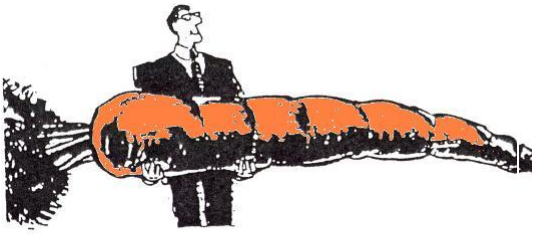

Carotenoid News

Vol. 23, No. 1
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FROM THE EDITOR

"Eyes are more accurate witnesses than ears."
– Heraclitus of Ephesus (535-475 BC)

As noticed by the Greek philosopher, vision is the most important sense for humans. Therefore, we are all very concerned about our eye health and the deterioration of vision in older people significantly affects their independence and life quality. Ultimately, our vision is totally dependent on carotenoids, because rhodopsin, a photosensitive pigment of photoreceptors, derives its 11-*cis*-retinal component from provitamin A carotenoids that are converted by us, or by animals in our food chain, to vitamin A. The tissues of eyes are exposed to damaging blue light during our life, especially the *macula lutea*, a small yellow-tinted area of the retina where the light rays are focused by the lens to provide a sharp picture of the surrounding world. The damage to the lens results in cataracts, while the macula may be partially protected by the presence of very high concentrations of lutein, zeaxanthin and meso-zeaxanthin. A diet rich in carotenoid-containing fruits and vegetables seems to increase the amount of macular pigment and decrease the risk of age-related macular degeneration. This important dependence of our eyes on carotenoids will be discussed at the annual CARIG Conference in Boston on April 19, 2013, entitled '**Carotenoids & Eye Health throughout the Life Cycle'**. See the program below and plan to attend this fascinating meeting!

Maria S. Sapuntzakis (Chicago)

CARIG Travel Awards

CARIG will award at least two monetary prizes, based on a poster competition to be held in conjunction with the CARIG/VARIG Social at Experimental Biology 2013. Graduate students and postdoctoral trainees are eligible. Posters must address carotenoid and/or vitamin A research. For those assigned an oral presentation rather than a poster at EB'13, printed copies of your slides with a print copy of your abstract and a small banner may be used for the CARIG/VARIG poster competition. No advance registration is required to participate in the poster competition. Contact: Earl Harrison, **e-mail**: harrison.304@osu.edu

UPCOMING EVENTS

April 19, 2013
CARIG Annual Conference, Boston, MA. Contact**:** Dr. Earl Harrison, CARIG RIS Chair, **e-mail**: harrison.304@osu.edu [see program below].

April 20-24, 2013
Experimental Biology 2013, Boston, MA. Contact: EB2013, FASEB Office of Scientific Meetings & Conferences, 950 Rockville Pike, Bethesda, MD 20814-3998, **website:** www.experimentalbiology.org, **e-mail:** eb@faseb.org.

May 11-12, 2013
13th International Conference of the Functional Food Center. First International Symposium of the Academic Society of Functional Food and Bioactive Compounds, Kyoto, Japan. Contact: Functional Food Center Inc. **tel:** 800-201-0152, **Website**: www.functionalfoodscenter.net.

May 15-18, 2013
Diet and Optimum Health, Cornvallis, OR. Conference organized by Linus Pauling Institute and Oxygen Club of California at CH2M HILL Alumni Center, Oregon State University. **Website:** http://lpi.oregonstate.edu/conf2013.

July 10-12, 2013
Macular Carotenoid Conference 2013. Downing College, Cambridge, UK. Abstracts will be published in the *European Journal of Ophthalmology* July-August 2013. www.macularcarotenoids.org

CARIG Events at Experimental Biology 2013
CARIG Annual Symposium
Friday, April 19, 2013: 1-5PM
Westin Boston Waterfront Hotel, Douglas Room
Chairs: Loredana Quadro and Zeina Jouni

1-1:10PM Introduction of the **James Allen Olson Memorial Lecture**
1:10-2:00 PM Olson Memorial Lecture: *Lutein & Zeaxanthin: Journey from the Eye to the Brain,* Elizabeth Johnson, Human Nutrition Research Center on Aging, Tufts, University, Boston

CARIG Conference: Carotenoids & Eye Health throughout the Life Cycle

2:00-2:30PM *Combating Vitamin A Deficiency through Agricultural Approaches: It Takes Communication*, Sherry Tanumihardjo, University of Wisconsin, Madison
2:30-3:00PM *It's Not Only AMD: Retinal Xanthophylls in Retinopathy of Prematurity & Diabetic Retinopathy*, Lewis Rubin, Texas Tech University Health Science Center, El Paso
3:00-3:30 PM Coffee Break
3:30-4:00PM *Fine-tuning of Avian Color Vision by Selective Apocarotenoid Metabolism*, Matthew Toomey, Washington University School of Medicine, St. Louis
4:00-4:30PM *Macular Pigment: Insights from History,* John Landrum, Florida International University, Miami
4:30-5:00PM General Discussion

Friday, April 19, 2013: CARIG/VARIG Social, Poster Competition & Business Meeting 6:30-8:30PM, Harbor Ballroom II (same hotel)

Saturday, April 20, 2013: Minisymposia (Boston Convention & Exhibition Center):

8-10 am. (CARIG 5031). **Carotenoids and Retinoids: Molecular Mechanisms of Action.**
Chair: Xiang-Dong Wang (Tufts)
e-mail: xiang-dong.wang@tufts.edu
Co-Chair: Klaus Kraemer (DSM Sight and Life)
e-mail: klaus.kraemer@dsm.com

10:30am- 12:30 pm.(CARIG 5032). **Bioavailability and Metabolism of Carotenoids and Vitamin A.**
Chair: Mario Ferruzzi (Purdue)
e-mail: mferruzz@purdue.edu
Co-Chair: Lewis Rubin (Texas Tech)
e-mail: lewis.rubin@ttuhsc.edu

Sunday, April 21, 2013: Posters (CARIG 5033): **Carotenoids and Vitamin A** – 26

RECENT / FORTHCOMING PUBLICATIONS

SIGHT AND LIFE Magazine 26 (2 and 3) 2012. PO Box 2116, 4002 Basel, Switzerland, **tel:** 41-61-815-8756, **website:** www.sightandlife.org
e-mail: klaus.kraemer@sightandlife.org
See especially:
Xanthophylls as provitamin A carotenoids. Tanumihardjo SA. (2):48-55. James Allen Olson 11th *Perspectives on Carotenoids* Memorial Lecture (CARIG Conference, April 20, 2012, San Diego,CA).

New findings on apo-carotenoid metabolites of β-carotene. Wang CX, Wongsiriroj N, Deckelbaum R, Blaner WS, Harrison EH.(3):18-27.

Proceedings of the 16th International Symposium on Carotenoids, July17-22, 2011, Kraków, Poland. Acta Biochimica Polonica (2012) 59 (1).

Proceedings of a conference held at the Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, March 11-12, 2011, Boston, MA. New Developments in Carotenoid Research. Am J Clin Nutr 2012; 96 (5S): 1155S-1244S.

Manual on Vitamin A Deficiency Disorders (VADD). McLaren DS, Kraemer K. World Rev Nutr Diet 2013, 103. www.karger.com/Book/Toc/257241

Carotenoids by Lindshield BL. Chapter 12 in **Present Knowledge in Nutrition**. Eds. Erdman JW, Macdonald IA, Zeisel SH, pp. 185-198 (2012) Wiley-Blackwell, Ames, IA

Alphabetical Listing of Recent Publications may be found at www.carotenoidsociety.org under **Articles.** It is prepared by Dr. Harold Furr, Department of Nutritional Sciences, University of Wisconsin, Madison.

MEETING REPORT

Gordon Research Conference on Carotenoids

The Gordon Research Conference (GRC) on Carotenoids was recently held in Ventura, California (January 6-11, 2013), preceeded by a new Gordon-Kenan Research Seminar (GRS) for early career scientists held at the same location (January 5-6, 2013). Over 120 attendees, representing almost every continent, participated in the 8th GRC on Carotenoids. Speakers and participants discussed a wide range of topics that encompassed research on carotenoids. Session topics with ~40 speakers included "Breeding for Human Health"; "Regulation of Carotenoid Biosynthesis"; "Carotenoids and Health - Epidemiology and Animal Studies"; "Apocarotenoid Biogenesis"; "Carotenoids and Health - Molecular Mechanisms"; "Apocarotenoid Signaling"; "Carotenoid and Apocarotenoid Functions in Diverse Organisms"; "Photosynthesis and Photochemistry"; and "Apocarotenoids in Vision". The GRC was organized by Eleanore Wurtzel, Lehman College, The City University of New York (Chair), Xiang-Dong Wang, Tufts University (Co-Chair) and Johannes von Lintig, Case Western

Reserve University (Vice Chair). During the conference, the attendees also presented their most recent unpublished findings in more than 60 posters, which provided a great opportunity for scientists from different disciplines to promote their research and to develop collaborations. The community elected Giovanni Giuliano, ENEA, Rome, to serve as the next Vice Chair, and together with Johannes von Lintig, who will serve as Chair, will organize the next GRC expected to take place in 2016. The GRS for early career scientists was the first for the Carotenoids community and participation was close to capacity. The GRS provided an excellent networking and community-building opportunity for early career carotenoids scientists, who presented their research and participated in formal and informal discussions over a two day period. The GRS was organized and the program developed by postdoctoral fellow Jaime Amengual Terrasa of Case Western Reserve University (Chair) and doctoral student Jesús Beltrán of the Graduate Center, The City University of New York (Associate Chair).

Eleanore Wurtzel (NY)
Xiang-Dong Wang (Boston)

TECHNICAL NOTES

Synthetic zeaxanthin approved in Europe as food ingredient

On June 1, 2004 the company DSM Nutritional Products VML made a request to the competent authorities of the Netherlands to place synthetic zeaxanthin on the market as a novel food ingredient. On June 16, 2005 the competent food assessment body of the Netherlands issued its initial assessment report. In that report it came to the conclusion that synthetic zeaxanthin with a maximum intake of not more than 20 mg per person per day, would not present a significant risk for human health. However, it concluded that the data presented were not sufficient to complete the safety assessment. Therefore an additional assessment was required. On September 13, 2012 European Food Safety Authority adopted a 'Statement on the safety of synthetic zeaxanthin as an ingredient in food supplements', concluding that the use level of 0.75 mg/kg body weight does not raise safety concerns.It corresponds to a daily intake of 53 mg for a person with a body weight of 70 kg.

www.nutraingredients.com, 10/5/2012

Raman spectroscopy used to characterize carotenoids in patinas on ancient frescos

Colonization of wall paintings by fungi, algae, cyanobacteria, lichen, moss, etc., is a well known phenomenon that causes damage to the surface by producing unsightly colored patinas. This work proposes new methodology for characterization of the nature of the main carotenoids and their distribution in brown stains or patinas of a deteriorated wall painting on the north wall of the atrium of the Marcus Lucretius House (Pompeii, Italy). Characterization of the brown patinas and surrounding areas (plaster and polychromy) from the wall painting started with *in situ* screening, using a portable Raman microprobe and a handheld Fourier transfer infrared spectrometer (diffuse reflectance infrared spectroscopy sampling interface) in order to select the sampling areas suitable for further analysis in the laboratory. Two wall painting fragments were then analyzed in the laboratory in two steps. First, microscopic observations (scanning electron microscope and phase-contrast microscopy) were used to determine the presence of *Bryopsida* moss. In a second step, confocal Raman microscopy (785 and 514 nm excitation lasers) was used to characterize the main biogenic compounds of the brown stains (chlorophyll *a*, lutein and β-carotene). Because of the resonance Raman effect (514 nm excitation laser), it was possible to obtain reliable Raman features of the carotenoids present in the stains. Moreover, Raman confocal applications, Raman imaging and depth profiling, were also used in a first attempt to determine the distribution of carotenoids in the stains, and to determine the thickness of the brown patinas.

Maguregui et al. Anal Bioanal Chem 402:1529-1539, 2012

NEWS AND VIEWS

Carotenoids as biomarkers of health in adolescents

1. Physical fitness

There is a lack of studies that analyze the association between micronutrient-related biomarker status and physical fitness in adolescents. In the present study, biochemical parameters for iron and vitamin status were studied, along with objective measures of physical fitness in healthy male and female European adolescents. Adolescents (n = 1089; 580 girls, 12.5-17.5 yr) from the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) cross-sectional study were included. Hierarchical linear models were performed to determine the associations between micronutrient biomarkers and physical fitness. Age, seasonality, latitude, body mass index, menarche (in girls), and physical activity were used as covariates. For cardiorespiratory fitness, concentrations of hemoglobin, retinol, and vitamin C in male adolescents, and β-carotene and 25(OH)D in female

adolescents, were associated with maximal oxygen consumption. For muscular fitness, concentrations of hemoglobin, β-carotene, retinol, and α-tocopherol in male adolescents, and β-carotene and 25(OH)D in female adolescents, were associated with better performance of the standing long jump test. The associations between physical fitness and micronutrient status observed in this cross-sectional study in adolescents should be followed up by a study specifically designed to evaluate causal relationships.

Gracia-Marco L et al. J Appl Physiol 2012; 113(4):566-573

2. Metabolic syndrome

Specific micronutrients, including retinol, retinyl esters, carotenoids [α-carotene, β-carotene (cis+trans), β-cryptoxanthin, lutein+zeaxanthin, and total lycopene], vitamin E, and vitamin C have anti-inflammatory and antioxidant effects, that may reduce oxidative stress, a process that accompanies the pathogenesis of many chronic diseases. It is still largely unknown whether these micronutrients are associated with the occurrence of metabolic syndrome (MetS) in the adolescent U.S. population. MetS was defined by the International Diabetes Federation (IDF) criteria. Other non-MetS outcomes relying on blood measurements were elevated insulin resistance (IR), C-reactive protein (CRP), and hyperuricemia. We tested associations between serum antioxidants and MetS outcomes among adolescents aged 12-19 y using cross-sectional data from NHANES 2001-2006. MetS prevalence was estimated at 7% among boys and 3% among girls. In adjusted models, adolescents with MetS had consistently lower carotenoid concentrations compared with their counterparts without MetS. Total carotenoids were also inversely related to IR and CRP. Vitamin C was inversely related to uric acid level and MetS. Retinol+retinyl esters exhibited an inverse relationship with CRP and a positive relationship with uric acid, IR and MetS. Vitamin E had no association with MetS, particularly after controlling for serum cholesterol and TG. In conclusion, among U.S. adolescents, serum carotenoid concentrations were inversely associated with MetS status, IR and CRP, whereas retinol+retinyl esters had a positive relationship with IR, uric acid, and MetS, while being inversely related to CRP. These associations need further study.

Beydoun MA et al. J Nutr 2012; 142:1693-704

Dietary Antioxidants and Dementia

Oxidative stress is believed to play a central role in the pathogenesis of Alzheimer's disease (AD), a neurodegenerative disease. Antioxidants may prevent the onset of AD, as high dietary intake of vitamin C and E were reported to be associated with lower risk of the disease. The objective of this study was to evaluate the serum levels of antioxidants in persons with mild dementia to test whether it is associated with lower levels of antioxidants in a cross-sectional study in the population of the "Activity and Function in the Elderly in Ulm" (ActiFE) study. Main exposure measures were vitamin C, vitamin E, β-carotene, lycopene, and coenzyme Q10, as analyzed by HPLC. Main outcome measures were mild cognitive impairment among 74 mildly demented subjects compared to 158 age and gender-matched controls. We found that blood vitamin C and β-carotene concentrations were significantly lower in demented subjects than in controls (3rd vs 1st tertile: OR: 0.29, 95%CI, 0.09-0.96 and 0.13, 95%CI, 0.03-0.55, respectively) even after adjusting for school education, intake of dietary supplements, smoking habits, body mass index, and alcohol consumption. No associations were found for vitamin E, lycopene, and coenzyme Q10. Our findings suggest an association of vitamin C and β-carotene with dementia. However, this is limited to the cross-sectional character of our study and longitudinal data will give further insight into this association.

Von Arnim CAF et al. J Alz Dis 31: 717-724 (2012)

Carotenoids are among dietary nutrients associated with optimal sleep duration

Short sleep duration is associated with weight gain and obesity, diabetes, cardiovascular disease, psychiatric illness, and performance deficits. Likewise, long sleep duration is also associated with poor physical and mental health. The role of a healthy diet in habitual sleep duration represents a largely unexplored pathway linking sleep and health. This study evaluated associations between habitual sleep parameters and dietary/nutritional variables obtained via the National Health and Nutrition Examination Survey (NHANES), 2007-2008. We hypothesized that habitual very short (<5h), short (5-6h), and long (9h+) sleep durations are associated with intake of a number of dietary nutrient variables. Overall, energy intake varied across very short (2036 kcal), short (2201 kcal), and long (1926 kcal) sleep duration, relative to normal (2151 kcal) sleep duration (p=0.001). Normal sleep duration was associated with the greatest food variety (17.8), compared to very short (14.0), short (16.5) and long (16.3) sleep duration (p<0.001). Associations

between sleep duration were found across nutrient categories, with significant associations between habitual sleep duration and proteins, carbohydrates, vitamins and minerals. In stepwise analyses, significant contributors of unique variance included theobromine (long sleep RR=0.910, $p<0.05$), vitamin C (short sleep RR=0.890, $p<0.05$), tap water [short sleep RR=0.952, $p<0.001$; very short (<5h) sleep RR=0.941, $p<0.05$], **lutein + zeaxanthin** (short sleep RR=1.123, $p<0.05$), dodecanoic acid (long sleep RR=0.812, $p<0.05$), choline (long sleep RR=0.450, $p=0.001$), **lycopene** [very short (<5h) sleep RR=0.950, $p<0.05$], total carbohydrate [very short (<5h) sleep RR=0.494, $p<0.05$; long sleep RR=0.509, $p<0.05$], selenium [short sleep RR=0.670, $p<0.01$) and alcohol (long sleep RR=1.172, $p<0.01$). Future studies should assess whether these associations are due to appetite dysregulation, due to short/long sleep and/or whether these nutrients have physiologic effects on sleep regulation. In addition, these data may help us better understand the complex relationship between diet and sleep and the potential role of diet in the relationship between sleep and obesity and other cardiometabolic risks.

Grandner MA,et al. Appetite 64:71-80, May 2013

Serum carotenoids are associated with optimism!

Psychological and physical health is often conceptualized as the absence of disease. There is less research that addresses positive psychological and physical functioning. For example, optimism has been linked with reduced disease risk and biological dysfunction, but very little research has evaluated associations with markers of healthy biological functioning. Thus, we investigated the association between two indicators of positive health: optimism and serum antioxidants. The cross-sectional association between optimism and antioxidant concentrations was evaluated in 982 men and women from the Midlife in the United States study. Primary measures included self-reported optimism (assessed with the revised Life Orientation Test) and serum concentrations of nine different antioxidants (carotenoids and vitamin E). Regression analyses evaluated the relationship between optimism and antioxidant concentrations in models adjusted for demographics, health status, and health behaviors. For every standard deviation increase in optimism, carotenoid concentrations increased by 3% to 13% in age-adjusted models. Controlling for demographic characteristics and health status attenuated this association. Optimism was associated with greater carotenoid concentrations but not with serum vitamin E, and this association was partially explained by diet and smoking status. The direction of effects cannot be conclusively determined. Effects may be bidirectional, given that optimists are likely to engage in health behaviors associated with more serum antioxidants, and more serum antioxidants are likely associated with better physical health that enhances optimism.

Boehm JK et al., Psychosom Med 75:2-10, 2013

Dietary carotenoids may reduce hip fracture risk

In this study, presented at the International Osteoporosis Foundation Regional Asia-Pacific Osteoporosis Meeting, December 13-16, 2012 in Kuala Lumpur, Malaysia, the researchers from the National University of Singapore examined an association between dietary antioxidant carotenoids and hip fracture risk across a range of BMI in elderly Chinese men and women, using data from the Singapore Chinese Health Study. This population-based, cohort prospective study recruited 63,257 men and women in 1993. In this group, a total of 1,630 incident hip fractures up to December 2010 were identified via record linkage with the nationwide hospital discharge database. The study found that low BMI (<20 kg/m^2) is a stronger risk factor for hip fracture risk among elderly men compared to women. Also, in men, hip fracture risk decreased with increasing intakes of total vegetables and of total carotenoids, particularly β-carotene. The protective effect was higher in lean men than in men with higher BMI. In contrast, the intake of vegetables or carotenoids had no association with hip fracture risk in women, regardless of levels of BMI. The findings may have important public health implications on hip fracture prevention, particularly among Asians.

Dai Z et al. Osteoporos Int 23 Suppl 7, 2012

Researchers breed potatoes with higher levels of carotenoids

Agricultural Research Service (ARS) scientists have bred yellow potatoes with carotenoid levels that are two to three times higher than those of the popular "Yukon Gold" potato. Intensely yellow-fleshed wild potatoes had been found that have about 23 times more carotenoids than white-flesh potatoes. By crossing these wild potatoes with cultivated types, high-carotenoid potatoes were developed. In 2007 the researchers developed a potato named "Peter Wilcox" with purple skin and yellow flesh that has become popular in niche roadside markets. The overall carotenoid levels in the "Peter Wilcox" potato are more than 15% higher than those in "Yukon Gold". Several carotenoids are involved, including

neoxanthin, antheraxanthin, violaxanthin, lutein and zeaxanthin. Among these, lutein and zeaxanthin are of keen interest for eye health; they appear to protect against age-related macular degeneration and perhaps against cataract formation.

www.ars.usda.gov/is/pr/2012/121024.htm

Internet Addresses for Carotenoid Researchers

1. USDA Nutrient Database for Standard Reference (SR25) is a major source of food composition data for epidemiologists and nutritionists. The carotenoid database contains the best available estimates of carotenoid content in foods. The Agricultural Research Service (ARS) searchable database allows one to view carotenoid profile for more than 13,000 foods: www.ars.usda.gov/foodsearch, www.ars.usda.gov/Services/docs.htm?docid=2114.

2. International Carotenoid Society (ICS) **Website**: www.carotenoidsociety.org

3. Carotenoid Section of the Lipid Database developed by Research Institute, International Medical Center of Japan webpage: www.lipidbank.jp. Also available on ICS webpage: www.carotenoidsociety.org through **Articles** button.

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