



The Evolution of Sports Nutrition



Abstract

The evolving sports nutrition consumer base spans a diverse landscape of active and health-conscious individuals, interested in more than just whey protein. In order to remain competitive, sports nutrition brands must continue to aid in meeting fitness, muscle health and performance goals, while also seeking innovation to support active lifestyles, unique diets, healthy aging and more.

The demand for plant and algae-based ingredients, sugar alternatives, high-protein, low carb and grain-free options continues to grow as many sports-nutrition consumers are looking for solutions that meet the requirements of specific diets and lifestyles, including keto, gluten-free and vegan.

Sports Nutrition Category

Market research firm Euromonitor reported that from 2004 to 2018 the sports nutrition category grew **190%** globally, and is expected to exceed **\$23 billion by 2023**.¹ The category has experienced unprecedented long-term, continuous growth. This is largely due to the broadening of the consumer base, moving beyond serious athletes and body builders, to encompass a variety of active and health-conscious individuals, including more women and older consumers.

These relative newcomers to the category have wide-ranging health, nutrition and lifestyle goals, and continue to drive innovation in the category. Sports nutrition must continue to address the needs of serious athletes, while also innovating to meet new demands for products that support fitness, active lifestyles, special diets, healthy aging, weight loss, balance and energy.

Physiological Effects of Physical Activity



Physical exercise is energy dependent. When the muscles burn calories by oxidation, free radicals and other reactive oxygen species (ROS) are formed as a by-product.² Free radicals can damage the muscles fibers and reduce their ability to contract.³ While exercise has health promoting effects and the ability to enhance metabolism, it can also lead to increased production of free radicals and other reactive oxygen species. It has especially been shown that athletes have increased free radical levels in the blood, and lower levels of antioxidants.⁴

One of the reasons that heavy exercise without proper antioxidant support has negative effects is that free radical formation exceeds the capacity of antioxidant defense in the body. Another reason is that blood flow is closed off to some tissues, organs, and parts of the muscles during exercise. This causes a lack of oxygen (ischemia). When oxygen returns to these areas (reperfusion), various free radical compounds are formed.⁵ An excess of free radicals/ROS creates oxidative damage and together with the production of lactic acid will contribute to reduced capacity, fatigue and a depletion of muscle energy stores during strenuous or prolonged muscle work.^{6,7}

From a biological point of view, aging also involves the accumulation of oxidative damage in cells and tissues. Younger people are naturally better protected from free radicals and other reactive oxygen species through balanced activity of the mitochondria, efficient antioxidant and DNA repair systems, and active protein degradation machinery. Older consumers who want to be healthy, active and at their best, are looking for potent antioxidant support to help mitigate some of this accumulation and damage.

Of course, having a healthy cardiovascular system is also key in remaining active, healthy and strong. The oxidative stress caused by ROS is a key contributor to CVD.⁸ Research has shown that astaxanthin can reduce oxidative stress and inflammation, improve lipid profiles, and promote better blood flow.^{9,10,11,12}

Growing Demand for Algae and Plant-Based Ingredients

According to a new research report by Global Market Insights, Inc., global plant-based ingredients market demand is expected to hit USD 13 trillion by 2025.¹³ Numerous factors help to foster this growth, including increasing demand for nutritional content, more inclination towards non-meat diets, along with concerns about agricultural sustainability, special diets and food sensitivities.

According to Euromonitor, sports protein powders make up 70% of the sports nutrition category.¹⁴ While sports nutrition consumers continue to recognize the broad benefits of protein, many are looking to plant and algae based ingredients, including protein, to achieve health and fitness goals while also supporting specific nutritional lifestyle choices.



Algae is a versatile ingredient with numerous applications in sports nutrition. It is also more sustainable than conventional crops because it requires significantly less energy/input to be kept alive, thereby limiting environmental impact. It is not only a renewable source of proteins but also a source for high-value compounds for human nutrition such as β -carotene, astaxanthin, EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid). These compounds have been studied extensively, and have been used in nutraceutical products for a long time due to the efficacy of their health promoting benefits.

Each species of algae has a different composition of lipids and it is common to cultivate certain species for certain nutrients. For example, astaxanthin is a carotenoid, and potent antioxidant, produced by the *Haematococcus pluvialis* species.

Considering Natural Astaxanthin for Sports Nutrition

Natural astaxanthin neutralizes ROS/free radicals and thus reduces fatigue and muscular ailments that are caused by these compounds. As a bioavailable antioxidant, astaxanthin is transported throughout the body to organs and muscle tissues, combating excessive free radical production. Natural astaxanthin improves muscle endurance and strength by helping to reduce oxidative stress.

Comparison studies have shown that natural astaxanthin is 6,000 times more powerful than vitamin C, 100 times more powerful than vitamin E, and five times more powerful than β -carotene in trapping energy from singlet oxygen, one of the most common ROS in biological systems.¹⁵ Astaxanthin has the ability to trap several types of ROS/free radicals. In addition, the way astaxanthin neutralizes harmful ROS/free radicals is gentle to the body's cells. Other antioxidants can be harmful since they may turn into highly reactive molecules.¹⁶

Natural astaxanthin is considered a "superior antioxidant" because of its molecular structure and localization within the cell membrane. While structurally similar to the carotenoid β -carotene, astaxanthin has 13 conjugated double bonds, whereas β -carotene has 11. The antioxidant activity of carotenoids depends on the length of the electron rich, conjugated, double bond system. An extension of the conjugated double bond system increases the potency of astaxanthin compared to β -carotene and vitamin E.¹⁷ Astaxanthin spans the membrane, with its polar end groups extending toward the head group regions of the membrane bilayer. Astaxanthin position does not modify the structure of constituent membrane lipids. As a result, astaxanthin acts as a chain-breaking antioxidant by stopping free radical chain reactions and scavenging lipid peroxy radicals. Furthermore, since astaxanthin spans the cell membrane bilayer, its terminal rings can effectively scavenge ROS on the membrane surface, while its polyene chain is responsible for trapping ROS in the interior of the membrane.¹⁸

Astaxanthin Research and Proven Sports Nutrition Benefits

Clinical studies have found that natural astaxanthin neutralizes exercise-induced free radicals, protects the activity of antioxidant enzymes, reduces muscle fatigue and inhibits the formation of lactic acid.^{19, 20, 21, 22, 23}

- **Astaxanthin can improve cycling time trial performance.** A placebo controlled study including 21 competitive cyclists demonstrated that 4 mg/day astaxanthin improved cycling time trial performance.²⁰
- **Astaxanthin can prevent exercise induced free radical production in soccer players.** The purpose of the study was to examine the effect of astaxanthin supplementation on muscle enzymes as indirect markers of muscle damage, oxidative stress markers and antioxidant response in elite young soccer players. 32 male elite soccer players were randomly assigned in a double-blind fashion to an astaxanthin and a placebo group. The results of the study suggested that soccer training was associated with excessive production of free radicals and oxidative stress. Supplementation with astaxanthin could prevent exercise induced free radical production and depletion of non-enzymatic antioxidant defense in young soccer players.²¹
- **Astaxanthin may promote lipid metabolism, improve endurance and decrease body fat accumulation.** This animal study investigated the effect of astaxanthin on muscle lipid metabolism in exercise. The results suggested that astaxanthin promoted lipid metabolism (rather than glucose utilization) during exercise via CPT I activation, leading to improvements in endurance. In an additional experiment, the researchers found that astaxanthin accelerated the decrease of body fat accumulation with exercise training.²²
- **Astaxanthin improves immune responses and reduce inflammation induced by rigorous physical training in soccer players.** A placebo controlled study including 40 trained male soccer players demonstrated that 4 mg/day of astaxanthin improved mucosal immunity and reduced inflammation under conditions of increased oxidative stress due to heavy exercise.²³
- **Astaxanthin supports cardiovascular health by improving blood lipid profiles in healthy seniors.** It has a protective effect against cholesterol and triglyceride oxidation.^{24, 25}





Conclusion

Exercise can lead to an excess of free radicals/ ROS, ultimately causing oxidative damage. Together with the production of lactic acid, oxidative stress can contribute to reduced capacity, fatigue and a depletion of muscle energy stores during strenuous or prolonged muscle work. Natural astaxanthin supports cardiovascular health, and improves muscle endurance and strength by helping to reduce oxidative stress. Astalif™ astaxanthin is a pure, potent, high-grade natural astaxanthin extracted from the microalgae *Haematococcus pluvialis* with proven benefits that make it ideal for specific applications in sports nutrition.

FOR MORE INFORMATION

WEBSITE: Algalif.com

EMAIL: sales@algalif.com

PHONE: +35 4 5711066

About Algalif

Algalif® is a leading supplier of high-grade natural astaxanthin from microalgae, produced at its state-of-the-art facility in Iceland. Manufactured to rigorous quality standards and supported by science, Astalif™ astaxanthin is built on a solid foundation of quality, purity and sustainability. Produced in a cGMP-compliant facility in Iceland that is powered by 100% renewable geothermal energy, Algalif utilizes proprietary growing and harvesting processes including a customized LED-illuminated photobioreactor system with optimized light utilization. Astalif™ Astaxanthin by Algalif is a powerful natural antioxidant with multiple health benefits and a solid scientific foundation.

These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease.

REFERENCES:

1. Oster, M., *Euromonitor International, Sports nutrition is expanding across consumers, categories, and positionings. Nutritional Outlook, (March 2019).*
2. Turrens, J.F. and A. Boveris, *Generation of superoxide anion by the NADH dehydrogenase of bovine heart mitochondria. The Biochemical journal, 1980. 191, 421-7.*
3. Fulle, S., T. Pietrangelo, R. Bellomo, et al., *The relationship between oxidative stress and the functional capacity of skeletal muscle. Basic Appl Myol, 2004. 14, 33-36.*
4. Balakrishnan, S. and C. Anuradha, *Exercise, depletion of antioxidants and antioxidant manipulation. Cell biochemistry and function, 1998. 16, 269-75.*
5. Zweier, J.L., J.T. Flaherty and M.L. Weisfeldt, *Direct measurement of free radical generation following reperfusion of ischemic myocardium. Proc Natl Acad Sci U S A, 1987. 84, 1404-7.*
6. Kinugawa, S., Z. Wang, P.M. Kaminski, et al., *Limited exercise capacity in heterozygous manganese superoxide dismutase gene-knockout mice: roles of superoxide anion and nitric oxide. Circulation, 2005. 111, 1480-6.*
7. Neubauer, O., S. Reichhold, A. Nersesyan, et al., *Exercise-induced DNA damage: is there a relationship with inflammatory responses? Exercise immunology review, 2008. 14, 51-72.*
8. Visioli F et al. "Astaxanthin in cardiovascular health and disease: mechanisms of action, therapeutic merits, and knowledge gaps." *Food and Function, vol. 8, no. 1 (January 25, 2017): 39-63.*
9. Kim YK et al. "The effects of astaxanthin supplements on lipid peroxidation and antioxidant status in postmenopausal women." *Nutritional Sciences, vol. 7, no. 1 (January 1, 2004): 41-46.*
10. Choi HD et al. "Positive effects of astaxanthin on lipid profiles and oxidative stress in overweight subjects." *Plant Foods for Human Nutrition, vol. 66, no. 4 (November 2011): 363-369.*
11. Iwabayashi M et al. (2009). "Efficacy and safety of eight-week treatment with astaxanthin in individuals screened for increased oxidative stress burden." *Anti-Aging Medicine, vol. 6, no. 4 (January 2009): 15-21.*
12. Chew W et al. "Astaxanthin decreases inflammatory biomarkers associated with cardiovascular disease in human umbilical vein endothelial cells." *American Journal of Advanced Food Science and Technology, vol. 1 (January 2013): 1-17.*
13. Global Market Insights, Inc., *Plant-based ingredients market will cross \$13tn by 2025. Global Market Insights (February 2019)*
14. Schmidt, C. *Euromonitor International, Protein powders: The heavyweight in the \$16bn sports nutrition market. Food Navigator, (December 2018).*
15. Nishida, Y., E. Yamashita and W. Miki, *Quenching Activities of Common Hydrophilic and Lipophilic Antioxidants against Singlet Oxygen Using Chemiluminescence Detection System. Carotenoid Science, 2007. 11, 16-20.*
16. Beutner, S., B. Bloedorn, S. Frixel, et al., *Quantitative assessment of antioxidant properties of natural colorants and phytochemicals: carotenoids, flavonoids, phenols and indigoids. The role of β-carotene in antioxidant functions. Journal of the Science of Food and Agriculture, 2001. 81, 559-568.*
17. Miki, V., *Biological functions and activities of animal carotenoids. Pure & App. Chem., 1991. 63, 141-143.*
18. Goto, S., K. Kogure, K. Abe, et al., *Efficient radical trapping at the surface and inside the phospholipid membrane is responsible for highly potent antiperoxidative activity of the carotenoid astaxanthin. Biochim Biophys Acta, 2001. 1512, 251-8.*
19. Sawaki, K., H. Yoshigi, K. Aoki, et al., *Sports Performance Benefits from Taking Natural Astaxanthin: Characterized by Visual Acuity and Muscular Fatigue Improvement in Humans Journal of Traditional Medicines, 2002. 19, 1-13.*
20. Earnest, C.P., M. Lupo, K.M. White, et al., *Effect of astaxanthin on cycling time trial performance. Int J Sports Med, 2011. 32, 882-8.*
21. Djordjevic, B., I. Baralic, J. Kotur-Stevuljevic, et al., *Effect of astaxanthin supplementation on muscle damage and oxidative stress markers in elite young soccer players. J Sports Med Phys Fitness, 2012. 52, 382-92.*
22. Aoi, W. et al. *Biochem Biophys Res Commun., 2008 Feb 22; 366(4):892-7. Epub 2007 Dec 17.*
23. Baralic, I., M. Andjelkovic, B. Djordjevic, et al., *Effect of Astaxanthin Supplementation on Salivary IgA, Oxidative Stress, and Inflammation in Young Soccer Players. Evid Based Complement Alternat Med, 2015. 2015, 783761.*
24. Kim YK, Chyun JH. *Nutritional Sciences, 2004. 7:41-46.*
25. Yoshida et al. *Atherosclerosis, 2010. 209(2): 520-523.*

DISCLAIMER: This white paper has been produced by Algalif ehf., and contains scientific and technical information for business-to-business informational and educational use only. It is not intended for use to promote or sell any product. Please consult with your counsel as to whether claims are properly substantiated and appropriate structure/function claims.