

Astaxanthin- a possible ocular antioxidant?

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Nutraceuticals and supplements

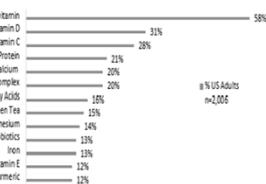
- To address dietary deficiencies (eg calcium, iron, magnesium, zinc)
- For dietary top-up/insurance policy
- Improve cognition (reduce depression)
- Slow down ageing
- Health-conscious (& exercise)
- Adjunctive to improve bioavailability
- Pet food (eg Radical Dog Biscuits!!)

- USA usage:**
76% in 2018 (vs 64% in 2008)

Very profitable multi-billion dollar industry; unregulated & under-researched in many areas



Ten Most Popular Supplements Among U.S. Adults



Different groups

- Vitamins & minerals
- Herbs/spices/plant & berry extracts, amino acids, enzymes

FDA: "common ones"
 *should not make disease claims
 (eg "lowers cholesterol")

- Warns about overdosing, combining & substituting for Rx medicines
- "oxidative tissue damage"
 = ageing & disease

"as we age, prooxidants overwhelm the eye's antioxidant defences resulting in oxidative stress & damage to tissues associated with the development of ocular pathologies such as corneal opacities, cataracts & glaucoma"

(Umaphathy A, Donaldson P & Lim J, 2013)



- Calcium
- Echinacea
- Fish Oil
- Ginseng
- Glucosamine and/or Chondroitin Sulphate
- Garlic
- Vitamin D
- St. John's Wort
- Saw Palmetto
- Ginkgo
- Green Tea

General eye health nutrition

The diagram illustrates the following nutrients and their sources:

- GENERAL EYE HEALTH NUTRITION**
- Omega-3**: High concentrations are found in oily fish (salmon, mackerel, trout and sardines).
- Zinc**: Found in red meat, poultry, fish, nuts and legumes.
- Vitamin C**: Citrus fruits, bell peppers, kiwi fruit, tomatoes and capsicums are all good sources.
- Lutein & Zeaxanthin**: These nutrients are found in dark green leafy vegetables that include kale, collard greens, and silver beet, also pumpkin, peas, corn and beans.
- SELENIUM**: Foods rich in this mineral include Brazil nuts, mushrooms and brown rice.
- Vitamin E**: Foods rich in this vitamin include sunflower, safflower, and hazelnut oil along with wheat germ oil.
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Did Popeye escape AMD?

Astaxanthin (ATX)

• Common marine xanthophyll carotenoid (main source marine algae *H. pluvialis*)

• Closely related to human retinal pigments lutein & zeaxanthin

• Strongest antioxidant (AO) activity of all the carotenoids

• Lipid soluble- so good absorption across cell membranes

• Can cross blood-retina and blood-brain barrier (Tso, 1996)

Astaxanthin: C₄₀H₅₂O₄; 596.84 g/mol; red powder; soluble in water and fat

Zeaxanthin: C₄₀H₅₆O₂; 568.88 g/mol; red-orange; insoluble in water

Lutein: C₄₀H₅₆O₂; 568.871 g/mol; red-orange crystalline solid; insoluble in water; soluble in fat

Haematococcus pluvialis

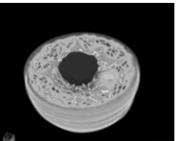
- Freshwater green marine algae, can be farmed
- Encysts & produces ATX as a protector against stress conditions such as UV light, high salinity, low nutrient availability & high temperature
- High bioavailability from dual lipophilic and hydrophilic properties across CMs
- AO activity of ATX:

10 x zeaxanthin, lutein & B-carotene

500 x Vit A

65 x Vit C

Also has immunomodulation & anti-inflammatory properties- reduces C-Rp, boosts NK, T & B- cells, cytokines

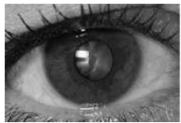


Existing products



ATX and the eye (con'd)

- Crystalline lens:** improved accommodation but no cataract data (high dietary intake of carotenoids – lutein & zeaxanthin- is assoc. with reduced risk of nuclear cataracts)



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Existing researched benefits (humans)

- Exercise recovery
- Reduced joint inflammation
- Improved mitochondrial function
- Skin protection (UV)
- Anti-diabetic
- Immunomodulation
- Neuro-protection
- Cardiovascular disease
- Anti-cancer

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ATX and the eye- existing study data and potential investigations?

- Dry eye disease:** krill oil-phospholipid containing AXT > fish oil- less inflammatory markers
- Sjogrens?:** helps salivary gland (but no studies on lacrimal gland)
- Aqueous humour:** has increased superoxide scavenging activity so potential less TM degeneration

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ATX and the eye (con'd)

- Retina: AMD, DR and glaucoma ?**
- RPE /photoreceptor damage/ageing**

MURINE STUDIES: induced elevated IOPs, diabetic retinopathy, photostress

- % of population- people aged 90 or over:
1980- 2.8%
2020- 4.7%
2050- 10% est.

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So do we need another carotenoid?

- The AREDS2 formula works best if poorer diet; risk of advanced AMD was lowered by about 20%
- Could the AREDS2 formula be due for a review?
- Can non-invasively measure the macular carotenoid pigment optical density (MPOD)



Other interesting compounds

- Saffron, turmeric & chamomile
- Blueberry & goji berry
- All potent antioxidants and anti-inflammatories; similar list of alleged benefits to ATX
- Plenty of PubMed published studies on retinal protection



Crystal ball gazing...

- I think that over the next 5-10 years there is going to be a surge of research attempting to legitimise some of these promising natural products
- We have to persuade some of these producers to fund proper research - even 1 Masters/PhD is great "value for money"...

