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Nutrient of the Month: Astaxanthin

Is it a phytonutrient or a zoo-nutrient? That depends on the species of crustacean, algae, or microorganism from which it is derived. Astaxanthin has come a long way in the last 20 years; previously unknown to any but fish farmers and enthusiasts who employ it to impart brilliant color to fish and shellfish, it is now celebrated as a valuable nutrient with hormetic properties. This xanthophyll carotenoid is most typically sourced from the green microalga *Haematococcus pluvialis*, but is found in certain other microalgae, shrimp, lobster, crab, salmon, trout, bacteria, fungi, and yeast, as well as in the brilliant pink plumage of flamingoes that consume marine species. *H. pluvialis* hormetically bioconcentrates astaxanthin in response to adverse environmental conditions like elevated temperature or salinity and low nitrogen availability. Astaxanthin hails from the same chemical family as lutein and zeaxanthin, and though it lacks the pro-vitamin A activity they possess, numerous analyses find that it has greater antioxidant potential than either.

The molecular character of natural astaxanthin is remarkable; its physical and chemical configuration seems practically custom-designed to be incorporated neatly across the entire span of cell membranes, where it contributes to cellular integrity and normal signaling. It is fat-soluble and thus more bioavailable taken with dietary fat. Astaxanthin occurs in multiple forms (isomers and esters; it has also been synthesized) found in distinctive proportions in different food sources, and its unusual structure features ionone rings with active groups that lend it notably heightened antioxidative potential. It is possible that astaxanthin’s hormetic benefits were first ‘discovered’ by single-celled organisms weaving some into their sole membrane (somewhat analogous to our skin) and reaping survival benefit, and this advantage was then passed on to consumers of these small beings. Bacteria, fungi, and yeast consist mainly of a single cell membrane encircling everything these microorganisms need in order to survive, and may employ
astaxanthin as an efficacious filter of ultraviolet light. In fact, exposing *H. pluvialis* to intense blue light (like that from electronic devices, linked to oxidative stress in sensitive eye structures) is employed commercially to increase its biosynthesis of astaxanthin.

Astaxanthin is one of 11 non-essential "longevity vitamins" recently highlighted by noted gerontologist Dr. Bruce Ames for limiting biological aging processes implicated in common chronic illnesses, and supplementation has shown an impressive combination of effects on immune balance and DNA integrity. In healthy young women receiving either 2 or 8 mg natural astaxanthin daily, it reduced levels of 8-hydroxydeoxyguanosine, a classic biomarker for DNA damage. The lower dosage level reduced levels of C-reactive protein while the higher dosage induced expansion in T and B immune cell populations and increased natural killer cell activity, leading to greater production of interferon and interleukin cytokines—a compelling display of anti-inflammatory and pro-immune effects at different daily intakes, with valuable genomic stabilization at both. Astaxanthin’s unusual redox capacity may explain effects demonstrated in smokers and in overweight or obese individuals, who typically exhibit greater oxidative stress. Supplementation with natural astaxanthin tended to normalize measures of oxidative stress, total antioxidant capacity, and antioxidant enzyme (superoxide dismutase, SOD) activity in these populations in as little as 3 weeks.

Mitochondria present a particularly curious example of membranes; in this case, an entire set of highly specialized ones that create separate redox environments for dealing with different echelons of high-energy molecules. It is thought that mitochondria were once single-celled organisms that merged with our cellular progenitor millions of years ago, gifting it with the metabolic power and speed to evolve into humans. While we are indebted to mitochondria for rapid energy creation, they are, by that same virtue, a major origin of pro-oxidant substances implicated in biological aging processes. Due to the central importance of mitochondria in powering cellular activities, their dysfunction may contribute to many serious age-related diseases, including cardiovascular, neurodegenerative, inflammatory, and cardiometabolic conditions that are, unfortunately, common. Astaxanthin confers greater stress resistance upon intricate mitochondrial membrane systems to help maintain their extreme redox capacity and respiratory efficiency.

Astaxanthin’s star role in the fatty environment of cell membranes partly explains why it displays a seemingly disparate range of effects:

- The brain’s high energy demands make it susceptible to redox stress, but astaxanthin passes through the blood-brain barrier (yet another membrane!) in animals, and soon after brain injury, has been seen to recruit the Nrf2/ARE system that regulates antioxidant and detoxification functions.
- In type 2 diabetics, astaxanthin favorably influenced several measures of fat and glucose metabolism, reduced visceral adiposity, and improved systolic blood pressure after only 8 weeks.
- Astaxanthin has long been studied for protective effects during hepatic processing of fats and toxins, and a recent animal study found that it increased gut microbiome levels of desirable Akkermansia species.
- Most of the body’s blood is found in veins, and in older men, astaxanthin significantly improved venous blood flow through venous capillaries, the diameter of which compares with that of red blood cells.
- In a 2018 Japanese study of adults, astaxanthin augmented skin protection against ultraviolet light exposure and dehydration, and improved subjective measures of skin smoothness in study subjects.

It is interesting to note that the frontal lobe of the human brain appears to selectively concentrate xanthophyll carotenoids, though the best-known examples of this are zeaxanthin and lutein, as yet.
We get it. You have a lot of professional meetings to choose from. Your time is valuable and you must allocate it wisely. How can you be sure that the Thought Leaders Consortium is the right meeting for you? In this 1-minute video message, PLMI President Dr. Jeffrey Bland aims to both intrigue and inspire you. If he can do that in a single minute, consider what two full days of educational immersion will feel like. We hope you will join the PLMI team, our extraordinary 2019 faculty, and 300+ colleagues in Seattle this October. Register today to secure your seat!

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5 Things We Want You to Know>>
Speaker Gallery>>
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A Treasure Chest of a Toolbox

HealthMeasures is a collection of questionnaires and other tools for assessing and tracking health-related function over time, and it includes tests for general well-being, neurological conditions, and sickle cell disease. While mainly directed at professional users, many of these tools are freely available to the public, though some (like cognition testing) require special permissions or approval or have user agreements. Most can be completed in around 5 minutes, but Cognition assessments may take 30 minutes or longer. Publicly available HealthMeasures include:

- **PROMIS** (Patient-Reported Outcomes Measurement Information System) is a freely-available set of measures that may be used to monitor physical, mental, and social functioning in healthy adults or children, or in persons with chronic conditions. Starting with more generalized symptoms like fatigue, anxiety, and pain, PROMIS provides immediate results that are compared with those of the general population and in the target age/gender group. Parents and caregivers can also go through these questionnaires for those under their care, and no training or permissions are needed. PROMIS has been employed by the Institute for Functional Medicine in its clinical research.
- **NeuroQoL** tracks quality-of-life measures in adults or children living with brain injury, multiple sclerosis, and many other chronic neurological conditions. They may be self-administered or parents and caregivers can perform assessments for those in their care. These assessments are freely available to the public in English.
and Spanish, and no special training is needed. NeuroQoL measures have been employed and validated in dozens of clinical studies.

- The NIH Toolbox is mainly intended for administration by health professionals, and training is needed for some tests. Included are over 100 validated neuro-behavioral assessments of cognition, emotion, motor, and sensory functions in those aged 3-85. Cognition evaluations include: Executive Function, Attention, Episodic Memory, Language, Processing Speed, Working Memory, and include Fluid and Crystallized Cognition scores. Emotion assessments include: Social, Stress, Anger, Anxiety, and many others. Sensory measures include: Hearing, Vision, Vestibular, Olfaction, Pain, and Taste. Motor evaluations include: Dexterity, Strength, Balance, Endurance, and Locomotion. Developed for research, NIH Toolbox assessments offer relatively simple, reliable, and inexpensive ways to evaluate specific changes in individuals’ function over time; they are also available in Spanish and, through the link on this page, as an app.

- ASCQ-Me provides a method of personal health tracking for adults (but not for children) with sickle cell disease, to gauge the severity of physical, mental, and social impacts of this condition. It is available in Spanish.

- Developed through the National Institutes of Health and Northwestern University, HealthMeasures is a valuable resource for empowering individuals to track their own long-term health and function, and more tools will probably become available in the future. This comprehensive pull-down menu of available HealthMeasures may be useful once users have gained basic familiarity with offerings.