



ASTAXANTHIN

IN SPORTS NUTRITION

It wasn't so long ago that I hadn't heard of the astaxanthin. I, like so many, responded with Asta-what? Hardly being able to pronounce the entire word, let alone remember it. A huge challenge to popularize any ingredient, I'd say.

This was until I starting reading all the science available on it. Well, nearly all, I probably missed a few. I don't mean the "science" proclaiming it is 300x stronger antioxidant than vitamin C in some model system or chemical assay. That has no value. Real effects, in real people, that is what we are looking for, isn't it?

In this post I'd like to address impact of Astaxanthin on performance in sports.

EXERCISE

To understand the impact of astaxanthin on improved sports performance we first need to understand how exercise impacts us. There are plenty of good reviews on this topic but let's stick with the most relevant area for astaxanthin: the role of mitochondria.

Mitochondria are vital intracellular structures present in each of our cells and are our engines, i.e. they create ATP, also known as energy. They do so by a complex biochemical process that involves beta oxidation of fatty acid & the electron transport chain (ETC). During this process mitochondria tend to "leak" a small percentage of electrons from the ETC, but who about cares electrons, right?

Well, these electrons actually create local free radicals and reactive oxygen species (ROS). The healthy body is fully capable to deal with these free radicals and employs a variety of strategies to neutralize them including glutathione, superoxide dismutase and catalase. That is the simplified human biochemistry going on in each of our cells just reading this paper.

Let's now imagine your Sunday morning run, your Tuesday evening gym visit or the sunny bike ride you just took. Your muscles require to perform and so the energy need is highly increased. This also means the mitochondria are working "overtime" creating lots more free radicals than while in rest. What is lot's more you wonder?





Think about what I said before, every cell has mitochondria. I just did not tell you yet how many. In human skin there are roughly 300-500 mitochondria per cell. In muscle cells 3500. That is right 3500! Imagine the amount of muscle cells we have and now they are all working full speed, creating free radicals 10 or 100-fold to whilst in rest. The body will try and cope with these, but often does not manage. The consequence of the excess ROS can be measured in our blood in the form of protein & lipid oxidation.

Regular, and well built-up, training actually trains our complete metabolic systems and leading to

- Elevated steady state levels of glutathione, superoxide dismutase and catalase
- Increased responsiveness to free radical formation during (intense) exercise

PART OF THE FOOD CHAIN

Most of you that had already heard of the antioxidant capacity of astaxanthin, will, by this time, have a feeling that I will mention astaxanthin will reduce free radicals. Yes I will, but it does so much more as it turns out.

It is helpful to understand some of the basics of the molecular structure and the role of astaxanthin has had in biology & evolution even. Astaxanthin, part of the carotenoid family is a keto-carotenoid. This means it has two more hydrophilic groups on each side with a highly saturated and lipophilic carbon chain in the middle (see figure 1). This structure, other than most carotenoids, allows for quick incorporation into membranes, which, we will see, is quite important.

This keto carotenoid has been present in nature for millions of years, produced by bacteria, fungi and plants (like algae) to protect these organisms against ROS. During the evolutionary period in which fish and mammals came into the world many of these microorganisms were actually part of the food chain for (predecessor of) krill, shrimp, salmon and flamingos. Humans, currently, on top of the food chain have always had settlements near the sea and have thus been exposed to Astaxanthin in their diets. Just like omega 3 fatty acids by the way.

When you think of Astaxanthin in biology and evolution, it, to me, only makes sense that it has an important role in the human body. And of course, we are talking about NATURAL astaxanthin, and not the synthetic stuff thrown in the diets of farmed salmon these days as that does not get into the muscles (30x less than natural) and is nearly functionless. If you'd like to learn more about the bioavailability of astaxanthin get in touch with us @ info@lusingredients.com

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ASTAXANTHIN - A FUNCTIONAL ANTIOXIDANT

As it turns out, the amount of astaxanthin found in muscle tissue shows a remarkable connection with the ability to perform. In animal studies in which mice were trained to run on a treadmill, the group fed natural esterified astaxanthin was able to run 80 minutes until exhaustion, double that of control or free forms of Astaxanthin, as shown in Figure 1.

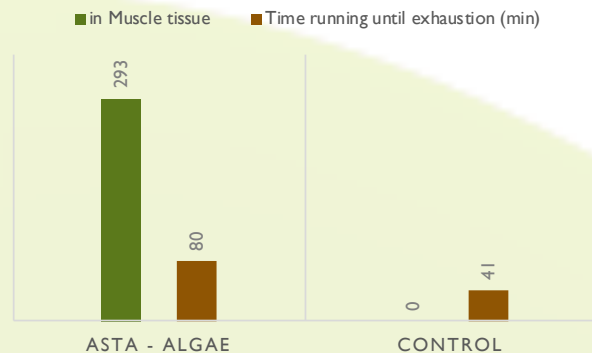


Figure 1: Astaxanthin in muscle tissue doubled the time until exhaustion in mice

Although animal studies are helpful I believe that studies with humans are the only way to go. Runners, taking 12mg of astaxanthin per day for 8 weeks during their training, showed findings in line with those in the Mice. After 8 weeks, the control group running on aerobic threshold (AeT) had a heart rate of 153, similar to at the start. The group taking Astaxanthin, however, significantly lowered their heart rate (-15 hearts beats). Similar improved were shown on anaerobic threshold (AT), as shown in figure 2.

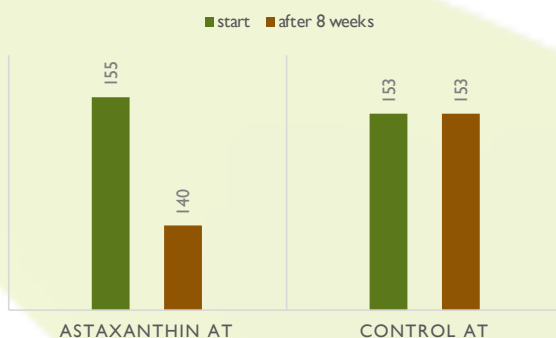


Figure 2 Runners on astaxanthin lowered heart rates at aerobic threshold

The runners from the above study were amateurs, so how will high-level athletes, already on top of their game respond to these interventions? In a 2015 study, semi-professional cyclist were asked to perform a 20km time trial in the morning without any breakfast, or doping :-). Times were recorded and then they were divided into a placebo group and 4mg / day Astaxanthin group. Just four weeks

after the first time trial they went on to perform the second with the same starting conditions. Average time for the control group improved with 19s and the power with 1,6W, both insignificant. The astaxanthin group, however, improved a staggering 121 seconds and 20W in power, highly significant changes.

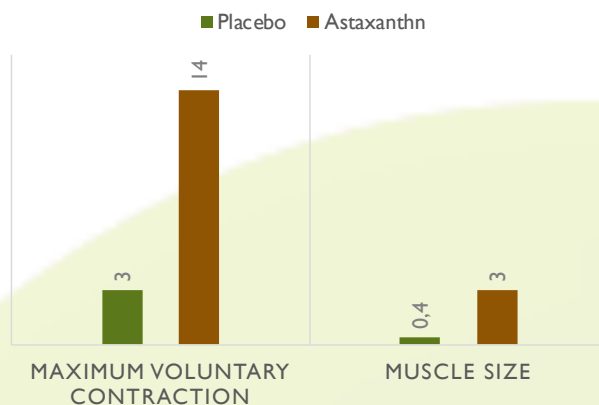


Figure 3 Performance difference after 4 months of training

El These remarkable effects are also seen in different age groups. Elderly (65+) are in danger of losing muscle mass, also known as sarcopenia. A lifestyle with exercise & protein rich meals have shown to prevent muscle mass loss and even be able to rebuild. When performing a 4 month guided training regime Astaxanthin was shown to impact power & muscle mass GAINS in a group of 65-82 that performed weight training during four months. Can all grandpa's please go to the gym as of today?

Big question is, why would an antioxidant, like astaxanthin, improve power, speed and endurance levels?

ASTAXANTHIN - DUAL FUNCTION

As was mentioned in the beginning of this blog exercise creates reactive oxygen species (ROS). And, as could be expected from a strong antioxidant like astaxanthin, it decreases oxidation parameters, as can be shown in figure 4. Young dogs were repeatably trained over the course of 8 and supplemented with Astaxanthin. The

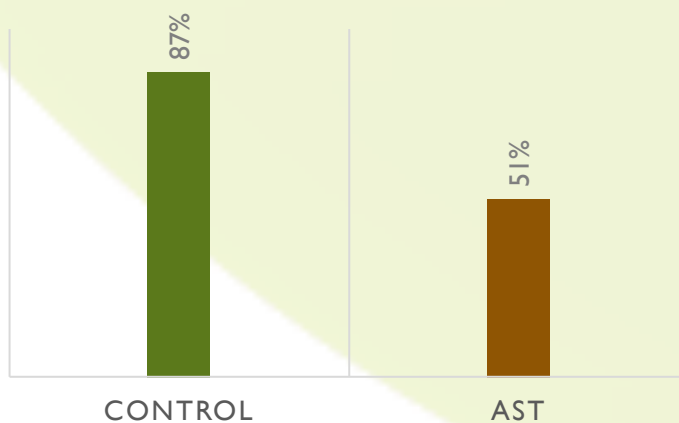


Figure 4 Protein oxidation after exercise in young dogs after 8 weeks of asta vs placebo

protein oxidation level after the first training was set as 100%. Now, as can be expected from a well built up training the body starts to cope better with ROS and after 8 weeks protein oxidation is at 87% of the first training, but insignificant. Astaxanthin, however, did significantly reduce protein oxidation which might be a hint upon faster ROS recovery after training.

This is important for athletes: Faster recovery helps increase training frequency and this will lead to a more effective increase in fitness & muscle building. More interesting than the antioxidant effect is something that blew my mind.....



In the same study with the dogs the Astaxanthin group was shown to have a significant increase of nearly 10% ATP. Yes ATP! Energy!! This is critically important and confirmed also by other studies in rats and humans. NOW the impact shown in the randomized clinical trials with humans make more sense. With 10% more energy AND more training capacity (quicker recovery) astaxanthin gives a basis for a real UPGRADE in the metabolic process that is the foundation of our energy management. That should be interesting to all of us and of particular interest in sports.

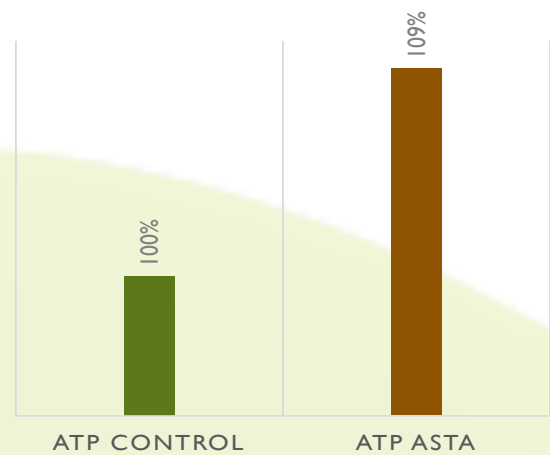


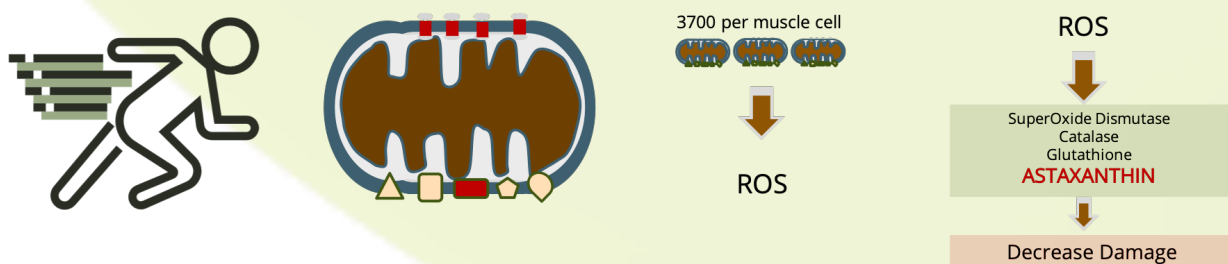
Figure 5 Astaxanthin showed a significant increase in ATP production in dogs fed astaxanthin

So what could be the mechanism behind the ATP increase?

POTENTIAL MECHANISMS EXPLAINED

Due to the molecular nature of astaxanthin, it can easily integrate into cellular membranes, also that of mitochondria. Studies have shown that in mitochondria, astaxanthin has been shown to positively influence the electron transport chain, responsible for the ATP production specifically, complex III. It seems to function as an accelerator, a catalyst almost of the electron transport chain.

Next to this, the presence of the antioxidant directly at the site of free radical / electron production gives immediate protection. This thinking is summarized in the figure below.



1. Exercise increases the need for energy product

2. Astaxanthin is uploaded in Mitochondria cell membrane Improves electron transfer chain Complex 3 and increases ATP output

3. Mitochondria Leak some electrons which lead to reaction oxygen species (ROS) more exercise = more ROS

4. Astaxanthin helps catching ROS both at the source (mitochondria) as well as other parts of the body Effectively decreasing (joint) inflammation

Exercise creates the need for more energy output, driving mitochondrial ATP production. With Astaxanthin uploaded in the mitochondrial membrane (takes 4-6 weeks of supplementation with 4-8mg), the electron transport chain produces 10% more energy - in all 3700 mitochondria - in every muscle cell. With the increased

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energy output, mitochondria will normally also have a higher ROS production leading to more stress to the body and longer recovery periods. With Astaxanthin at the site of ROS production it will work in coherency with the bodies own free radical defense mechanism and recover quicker.

From a biological perspective this absolutely makes sense, at least to me. It mimics perfectly how leaves produce their energy and how they protect their chlorophyll. In leaves chlorophyll is accompanied with (keto) carotenoids as violaxanthin to optimize photosynthesis. Could it just be that Astaxanthin & Mitochondria are the mammal equivalent to the system as seen in leaves? I believe so and it will not be a surprise to most readers that I personally and many around me take astaxanthin on a daily basis.

This product has also been shown to enhance eye health, decrease (joint) inflammation and to be beneficial to the skin.

I personally hope you enjoyed reading this report, know that any feedback is welcome.

Do you want to find out more about Astaxanthin? its role in sports nutrition or other areas? [Please contact us](#)