

Article

The Effect of Astaxanthin as the Strongest Antioxidant on the Human Body.

Mariana Samoilova ¹, Tamara Kosyreva ¹, Olga Voeikova ^{1*}, Svetlana Dragunova ¹, Margarita Sakanyan ¹, Nikolay Tuturov ¹
Ekaterina Ezhova ¹, Angelina Kozhokar ¹.

¹ Federal State Educational Institution of Higher Education 'Peoples' Friendship University of Russia', Department of Pediatric Dentistry and Orthodontics; 117198, Moscow, Russia;

* Correspondence: o_vir@mail.ru; Tel.: +89255898175;

marsamoylova@gmail.com, <https://orcid.org/0000-0001-6771-919X> (M.S.);

kosyreva-tf@rudn.ru, <https://orcid.org/0000-0003-4333-5735> (T.K.);

voeykova-ov@rudn.ru, <https://orcid.org/0000-0003-2935-8965> (O.V.);

dragunova.s@bk.ru, <https://orcid.org/0000-0003-2497-2253> (S.D.);

mag.sakanyan@mail.ru, <https://orcid.org/0000-0001-8219-6358> (M.S.);

tuturov-ns@rudn.ru, <https://orcid.org/0000-0001-8048-5703> (N.T.);

ezhova.ek4terina@yandex.ru, <https://orcid.org/0000-0001-8804-681X> (E.E.);

angelinakozhokar@yandex.ru, <https://orcid.org/0009-0006-7792-3542> (A.K.);

Citation: Samoilova M., Kosyreva T., Voeikova O., Dragunova S., Sakanyan M., Tuturov N., Ezhova E., Kozhokar A. The effect of Astaxanthin as the strongest antioxidant on the human body. *Otorhinolaryngology, Head and Neck Pathology (ORLHNP)*. 2024; 3 (1): 22-26.

<https://doi.org/10.59315/ORLHNP.2024-3-1.22-26>

Academic Editor: Valentin Popadyuk

Received: 18.01.2024

Revised: 15.02.2024

Accepted: 17.03.2024

Published: 30.03.2024

Publisher's Note: International Society for Clinical Physiology and Pathology (ISCPP) stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2024 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Abstract: Periodontal is a set of complex complex tissues that hold the tooth. If the violation adequate oral hygiene in inflammation, in which the antioxidant defense system of the person is not coping According to the synthesis report of the WHO (1978), chronic gingivitis in the European population is found in almost 80 % of children 10-12 years old and up to 100 % of children aged 14 years. Traditional methods of treatment aimed at eliminating the microbial factor are not always effective enough. Thus, periodontal diseases are an urgent problem today. Of great interest is the natural Astaxanthin, which surpasses other antioxidants in its anti-inflammatory and immunomodulatory properties.

Keywords: periodontal disease, antioxidant, astaxanthin, peroxidation, beta-carotene, Hematococcus pluvialis.

1. Introduction

Inflammatory diseases of periodontal tissues play a leading role in the structure of dental morbidity in Russia [4]. Their early signs are revealed in the form of bleeding gums and tartar [1]. Tissue hypoxia and an increase in the activity of free radical oxidation play a key role in the pathogenesis of many inflammatory diseases of the periodontal mucosa, which leads to the intensification of lipid peroxidation, the release of enzymes and inflammatory mediators with pro-oxidant action [8].

2. Purpose of work

Improving the treatment and prevention of patients with inflammatory periodontal diseases with a new therapeutic and prophylactic agent based on astaxanthin. The research task is to develop innovative forms of therapeutic and preventive tool and incorporate it into clinical practice for patients with periodontal disease.

3. Materials and methods

Astaxanthin was studied in the eyes of rats.

4. Research results and their discussion

In the conditions of changing external environment, in response, the body activates protection systems in order to maintain the constancy of its function and structure. There is a multicomponent response aimed at eliminating the imbalance induced by a shift in metabolic equilibrium. If it is impossible to achieve equilibrium in the metabolism, one or another pathology



develops [3]. The leading role of antioxidants is to prevent oxidation processes, preventing the action of free radicals on the cells of living organisms, thereby slowing down the aging process.

A new progressive direction in the treatment of periodontal diseases is the use of antioxidants. It is proved that the oxidative process, which leads to a sharp increase in the number of reactive oxygen species, which are free radicals, causes cell death.

Toxic substances are actively synthesized when the blood supply to tissues slows down, the local immune status decreases, because normally they perform protective functions, damaging the shells of microbes. However, in the presence of various conditions that have a long-term pathological effect on the body, uncontrolled formation of a large number of free radicals occurs, which the body's own antioxidant system cannot cope with.

Antioxidants are various natural products and their components. They protect the body from the inevitable harmful effects of oxygen. Astaxanthin, as a natural antioxidant, is present in various amounts in all living organisms on earth [6]. It is the most powerful antioxidant today [7]. Astaxanthin belongs to the group of carotenoids. Carotenoids are pigments that give some foods a rich bright color. A large amount of astaxanthin is found in algae and plankton, which are the basis of many food chains, so it can be found in the organisms of various animals. For example, red fish, crustaceans. The rich and beautiful color of flamingos also provides astaxanthin. Most of it is contained in the algae *Hematococcus pluvialis* (*Haematococcus Pluvialis*).

Many dietary supplements and even food products are considered antioxidants, but only natural astaxanthin prevails over others in its properties.

Here are just some of the properties that other carotenoids do not possess, but are inherent in natural astaxanthin:

1. *Overcoming the blood-brain barrier. Supplying the brain and central nervous system with an antioxidant, providing an anti-inflammatory effect.*
2. *Penetrates into the retina of the eye, providing the eyes with an antioxidant and having an anti-inflammatory effect.*
3. *It spreads throughout the body, exerting an anti-inflammatory effect on all organs and skin, while simultaneously supplying them with an antioxidant.*
4. *Penetrates the cell membrane.*
5. *Interacts with muscle tissues.*
6. *Acts as the strongest antioxidant, quickly catches free radicals and extinguishes singlet oxygen.*

Those companies that used astaxanthin as a dietary supplement in the early 1990s advertised it as the strongest antioxidant, but its other benefits became known much later. People taking these dietary supplements talked about how their well-being improved significantly, arthritic pain disappeared, the number of colds and flu decreased, and also allowed them to stay in the sun for a long time without the risk of getting burned.

Two independent studies have shown that Astaxanthin is the strongest antioxidant [7]. There are several ways to measure the strength of an antioxidant. The most common to date: The ability to absorb oxygen (ORAC), developed in the laboratory of Brunswick, Massachusetts, USA [8]. But according to the laboratory, this experiment is not suitable for oil-soluble carotenoids. Therefore, natural astaxanthin was tested in other ways.

According to the results of one of the experiments, this antioxidant surpassed vitamin E by 550 times in terms of the method of absorption of singlet oxygen. Vitamin E has always been considered a strong antioxidant in its effect on the body and cosmetic effect, but natural astaxanthin surpassed it. A comparison was also made with other antioxidants in terms of the level of singlet oxygen quenching (Fig.1, 2).

A comparison [2] of natural astaxanthin with lutein, beta-carotene and vitamin E in terms of the level of singlet oxygen quenching is presented in Figure 1.



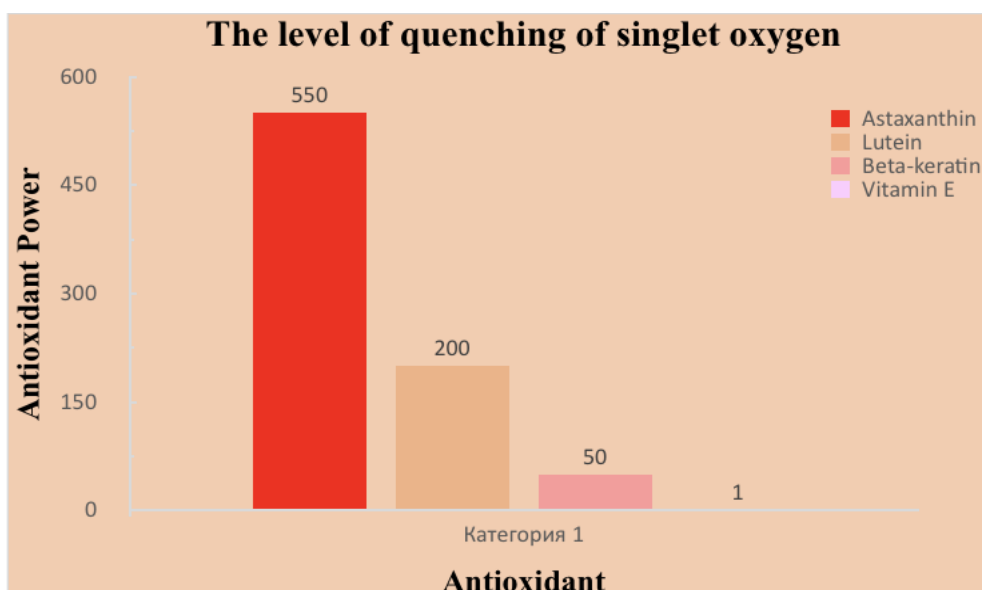


Figure 1. Comparison of Natural Astaxanthin with Lutein, Beta-carotene and vitamin E by the level of singlet oxygen quenching.

The second study was conducted at Creighton University [2] (Figure 2). Scientists compared Natural Astaxanthin, Vitamin E, Vitamin C, Pycnogenol, synthetic Astaxanthin and other antioxidants by the level of destruction of free radicals. Studies have shown that Natural Astaxanthin is 14 to 60 times more powerful than all other antioxidants [2].

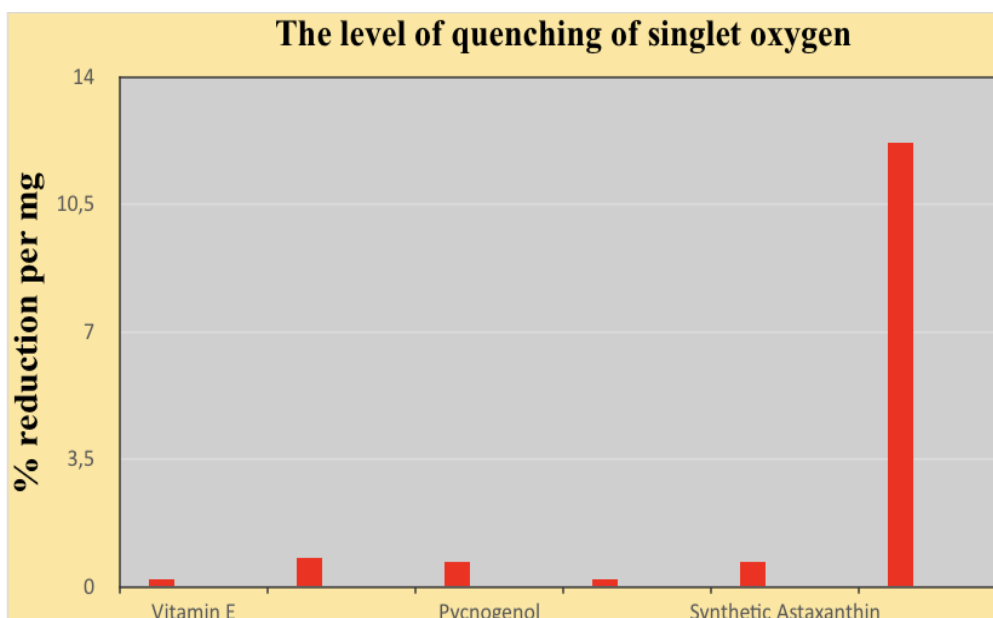


Figure 2. Comparison of Natural Astaxanthin with vitamin E, vitamin C, Pycnogenol, Beta-carotene, Synthetic Astaxanthin by the level of singlet oxygen quenching.

It was noted that different testing methods gave very different results. In the first experiment, Natural Astaxanthin proved to be 550 times stronger than vitamin E, but in the second experiment it surpassed it by 14.3 times. In the future, many studies have been conducted that have shown that Natural Astaxanthin is indeed the most powerful antioxidant.



Many companies obtain Synthetic Astaxanthin from petrochemical raw materials. Despite the similarity of the chemical formula with natural Astaxanthin, its synthetic analogue is another molecule with a different shape. Natural Astaxanthin has hydroxyl groups at the ends of the molecule that trap free radicals.

Some antioxidants turn into pro-oxidants, enhancing the oxidation process and starting to harm the body. Such antioxidants are vitamin C, vitamin E, zinc, beta-carotene, lycopene, zeaxanthin [3].

In the 1990s, a large-scale scientific experiment was conducted to study antioxidants in Finland. Research data has shown that smokers taking dietary supplements with synthetic beta-carotene suffer from lung diseases more often than those who took a placebo. This is due to the fact that the protection of cells by beta-carotene depends on the presence of other antioxidants in the body, especially vitamin C. With vitamin C deficiency, beta-carotene receives destructive energy and turns into a pro-oxidant. If the amount of vitamin C is normal, then this prooxidant turns into an antioxidant.

The peculiarity of the molecular structure of Natural Astaxanthin is that it never turns into a prooxidant and does not cause harm.

5. Conclusion

One of the important properties of natural Astaxanthin is anti-inflammatory. It fights inflammation in various ways that are closely related to its antioxidant capabilities. The mechanism of anti-inflammatory action consists in the suppression of various inflammatory mediators, such as cell necrosis factor (FOC), Prostaglandin E2 (PE-2), Interleukin 1B (IL-1B), nitric oxide (OA), reducing the effect of C-reactive protein [7]. In one of the experiments conducted at the Medical College of Hokkaido University (Japan), under the conditions of chemical experiment, Natural Astaxanthin suppressed nitric oxide, cell death factor and Intraleukin 1B.

A study was also conducted on rats, which showed the anti-inflammatory effect of Astaxanthin on the eyes of rats, suppressing the effect of inflammatory mediators [7].

In addition, antibacterial action has been shown on *Helicobacter pylori* in patients with gastric ulcer. *Helicobacter pylori* is a bacterium that settles in the epithelium of the human stomach and causes type B gastritis, gastric ulcer, duodenal ulcer and stomach cancer. After infection, a chain of events occurs on the gastric mucosa, leading to the activation of phagocytes, which leads to damage to the mucous membrane and inflammation. Recent studies have shown that mice infected with *H. pylori* and then consuming *Haematococcus* extract, there is a significant decrease in inflammation and the number of bacteria in the stomach. Treatment of infected mice with *Haematococcus* algae reduced the total number of bacteria by four times, and inflammation by 35%. These positive results are associated with the modulation of the immune response, as well as the neutralization of reactive oxygen species, the appearance of which accompanies inflammation. [5,6]

In a number of other experiments, the protective effect of Astaxanthin on the retina of the eye has been proven. The yellow spot is a small area in the center of the retina, consisting of cones, which are responsible for distinguishing colors. This area provides the clear vision needed to read and to distinguish fine nuances. Photoreceptor cells of the retina contain a large amount of polyunsaturated fatty acids, and are relatively highly saturated with oxygen, which is associated with an increased probability of lipid peroxidation. It is known that high-energy blue light is capable of generating reactive oxygen species in the process of photooxidation, mainly a singlet form capable of generating peroxides and other unstable molecules that can damage lipids. The accumulating oxidative process leads to degenerative changes noticeable in the aging spot. Blue light in the spectral region (400-500 nm) damages the retina, generating unstable forms of oxygen inside the eye. Clinical studies have shown that light burns are the main cause of the disease, the so-called "age-related macular degeneration". Due to its unique ability to cross the blood-brain barrier, astaxanthin can provide protection against oxidation to the retina, brain, spinal cord, and nerves. In the USA, the University of Illinois owns a patent for the use of astaxanthin as a means to combat age-related macular degeneration. The optimal dose of astaxanthin for visual fatigue was determined, which was 6 mg per day [6].

In large doses, Astaxanthin has demonstrated neuroprotective effect, preventing the phenomena of stroke and ischemia. Current studies show that this antioxidant can improve memory in the case of multiinfarction dementia [2].

The results of experiments with ultraviolet irradiation have shown that Natural Astaxanthin is able to complement the antioxidant systems of cells, reducing damage to the DNA structure. It specifically affects transglutaminase enzymes that help neutralize harmful polyamines resulting from skin irradiation [5].

Singlet oxygen is toxic to the immune system due to its ability to catalyze the occurrence of free radicals that can damage blood cells. Prolonged stress caused by intense physical exertion can lead to a violation of the immune system, for example, disrupt the activity of cells such as T-killers



or certain antibodies. Carotenoids strengthen both the specific and non-specific immune system and protect cell membranes and DNA from mutations from destruction, also having a strong stimulating effect on the immune system. Astaxanthin also enhances the secretion of Interleukin-1 alpha and Tumor Necrosis Factor alpha significantly more than astaxanthin or beta-carotene.

In the course of one of the studies, it was shown that astaxanthin had the greatest cytokine-stimulating activity among the tested substances, and that this carotenoid is even able to play the role of an immunomodulator. Studies have shown that the synthesis of immunoglobulin M increases with the intake of astaxanthin even in small concentrations.

The significance of periodontal diseases as a general medical and special problem is determined by their prevalence in the world, a large loss of teeth and the negative influence of foci of infection with the formation of a periodontal pocket. [1]

Periodontal diseases are divided into inflammatory (periodontitis) and dystrophic (periodontal disease). Their causes have not been definitively clarified. For a number of reasons (vitamin and protein deficiency, violation of the intake of trace elements into the body, excessive consumption of carbohydrates and fats with food, smoking, hereditary predisposition, etc.) with periodontitis, the periodontal blood supply deteriorates, local immunity decreases and microorganisms contained in plaque penetrate into the soft and bone tissues of the jaw, foci of inflammation appear. Periodontal disease is much less common and is manifested by dystrophic changes in bone tissue. The causes of this disease are diabetes mellitus, chronic diseases of the digestive system, hereditary predisposition. These causes cause circulatory disorders in the tissues surrounding the tooth. The oxidative process triggers a certain "metabolic cascade", or, in other words, a set of interrelated pathological reactions that irreversibly damage the cell and lead to atrophy of jaw tissues and loss of teeth. One of the main reasons for the development of periodontal diseases is inadequate oral hygiene. Modern dentistry offers the treatment of periodontal diseases with antioxidants, by introducing them into toothpastes. Astaxanthin, which is part of pastes, significantly increases their antimicrobial properties, leads to the restoration of intracellular metabolism and stimulates regeneration processes [6].

Modern innovative biotechnologies of production make it possible to obtain stable astaxanthin that does not break down under the influence of environmental factors. Modern science continues to study the properties of the release of this strong natural antioxidant. In the near future, Natural Astaxanthin will be used more widely. You can only fantasize about where and how its anti-inflammatory properties will be useful.

Application of artificial intelligence: The article is written without the use of artificial intelligence technologies.

Conflicts of Interest: The authors declare no conflict of interest

References

1. Kuzmina IN, Lopatina AV, Tsomaeva LA. Effectiveness of oral hygiene products based on antioxidants for the prevention of dental diseases. *Caedra of prevention of dental diseases of the Moscow State Medical University Journal Dental Forum* 2009 3: 28-35.
2. Dong LY, Jin J, Lu G, Kang XL. Astaxanthin attenuates the apoptosis of retinal ganglion cells in db mice by inhibition of oxidative stress. *Marine Drugs* 2013; 11(5):960-974
3. Pechinsky SV, Koryagin AG, Oganessian ET, Stepanova EF. Synthesis of lutein and Astaxanthin esters and prediction of their activity. *Journal of General Chemistry* 2019: 721-725. (In Russian).
4. Shvydkaya MG, Zatevalov AM, Mitrokhin SD, Dzhandarova DT, Mironov AY. Combined effect of immunofan peptide and moxifloxacin in vitro on the toxigenic strain of clostridium difficile. *Clinical laboratory diagnostics*. 2020; 65(8): 516-520. (In Russian).
5. Danciuk NV. Green microalgae *Haemotococcus Pluvialis* as a renewed source of natural astaxanthin. Danciuk NV, Minyuk GS, Drobetskaya IV, Chubchikova IN, Chelebieva ES *Marine biological research: achievements and prospects*; 2016; 3: 370-373. (In Russian).
6. Karkishchenko NI. *Aslanyants Pyrimidines ZhK Pharmacology and Toxicology*. 1989; 52(6): 100-103. (In Russian).
7. Capelli B, Talbott S, Ding L. Astaxanthin sources: suitability for human health and nutrition *Functional Foods in Health and Disease*, 2019; 9(6): 430-445.
8. Hama S, Takahashi K, Inai Y, Shiota K, Sakamoto R, Yamada A, Tsuchiya H, Kanamura K, Yamashita E, Kogure K. Protective effects of topical application of a poorly soluble antioxidant astaxanthin liposomal formulation on ultraviolet-induced skin damage. *Journal of Pharmaceutical Sciences* 2012, 101: 2909-2916.

