Phytonutrients, Part II: Carotenoids and Eye Health

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Last time we looked at what phytonutrients are. Now let's start digging into some specific phytonutrients and how they improve our health.

Carotenoids

Carotenoids are the yellow, orange, and red colorings made by plants. There are more then 750 naturally occurring carotenoids. The most common carotenoids in the North American diet are alpha carotene, beta carotene, lycopene, lutein, beta cryptoxanthin, and zeaxanthin. Most of these are found in fruits and vegetables. Alpha carotene, beta carotene, and beta cryptoxanthin are considered "provitamin A" carotenoids as our bodies can convert them to vitamin A.

Eating fruits and vegetables rich in carotenoids is associated with a reduced risk of heart disease and some cancers.[1] Carotenoids are absorbed in a much higher concentration when you eat them with fat in the meal. Three to 5 grams of fat is enough to optimize absorption. Chopping and cooking carotenoids also increases their bioavailability.[2]

Lutein and Zeaxanthin

Lutein and zeaxanthin (and meso-zeaxanthin which is made by the body from lutein) are found in high concentrations in the macula of the eye and are known as the macular pigments. They are the only carotenoids that cross the blood-retina barrier and are therefore the only carotenoids found in the eye. Lutein and zeaxanthin protect the eye by filtering out blue light and acting as antioxidants. They may improve visual acuity and slow the progression of age-related macular degeneration (AMD). AMD is the leading cause of blindness in older adults in the developed world. Consumption of about 6 mg/day of lutein and zeaxanthin from fruits and vegetables may decrease the risk of AMD.[3] A 2019 study found that high adherence to a Mediterranean diet rich in fruits, vegetables, legumes, and fish was associated with a 41% reduced risk of advanced AMD.[4]

A typical US diet only has 1-3 mg/day of lutein and zeaxanthin.[5] Ten to 20 mg of lutein/zeaxanthin per day may be ideal for reducing the risk of AMD.[6] In the AREDS2 study, 10 mg of lutein and 2 mg of zeaxanthin lowered the progression to advanced AMD in those with the lowest dietary intakes of lutein and zeaxanthin.[7]

Cataracts are another major cause of blindness among people over the age of 40. Observational studies find those eating a diet high in lutein and zeaxanthin containing foods are less likely to require cataract extraction or develop cataracts.[8] A 2019 meta-analysis found the risk of age-related cataract decreased by 26% for each additional 10 mg of lutein or zeaxanthin eaten per day.[9]

Until recently, testing technologies did not allow for lutein and zeaxanthin to be measured separately. Because of this most tables report their content as a single figure.[10] By far, the greatest sources of lutein and zeaxanthin, by weight or calorie, are dark green leafy vegetables.

Table 5. Lutein and zeaxanthin content of common foods [66].

Food	Lutein and Zeaxanthin (μg/100 g)
Kale, cooked	18,246
Spinach, raw	12,197
Spinach, cooked	11,308
Parsley	5562
Peas, green (boiled)	2593
Lettuce (romaine or cos)	2313
Squash (boiled)	2249
Edamame beans	1619
Brussels sprouts (boiled)	1541
Pistachio nuts, raw	1404
Egg yolk, raw	1094
Broccoli (cooked)	1079
Pumpkin (cooked)	1014
Asparagus, cooked	771
Frozen corn (boiled from frozen)	684
Frozen green beans (cooked)	564
Egg whole, raw	504
Egg whole, cooked (hard-boiled)	353
Avocado (all commercial)	270
Orange (all commercial)	129
Tomato (red, ripe, cooked)	94

Image: Lutein and Zeaxanthin-Food Sources, Bioavailability and Dietary Variety in Age-Related Macular Degeneration Protection. Nutrients. 2017 Feb 9;9(2):120.

Just 100 grams of cooked kale (about 1 cup) would provide 18 mg of lutein and zeaxanthin. Like the other carotenoids, fat greatly increases the absorption of lutein and zeaxanthin. Make sure you have at least 5 grams of fat with your leafy greens or other foods high in lutein and zeaxanthin. A teaspoon of olive oil, 3 ounces of salmon, or about 5 walnut halves would have you covered. Although lutein and zeaxanthin in eggs may be better absorbed compared to vegetable sources, you would need to consume about 72 eggs to equal the amount of lutein and zeaxanthin in 100 grams of kale.[11] Taking into account the increased bioavailability of eggs, you might be able to decrease that to 44 eggs/day to equal the amount of lutein and zeaxanthin you would absorb from 100 grams of cooked kale. Those 44 eggs would cost you 4,500 calories, but the 100 grams of kale is only 60 calories for the same of amount lutein and zeaxanthin.

Lutein and zeaxanthin are not only associated with eye health. Eating foods high in these carotenoids is linked to a reduced risk of many diseases,[12] including Alzheimer's Disease.[13] This shouldn't be a surprise if you read my article on brain health.[14] Leafy greens, which are highest in lutein and zeaxanthin, may be the most important food for reducing the risk of cognitive decline, dementia, and Alzheimer's Disease.

I try to eat some leafy greens every day. How many days in a row do you think you can eat a salad

without missing a day?

About the Author: Keith Herman is an estate planning attorney who is also passionate about nutrition and helping others live their healthiest lives.

#HealthyEating

#HealthyLifestyle

#Wellness

References

[1] Carotenoids. Linus Pauling Institute Micronutrient Information Center. Author, Jane Higdon, reviewed August 2016.

https://lpi.oregonstate.edu/mic/dietary-factors/phytochemicals/carotenoids

Gammone, Maria Alessandra et al. “Carotenoids: potential allies of cardiovascular health?.” Food & nutrition research vol. 59 26762. 6 Feb. 2015.

[2] van Het Hof KH. Dietary factors that affect the bioavailability of carotenoids. J Nutr. 2000 Mar;130(3):503-6.

[3] Wu J. Intakes of Lutein, Zeaxanthin, and Other Carotenoids and Age-Related Macular Degeneration During 2 Decades of Prospective Follow-up. JAMA Ophthalmol. 2015 Dec;133(12):1415-24.

[4] EYE-RISK Consortium. Mediterranean Diet and Incidence of Advanced Age-Related Macular Degeneration: The EYE-RISK Consortium. Ophthalmology. 2019 Mar;126(3):381-390.

[5] Seddon, J, et al. Dietary carotenoids, vitamin A,C and E, and advanced age-related macular degeneration. Eye Disease Case-Control Study Group. JAMA 1994, 272, 1413–1420.

[6] Feng L, et al. Effects of lutein supplementation in age-related macular degeneration. PLoS One. 2019;14(12):e0227048. Published 2019 Dec 30.

[7] Age-Related Eye Disease Study 2 Research Group. Lutein + zeaxanthin and omega-3 fatty acids for age-related macular degeneration: the Age-Related Eye Disease Study 2 (AREDS2) randomized clinical trial. JAMA. 2013 May 15;309(19):2005-15.

[8] Braakhuis AJ, et al. Nutritional Strategies to Prevent Lens Cataract: Current Status and Future Strategies. Nutrients. 2019; 11(5):1186.

Brown L, Rimm EB. A prospective study of carotenoid intake and risk of cataract extraction in US men. Am J Clin Nutr. 1999 Oct;70(4):517-24.

Moeller SM, et al. Associations between age-related nuclear cataract and lutein and zeaxanthin in the diet and serum in the Carotenoids in the Age-Related Eye Disease Study, an Ancillary Study of the Women’s Health Initiative. Arch Ophthalmol. 2008;126(3):354-364.

[9] Jiang H, et al. Dietary vitamin and carotenoid intake and risk of age-related cataract. Am J Clin Nutr. 2019 Jan 1;109(1):43-54.

[10] Eisenhauer B, et al. Lutein and Zeaxanthin-Food Sources, Bioavailability and Dietary Variety in Age-Related Macular Degeneration Protection. Nutrients. 2017 Feb 9;9(2):120.

[11] Chung HY, et al. Lutein bioavailability is higher from lutein-enriched eggs than from supplements and spinach in men. J Nutr. 2004 Aug;134(8):1887-93.

[12] Elisabeth TM Leermakers, et al. The effects of lutein on cardiometabolic health across the life course: a systematic review and meta-analysis,, The American Journal of Clinical Nutrition, Volume 103, Issue 2, February 2016, Pages 481–494.

Ribaya-Mercado JD, Blumberg JB. Lutein and zeaxanthin and their potential roles in disease prevention. J Am Coll Nutr. 2004 Dec;23(6 Suppl):567S-587S.

Zou Z, et al. High serum level of lutein may be protective against early atherosclerosis: the Beijing atherosclerosis study. Atherosclerosis. 2011 Dec;219(2):789-93.

Dwyer JH, et al. Oxygenated carotenoid lutein and progression of early atherosclerosis: the Los Angeles atherosclerosis study. Circulation. 2001 Jun 19;103(24):2922-7.

Chung RWS, et al. Lutein exerts anti-inflammatory effects in patients with coronary artery disease. Atherosclerosis. 2017 Jul;262:87-93.

Johnson EJ, et al. Relationship between Serum and Brain Carotenoids, alpha-Tocopherol, and Retinol Concentrations and Cognitive Performance in the Oldest Old from the Georgia Centenarian Study. J Aging Res. 2013;2013:951786.

Johnson EJ, et al. Cognitive findings of an exploratory trial of docosahexaenoic acid and lutein supplementation in older women. Nutr Neurosci. 2008;11(2):75-83.

[13] Min JY, Min KB. Serum lycopene, lutein and zeaxanthin, and the risk of Alzheimer’s disease mortality in older adults. Dement Geriatr Cogn Disord. 2014;37(3-4):246-56.

[14] https://www.linkedin.com/pulse/4-most-important-foods-improve-brain-health-reduce-your-keith-herman/