

Carotenoid News

August 2013
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FROM THE EDITOR

*"That which we call a rose, by any name would smell
as sweet"*

Shakespeare, Romeo and Juliet, Act II, Scene II

Carotenoids and their derivatives, retinoids, are highly involved in our visual processes, both as receptor constituents and as colorants of the surrounding world, providing cues about nutritious food and suitable healthy mates. Because of its powerful effect on memory, a sense of smell may be of equal or greater importance in recognizing familiar persons, foods and flowers, experiencing pleasure and building preferences. Surprisingly, carotenoids play a crucial role in the production of volatile compounds by many fruits and flowers. The human nose is very sensitive to the scent of β -ionone, an apocarotenoid derivative produced by enzymatic cleavage in roses, violets, petunias, plums, peaches, raspberries, tomatoes, oranges and muscat grapes. However, the sensitivity to β -ionone may vary hundred-fold among different people. Recently, it was found to be dependent on a single gene, where a sensitive G allele is dominant over a recessive A allele (Jaeger *et al. Curr Biol* 23:1601-5, 2013). Thus our genetic differences may determine how we perceive the world and how sweet is the fragrance of a rose.

Maria S. Sapuntzakis (Chicago, IL)

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 2014. 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'14, 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: Loredana Quadro, e-mail: quadro@aesop.rutgers.edu.

News from CARIG Steering and Advisory Committee

Please mark your calendars for several upcoming CARIG sponsored events to be held next spring at Experimental Biology 2014 in San Diego. The CARIG 2014 Conference will again be held on the Friday afternoon before the Saturday opening of the ASN program. EB2014 also will feature a CARIG/VARIG trainee poster and award session and business meeting during the annual social following the CARIG Conference. If you are interested in contributing as a RIS officer, or if you have ideas for symposia or CARIG Conference topics for EB 2014, please contact RIS leadership: Earl Harrison (Past Chair, harrison.304@osu.edu), Loredana Quadro (Chair, quadro@aesop.rutgers.edu), or Zeina Jouni (Chair Elect, zeina.jouni@mjn.com). Additional information on these events will appear through the CARIG ListServe and in subsequent issues of Nutrition Notes, as well as in the next issue of Carotenoid News.

The steering committee has set the CARIG minisymposium topics for 2014:

1. Carotenoids and Health
2. Carotenoids & Retinoids: Molecular Mechanisms of Action
3. Bioavailability & Metabolism of Carotenoids & Vitamin A
4. Biofortification of Staple Crops with Micronutrients

Thanks to all who have already volunteered to help us in the coming year. Special thanks to our outgoing Chair, Earl Harrison, to our outgoing acting Treasurer Elizabeth Johnson and to our Chair Elect, Zeina Jouni. We would like to welcome Jessica Campbell as the new Treasurer, as well as five new members: Lisa Jahns; two student representatives, Bryan Gannon and Jessica Copperstone; and two postdoc representatives, Shellen Goltz and Matthew Toomey.

The current membership of the Committee includes:
Loredana Quadro (Chair) – Rutgers University
Earl Harrison (Past Chair) – Ohio State University
Zeina Jouni (Chair Elect) - Mead Johnson Nutrition
Jessica Campbell (Treasurer) – General Mills
Mario Ferruzzi – Purdue University
Lisa Jahns - USDA-ARS, North Dakota
Elizabeth Johnson – Tufts University
Klaus Kraemer – Task Force Sight and Life

Georg Lietz - Newcastle University
Lewis Rubin – University of South Florida
Maria Stacewicz-Sapuntzakis (newsletter editor)
Sherry Tanumihardjo – University of Wisconsin
John Landrum - Florida International University
(liaison to the International Carotenoid Society, ICS Secretary)

Student representatives:

Jessica Copperstone - Ohio State University

Bryan Gannon - University of Wisconsin

Postdoc representatives:

Shellen Goltz –University of Wisconsin

Matthew Toomey – Washington University

Special thanks are due to Harold Furr, who has retired from CARIG Steering Committee. His innumerable contributions include, among others, organizing our conferences and workshops, hosting the annual CARIG/VARIG Social & Poster Competition, constant help with publication of this newsletter, and tireless preparation of recent publication listings for the membership (www.carotenoidsociety.org/articles-books-and-databases).

As of April 1, 2013, CARIG RIS had 371 members.

UPCOMING EVENTS

September 11-14, 2013

The First International Retinoids Meeting, Rende, Italy. Website: <http://www.retinoidsmeeting.com>

March 13-14, 2014

Functional Food Center 15th International Conference, Tainin, Taiwan.

E-mail: ffc_usa@sbcglobal.net,

website: www.functionalfoodscenter.net

April 25, 2014

CARIG Annual Conference, San Diego, CA.

Contact: Dr. Loredana Quadro, CARIG RIS Chair,

e-mail: quadro@aesop.rutgers.edu

April 26-30, 2014

Experimental Biology 2014, San Diego, CA.

Contact: EB2013, FASEB Office of Scientific Meetings & Conferences, 950 Rockville Pike, Bethesda, MD 20814-3998, e-mail: eb@faseb.org

website: www.experimentalbiology.org

May 7–10, 2014

Oxygen Club of California 2014 World Congress, Davis, CA. Oxidants and Antioxidants in Biology.

Nutritional and Redox Biology in Development and Health. E-mail: oxyclubcalifornia@ucdavis.edu

website: www.oxyclubcalifornia.org

June 29 – July 4, 2014

The 2014 International Symposium on Carotenoids, Salt Lake City, UT, USA. Contact Paul S. Bernstein, M.D., Ph.D., Department of Ophthalmology and Visual Sciences, Moran Eye Center, University of Utah, 65 Mario Capecchi Drive, Salt Lake City, UT 84132, USA. Tel: 801-581-6078.

Fax: 801-581-3357, paul.bernstein@hsc.utah.edu

FORTHCOMING PUBLICATIONS

SIGHT AND LIFE Magazine 27 (1) 2013. PO Box 2116, 4002 Basel, Switzerland, tel: 41-61-815-8756, e-mail: klaus.kraemer@sightandlife.org website: www.sightandlife.org. See especially:

Using plant foods rich in β -carotene to combat vitamin A deficiency. Tang G : 20-28.

Microbial Carotenoids from Bacteria and Microalgae. Ed. J-L. Barredo, Methods in Molecular Biology, vol. 892 (2012).

Carotenoids and Vitamin A in Translational Medicine. Eds. O. Sommerburg; W. Siems; K. Kraemer. CRC Press (2013).

Macular Carotenoids Conference (Cambridge, UK, July 10-12, 2013) **Abstracts.** Eur J Ophthalmol (2013) 23(4): 604-13.

Alphabetical Listing of Recent Publications may be found at www.carotenoidsociety.org/articles-books-and-databases. It is prepared by Dr. Harold Furr, Department of Nutritional Sciences, University of Wisconsin, Madison.

MEETING REPORT

CARIG Conference 2013 in Boston

The CARIG Conference 2013 was held on Friday, April 19, the day Boston was paralyzed due to police search for the perpetrators of Boston marathon bombings on April 15. Dr. Elizabeth Johnson was not able to attend, so she will give the Olson Memorial Lecture next year (2014). Only three speakers were present: Lewis Rubin, Sherry Tanumihardjo and Matthew Toomey. About 20 people attended the symposium. Each talk was followed by a lively and stimulating discussion, with great participation from the people in the audience. Dr. Tanumihardjo (*Combating vitamin A deficiency through agricultural approaches: it takes communication*) made a strong case for biofortification rather than vitamin A supplementation as the more efficient and cost-effective approach for combating world-wide vitamin A deficiency. Dr. Rubin (*It's not only AMD: retinal*

xanthophylls in retinopathy of prematurity and diabetic retinopathy) talked about the selective transfer of lutein to fetal photoreceptors and its possible role in the prevention of the retinopathy of prematurity. Dr. Toomey (*Fine-tuning of avian color vision by selective apocarotenoid metabolism*) discussed the role of xanthophylls droplets narrowing the absorption spectrum, and the four cone types providing increased acuity to bird vision. Each cone type contains a unique carotenoid metabolite derived from zeaxanthin.

The CARIG Social & Poster Competition was very well attended, given the circumstances. About 20 posters were displayed and discussion around them was again very active. Three volunteer judges (Loredana Quadro, Lewis Rubin and Nikki Ford) selected the two winners of the poster competitions (two graduate students), who received a \$500 awards. They are: Elizabeth Spiegler (Food Science Department, Rutgers University) for poster titled "*Does β -carotene-9',10'-oxygenase (CMO2) generate retinoic acid during embryonic development?*", and Carlo dela Sena (Department of Human Nutrition, Ohio State University) for poster titled "*Purified recombinant human β -carotene-15,15'-oxygenase cleaves β -apocarotenals and lycopene*". I would like to thank Earl Harrison for his help in organizing the CARIG EB 2013 Conference.

Loredana Quadro (New Brunswick, NJ)
and Phyllis Bowen (Chicago, IL)

TECHNICAL NOTES

Simultaneous HPLC analysis of circulating lipid-phase micronutrients (LPM) using C18 and C30 columns alone or in combination

We have developed fast, affordable, and accurate HPLC assays that simultaneously measured 25-hydroxylated D vitamers, retinol, tocopherols, carotenoids (including their isomers), and oxidized and reduced coenzyme Q10 (in plasma in a single run using UV/VIS detection at 265 nm, 295 nm, and 480 nm with: (1) a C18 column alone; (2) a C30 column alone; or (3) each of these columns connected in series. The C18 column alone could separate all major LPM of interest in less than 17 min but insufficiently resolved the lycopene isomers, the 25-hydroxylated D vitamers, lutein from zeaxanthin and β -tocopherol from γ -tocopherol. The C30 column alone separated all LPM of interest including many isomeric analytes but failed to resolve the Q10 compounds, which co-eluted with carotenoids. Connecting the C18 and C30 columns in series with a detector after the C30 column and a

pressure resistant detector between the columns resulted in ideal resolution and accurate quantitation of all LPM of interest but required software capable of processing the acquired data from both detectors. Connecting the C18 and C30 columns in series with exclusively one detector after the C30 column resulted in carotenoid - Q10 interferences. However, this was remedied by heart-cutting 2D-LC with a 6-port valve between the columns, which resolved all analytes in 42 min. Faster run times led to some analytes not being resolved. Many variations of these methods are possible to meet the needs of individual requirements while minimizing sample material and turn-around-times.

Franke AA et al. *J Chromatogr A* 1301 (2013):1-9

NEWS AND VIEWS

A Mendelian trait for olfactory sensitivity to a carotenoid derivative, β -ionone

Humans vary in acuity to many odors, with variation within olfactory receptor (OR) genes contributing to these differences. How such variation also affects odor experience and food selection remains uncertain, given that such effects occur for taste. Here we investigate β -ionone, which shows extreme sensitivity differences. β -ionone is a key aroma in many foods and beverages, and is added to cosmetic products in order to give a pleasant floral note. Genome-wide and in vitro assays demonstrate rs6591536 as the causal variant for β -ionone odor sensitivity. rs6591536 encodes a N183D substitution in the second extracellular loop of OR5A1 and explains >96% of the observed phenotypic variation, resembling a monogenic Mendelian trait. Individuals carrying genotypes for β -ionone sensitivity can more easily differentiate between food and beverage stimuli with and without added β -ionone. Sensitive individuals typically describe β -ionone in foods and beverages as "fragrant" and "floral", whereas less-sensitive individuals describe these stimuli differently. rs6591536 genotype also influences emotional associations and explains differences in food and product choices. These studies demonstrate that an OR variant that influences olfactory sensitivity can affect how people experience and respond to foods, beverages, and other products.

Jaeger SR, et al, *Curr Biol*,(2013),23:1601-5

Gac superfruit - a rich source of carotenoids



The *gac* plant (*Momordica cochinchinensis* Spreng) is a member of the melon family (*Cucurbitaceae*), grown in Vietnam and Thailand. The arils and seeds of the fruit are cooked in glutinous rice for festive occasions, imparting color and flavor. *Gac* fruit has very high concentrations of carotenoids – 74 times the lycopene of tomato, 10 times the β -carotene of carrots and 40 times the lutein in corn. Aril oil contains high amounts of vitamin E and facilitates the absorption of carotenoids. In addition, the vitamin C content is twice that of orange. Currently, Superfruit Nutrition LLC offers a freeze dried *gac* fruit ingredient labeled as Carogac, and Chromadex is developing a *gac* fruit powder called nutraGac.

www.nutraingredients-usa (4/8/2013)

β -Carotene-15,15'-monooxygenase and β -carotene modulate migration and invasion in colorectal carcinoma cells

β , β -Carotene-15,15'-monooxygenase (BCMO1) converts β -carotene to retinaldehyde. Increased β -carotene consumption is linked to antitumor effects. Retinoic acid reduces the invasiveness in cancer, through inhibition of matrix metalloproteinases (MMPs). Our goal was to determine whether *BCMO1* expression could influence transformation potential in human colorectal carcinoma cells, by examining the effect of *BCMO1* modulation on cellular migration and invasion, and on expression of *MMPs*. LoVo colon carcinoma cells were transfected with *BCMO1* small interfering RNA (siRNA) or scrambled siRNA. Migration and invasion were measured, and the expression of *BCMO1*, *MMP7*, and *MMP28* was assessed by quantitative reverse-transcriptase polymerase chain reaction. These variables were also measured after treatment of cells with retinoic acid, 5-aza-2'-deoxycytidine, folate-depleted/high-methionine medium, and β -carotene. Retinoic acid decreased the migration, invasion, and expression of *MMP28* mRNA. Transfection of cells with *BCMO1* siRNA inhibited *BCMO1* expression, enhanced migration and invasion, and increased expression of *MMP7* and *MMP28*. 5-Aza-2'-deoxycytidine decreased, whereas folate-depleted/high-methionine medium increased invasiveness. β -Carotene increased *BCMO1* expression and reduced

invasiveness with a decrease in expression of *MMP7* and *MMP28*. Inhibition of *BCMO1* expression is associated with increased invasiveness of colon cancer cells and increased expression of *MMP7* and *MMP28*. β -Carotene can upregulate *BCMO1* and reverse these effects. These novel associations suggest a critical role for *BCMO1* in cancer and provide a mechanism for the proposed antitumor effects of β -carotene.

Pham DNT et al, *Am J Clin Nutr* (2013) 98: 413-22

Metabolomic profile of response to supplementation with β -carotene in the ATBC Study

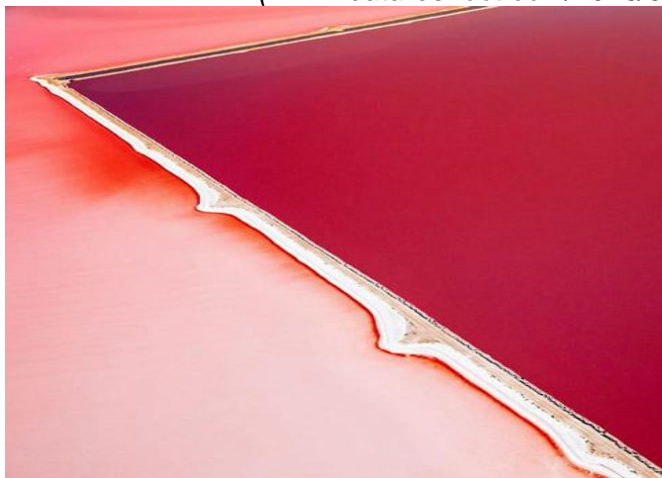
Two chemoprevention trials found that supplementation with β -carotene increased the risk of lung cancer and overall mortality. The biologic basis of these findings remains poorly understood. The objective was to compare the on-study change in metabolomic profiles of men randomly assigned to receive or not receive β -carotene supplements in the Alpha-Tocopherol, Beta-Carotene Cancer Prevention (ATBC) Study. The ATBC Study was a randomized, double-blind, placebo-controlled, primary cancer prevention trial; participants were Finnish male smokers assigned to one of 4 intervention groups: 1) α -tocopherol, 2) β -carotene, 3) both, or 4) placebo. Fifty participants with both baseline and follow-up fasting serum samples were randomly selected from each of these groups. Metabolomic profiling was conducted by mass spectrometry. The association between change in each metabolite over time and trial assignment (β -carotene or no β -carotene) was estimated by linear regression. We measured 489 metabolites, and 17 changed significantly ($P < 0.05$) in response to β -carotene supplementation. More of these 17 metabolites were of xenobiotic origin than would be expected by chance (9 of 60, or 15%; $P = 0.00004$). We also found a suggestive association with 1,5-anhydroglucitol - a marker of glycemic control ($\beta = -0.379$, $P = 0.0071$). Male smokers supplemented with β -carotene developed metabolomic profiles consistent with the induction of cytochrome P450 enzymes, the primary metabolizers of xenobiotics in humans. These findings may shed light on the increased mortality associated with β -carotene supplementation in the ATBC Study and suggest the need to explore potential interactions between medication use and dietary supplements, particularly among smokers.

Mondul AM et al, *Am J Clin Nutr* (2013) 98:488-93

Abstract Aerial Photos of a β -Carotene Farm in Western Australia

The most intriguing part of Australian photographer Steve Back's gorgeously graphic series *Hutt Lagoon* is that the bright pink-colored water is all natural. "The images are not manipulated for color," said Back. "I was commissioned to shoot some abstract landscape shots of Western Australia for a big Perth hotel. I chartered a light aircraft to explore shooting some islands off the coast of Northern WA. I had noticed these lakes on the map and Google Earth, and decided that they were worth a look. From the ground, the pink coloring is not so evident and a bit unimpressive, yet from the air, it looks fantastic. These are natural landscapes but the coloring is out of this world. And at first sight it is not easy to tell whether they are close up or far away." Hutt Lagoon is the world's largest β -carotene farm (produced by naturally occurring algae in the water). In the middle of the lagoon are a series of manmade ponds that form the fundamental composition elements of Back's images.

Carolyn Rauch
(www.featureshoot.com/2013/05/)



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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