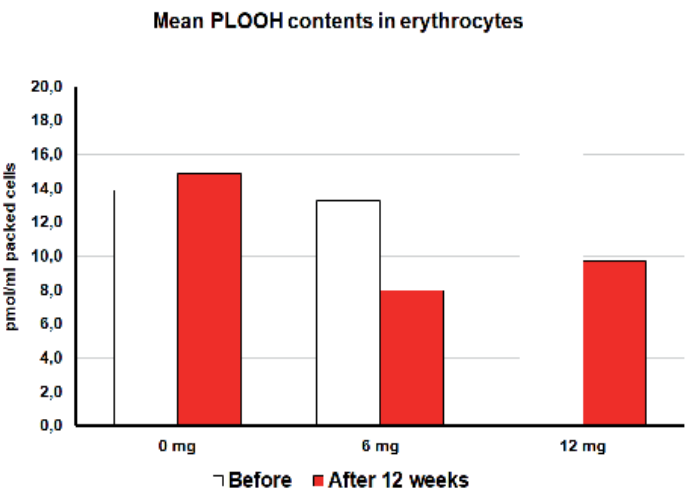


Figure 2: Changes in phospholipid hydroperoxides content in erythrocytes before and after 12 weeks of astaxanthin administration. $p<0,05$[2]

Promotion of recovery from mental fatigue

Severe fatigue can negatively affect the quality of life, and oxidative stress may play a role in that. In 2018, a study by *Imai et al.* evaluated the effect of astaxanthin-enriched dietary supplementation and sesamin, a strong food-derived antioxidant, on fatigue.[4]

Over 4 weeks, 24 healthy subjects participated in this double blind, randomized, placebo-controlled study. Each morning after breakfast, the participants had to take two capsules containing 3mg astaxanthin and 5mg sesamin.

After each supplementation period, participants underwent tasks inducing mental and physical fatigue (visual display terminal task and ergometer task, respectively). The subjective fatigue was evaluated using a visual analog scale during and after the mental and physical tasks, while the daily subjective fatigue was evaluated by the Chalder fatigue questionnaire. Secondary outcomes included other subjective feelings, work efficiency, autonomic nerve activity, levels of an oxidative stress marker (plasma phosphatidylcholine hydroperoxide (PCOOH) and safety.

The supplementation was associated with significantly improved recovery from mental fatigue compared to the placebo. Increased PCOOH levels during mental and physical tasks were attenuated by the supplementation (figure 3).

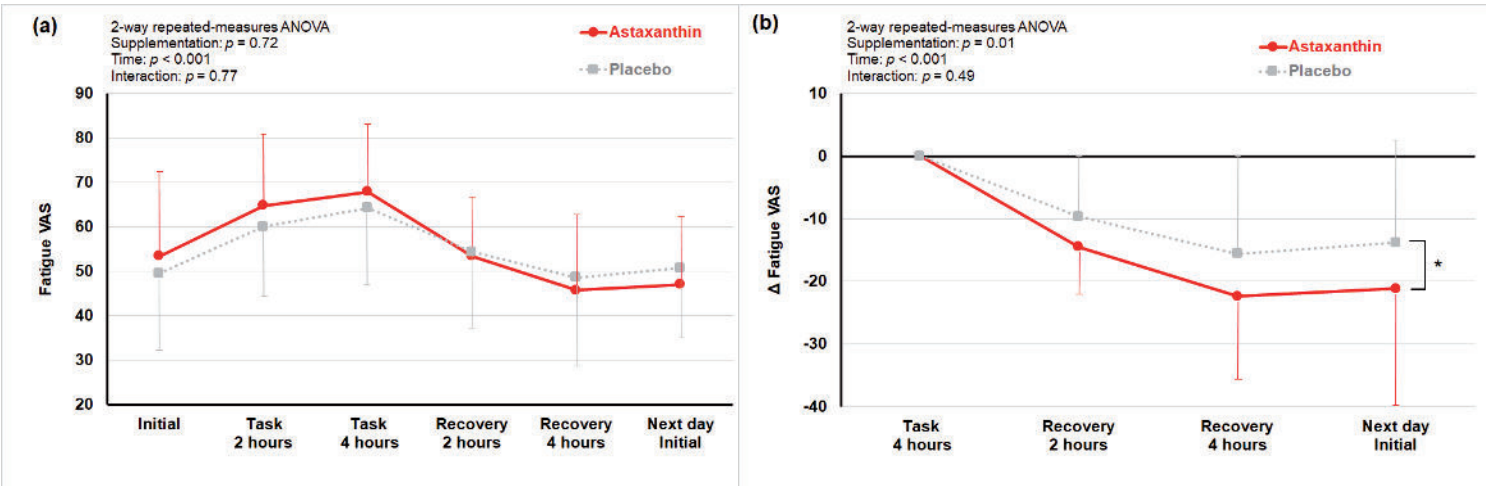


Figure 3: Subjective fatigue evaluated with VAS on mental task day. (a) VAS scores on mental task day; (b) Difference in VAS scores in recovery period.
$p < 0.05$ between AS and placebo by 2-way repeated-measures ANOVA. Data are presented as the means ± S.D[4].

The authors concluded that the supplementation with astaxanthin and sesamin may provide an opportunity to promote recovery from mental fatigue, which was mostly experienced by healthy people. No differences between the supplementation and placebo were detected in secondary outcomes, and no adverse effects of the supplementation were observed.

The use of natural astaxanthin on different neuroprotective effects on the human brain shows great potential:[5]

Parkinson's Disease (PD)

Neuroinflammation and oxidative stress play a key role in the pathogenesis of PD.[6 7] The inhibition of the mediators of these pathways is crucial for preventing a disease progression, which is what astaxanthin does as a multi-target drug.[6]

Alzheimer's Disease (AD)

Oxidative stress is one of the main reasons to cause AD. Since the brain has a lot of blood vessels and a very high oxygen consumption, it is highly predisposed to oxidative stress.[8] Astaxanthin is one of the few compounds we know of that can cross the blood-brain barrier which might increase its known antioxidant properties in the human brain.[5]

Depression

Although the complex pathophysiology of depression has not yet been completely understood, recent studies show a close connection to oxidative stress and inflammation. Different experimental models suggest an antidepressant-like effect of astaxanthin by decreasing the level of inflammatory markers.[9, 10]

Ageing

Oxidative stress increases with aging, while the brain becomes more vulnerable to neurodegeneratve diseases.[11] Oxidative stress effects the synaptic plasticity in the hippocampus, which is associated with memory processes and learning. Besides, astaxanthin seems to improve all types of oxidative markers in the studied brain regions.[12, 13]

In their review, *Fakhri et al.* conclude that astaxanthin influences a variety of "*mechanism to tackle complex neurodegenerative diseases, mainly based on its anti-inflammatory, antioxidant and anti-apoptotic behaviour.*"[5]

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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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