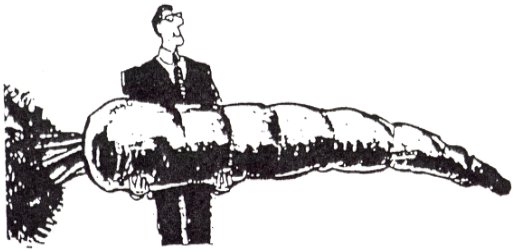

Carotenoid News

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AUGUST 2010

FROM THE EDITOR

"Nature goes her own way, and all that to us seems exception, is really according to order.
(Johann Wolfgang von Goethe, 1749 - 1832)

The great German writer and poet Goethe was also a philosopher and an exceptionally perceptive naturalist, who made important contributions in plant morphology and physics. It has been something like a dogma that carotenoids are produced by bacteria, archea, fungi and plants, but animals are unable to synthesize carotenoids. Now comes the exception – certain aphids display color polymorphism due to a plethora of carotenoids, and their genome contains seven loci homologous with genes for carotenoid biosynthesis (see News & Views in this issue). These genes are derived from fungal genes, which were acquired by aphids 30-80 million years ago. Since carotenoids are so important for ecological adaptations of many animals, we should really be surprised that such lateral gene transfer did not occur on a greater scale. As more genome sequences of various organisms are deciphered, the scientists may find more such exceptions, according to the order of nature.

Maria S. Sapuntzakis (Chicago)

IN MEMORIAM
Dr. Rodney Lee Ausich

It is with great sadness that I have to inform you of passing away of Dr. Rodney Lee Ausich, the President of Kemin Health, Des Moines, Iowa, USA. Dr. Ausich received his BS degree in Biology/Botany from the University of Wyoming in 1976, and his Master's and PhD degrees in plant sciences from Indiana University in 1978 and 1980, respectively. He also received a Master of Business Administration from Lake Forest Graduate School of Management in 1991. He began his career working as a research scientist in 1980 for Amoco Corporation, identifying genes that would increase the production of valuable chemicals in plants. Dr. Ausich joined Kemin in 1994, where he engaged in ground-breaking research and development, ultimately becoming the founding father of Kemin Health, after realizing the benefits of lutein for eye health in combating age-related macular degeneration (AMD). Dr. Ausich authored seven published and five pending patents, pioneering a new methodology for the development of purified lutein, while at Kemin, which is the world's leading supplier of lutein. Kemin Health grew from two employees to 150 employees, and became one of Kemin's most successful businesses under his leadership. He will be remembered by those who knew him as a man of quiet presence, but passionate about his family, his work, and natural environment, which he deeply enjoyed and championed. In lieu of gifts, donations may be made to the Dr. Rodney Ausich Scholarship Fund. Checks should be made payable to Rebecca Simmons. Please mail your donations to: Wells Fargo Advisors, ATTN: Tamara Elwell, 1245 Jordan Creek Pkwy, West Des Moines, IA, USA 50266. Dr. Ausich at Kemin Health, as well as Kemin Industries, have been a regular sponsors of CARIG and the ICS.

Fred Khachik, ICS President

News from the CARIG Steering Committee

The annual meeting of the CARIG Steering Committee was held during EB 2010 in Anaheim, CA. The new officers were elected for the next term (June 1, 2010 – May 31, 2011) and new members of the Committee were introduced. The current membership of the Committee includes:

Lewis Rubin (Chair) – University of South Florida
Sherry Tanumihardjo (Past Chair) – University of Wisconsin - Madison
Elizabeth Johnson (Treasurer) – Tufts University
Mario Ferruzzi (Chair Elect) – Purdue University
Klaus Kraemer – Task Force Sight and Life
John Landrum – Florida International University
Harold Furr - University of Wisconsin - Madison
Maria Stacewicz-Sapuntzakis (newsletter editor)
Jessica Campbell – General Mills
Earl Harrison – Ohio State University
Loredana Quadro – Rutgers University

We also have student representatives:

Nikki Ford – Univ. of Illinois at Urbana-Champaign
Shellen Goltz – Purdue University
Kara Bresnahan - University of Wisconsin - Madison

The Committee thanked Lew Rubin and Elizabeth Johnson for organizing this year's CARIG EB Symposium and discussed plans for the next CARIG EB2011 Symposium. A preliminary program

will be announced in the next issue of Carotenoid News. The topic will be "Biofortification of provitamin A in maize for Africa", chaired by Sherry Tanumihardjo, and the Symposium will take place after the Presidential Symposium "Ameliorating micronutrient deficiencies through biofortification" chaired by Robert Russell, on Sunday, April 10, 2011, 8-10 am in Convention Center Ballroom A. CARIG Symposium will be in the same room, 10:30 am - 12:30 pm.

The student/postdoc poster competition was held during CARIG/VARIG Social on April 23. There were three winners, whose awards were funded by the International Carotenoid Society:

Julie A. Evans, Elizabeth Johnson. Lutein and zeaxanthin in red blood cells as a measure of their status in humans. (*Tufts University*)

Nikki Ann Ford, Steven Clinton, Johannes von Lintig, John W. Erdman, Jr. Genotype and diet alter carotenoid bioaccumulation and the expression of carotenoid cleavage enzymes in CMO-I KO, CMO-II KO and wild-type mice. (*University of Illinois at Urbana-Champaign*)

Nancy J. Engelmann, Randy B. Rogers, S. Indu Rupassara, Peter Garlick, Mary Ann Lila, John W. Erdman, Jr. Production of [^{13}C]-lycopene from high-lycopene tomato cell suspension cultures. (*University of Illinois at Urbana-Champaign*)

The James A. Olson Memorial Lecture 2010 is now published in SIGHT AND LIFE Magazine 2/2010. You can find the report from CARIG Symposium 2010 below in this issue of Carotenoid News.

Since CARIG is now a Research Interest Section (RIS) of the American Society for Nutrition, we urge all members to sign up for RIS (60 have done it so far).

UPCOMING EVENTS

March 11 - 13, 2011
Conference on Progress in Carotenoid Research, Boston, MA. Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University. **Website**: www.carotenoidsconference2011.com

April 9 - 13, 2011
Experimental Biology 2011, Washington, DC. Contact: EB2011, FASEB Office of Scientific Meetings & Conferences, 950 Rockville Pike, Bethesda, MD 20814-3998, **website**: www.eb2011.org, **e-mail**:eb@faseb.org

July 12 - 15, 2011
Macular Carotenoids & AMD, 2001, Cambridge, UK. Contact: info@macularcarotenoids.org, **website**: www.macularcarotenoids.org

July 17 - 22, 2011
16th International Symposium on Carotenoids, Krakow, Poland. Contact: Dr. Kazimierz Strzalka, **e-mail**: strzalka@mol.uj.edu.pl

CARIG Symposium 2010 Report

The Carotenoid Research Interactive Group (CARIG) held its annual Symposium on Friday, April 23, 2010 at the Anaheim Hilton Hotel, Anaheim, CA. As custom, the Symposium took place one day before the opening of Experimental Biology (EB). The American Society for Nutrition (ASN) is a constituent society of the Federation of American Societies for Experimental Biology. This marks the second year that CARIG has been an ASN Research Interest Group (RIS).

CARIG 2010 Symposium was organized around the theme of "*Carotenoids and Cancer."* The conference was chaired by Elizabeth Johnson (Tufts University, Human Nutrition Research Center on Aging) and was attended by an audience of approximately 70, including excellent representation by trainees. Lewis Rubin (University of South Florida) introduced the 8th James Allen Olson Perspectives on Carotenoids Memorial Lecturer, **John Erdman, Jr.** (University of Illinois, Urbana-Champaign). Dr. Erdman's talk, "*Lessons Learned from β-Carotene Supplement Trials,"* was erudite and thought provoking. He also covered several emerging areas in carotenoid research including potential biological roles for carotenoid metabolism and the apparently unique biological functions of lutein, the carotenoid for which exist the best evidence of *direct* effects.

Earl Harrison (Ohio State University) next presented on "*Excentric Cleavage Products of Dietary Carotenoids: Occurrence & Possible Biological Functions."* Dr. Harrison's discussion continued the theme of carotenoid metabolism in light of anticarcinogenesis. He focused on oxidative metabolism via the enzyme, carotene-9',10'-oxygenase (CMO2, BCDO2), which produces apocarotenals, potentially other carotenoid-derived aldehydes and β-ionone. The third talk was delivered by Dr. **Jonathan Mein**, a recent graduate from the Tufts program. He presented *"Excentric Cleavage of Hydroxy Carotenoids by Carotene-9',10'-Oxygenase."* Dr. Mein expanded this theme to cover recent data on CMO2 activities using different carotenoid substrates: lutein, zeaxanthin, β-cryptoxanthin. Dr. Mein was, in turn, followed by **Mario Ferruzzi** (Purdue University), who addressed the critical topic of "*The Influence of Co-consumed Lipid on Carotenoid Absorption."* Intestinal absorption is necessary for access of dietary carotenoids. Dr. Ferruzzi presented an elegant overview that incorporated studies from his lab.

Mario deserves special thanks; he volunteered shortly before CARIG Symposium was held in order to substitute for a speaker who could not be present. **Sherry Tanumihardjo** (University of Wisconsin) delivered the final talk of the afternoon, "*Enhancing Carrot Colors for the Prevention of Disease."* Dr. Tanumihardjo demonstrated how collaboration between nutrition scientists and plant geneticists is synergistic and may lead to more effective dietary interventions. This last presentation segues nicely to the 2011 sessions which will highlight new dietary strategies.

Lewis Rubin, Symposium Chair (Tampa, FL)

RECENT / FORTHCOMING PUBLICATIONS

SIGHT AND LIFE Magazine 1 & 2 / 2010. PO Box 2116, 4002 Basel, Switzerland, **tel:** 41-61-815-8756, **fax**: 41-61-815-8190, **website:** www.sightandlife.org **e-mail**: klaus.kraemer@sightandlife.org
See especially in 2/2010:
Erdman JW, Liu AG, Zuniga KE. Lessons learned from β-carotene supplement trials. James A Olson Memorial Lecture 2010, pp 7-12.
Solomons NW. CARIG Conference 2010: Carotenoids and Cancer, p 58.

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.

TECHNICAL NOTE

MAGE – Multiplex Automatic Genetic Engineering

Dr George Church from Harvard Medical School has invented a table-top machine that allows researchers to make 50 different genome alterations at nearly the same time. MAGE can create billions of cellular mutations in a matter of days. Church's team was able to genetically alter *E.coli* to produce lycopene, in just 3 days, spending only $1000 on supplies. It would have taken months, using the old techniques. The device will go on sale later this year for about $90,000.

Bloomberg *Businessweek, August 16 - 29, 2010*

NEWS AND VIEWS

Aphids Synthesize Carotenoids

In the pea aphid *Acyrthosiphon pisum*, an insect that destroys plants by feeding on the sap, red and green color insects frequently coexist in natural populations. Among its major natural enemies, lady bugs preferentially attack red aphids on green plants, while parasitoid wasps deposit eggs in green aphids more frequently. It has been hypothesized that these opposite predation and parasitism pressures maintain the color variation in natural aphid populations. Moran and Jarvik (*Science 328: 624-27, 2010*) analyzed red and green laboratory strains of *A. pisum* and identified marked differences in the composition of their carotenoids. The authors determined that green aphids contain only yellow carotenoids (γ-, β-, and α-carotene), while red aphids possess red carotenoids (torulene and dehydro-γ,δ-carotene) in addition to the yellow ones. Searches of the aphid genome retrieved four copies of carotene desaturase genes and three copies of fused carotene cyclase and carotene synthase genes. Phylogenetic analysis revealed that all the aphid carotenoid genes clustered with fungal genes with high statistical confidence. Genomic features of these genes strongly suggested that they were transferred from a fungus to an aphid ancestor, and subsequently duplicated in the aphid genome. Because these genes were also found in the green peach aphid *Myzus persicae*, the lateral transfer event must have occurred in the common ancestor of *A. pisum* and *M. persicae*.

Fukatsu,T. Science 328:574 (2010)

β-Carotene Conversion to Vitamin A Decreases as the Dietary Dose Increases in Humans

It has been suggested that high doses of β-carotene limit its conversion to vitamin A, yet this effect has not been well established in humans. A feeding study was conducted in a randomized crossover design, in which 7 volunteers consumed 2 doses (20 and 40 mg) of deuterium-labeled β-carotene on two occasions, with β-carotene and vitamin A response assessed by plasma area under the concentration time curve (AUC). Serial blood samples were collected for 37 days after each dose. Plasma β-carotene-d8 was assessed by HPLC-MS. Plasma retinol-d4, which was derived from the β-carotene-d8, was evaluated by GC-MS after saponification to convert retinyl esters to retinol prior to the formation of the trimethylsilylether. The plasma AUC for β-carotene-d8 increased 2-fold from the 20-mg dose to the 40-mg dose. The plasma AUC for retinol-d4 increased 36% from the 20-mg dose to the 40-mg dose. These results establish that in humans β-carotene conversion to vitamin A decreases as the dietary dose increases.

Novotny JA et al. J Nutr 140:915-18 (2010)

Boosting Provitamin A Carotenoids in Corn

Agricultural Research Service (ARS) researchers are working on two genes in corn that could deliver higher β-carotene levels – a precursor to vitamin A – and help ease eye problems in the developing world. Vitamin A deficiencies contribute to afflictions, such as the eye disease xerophthalmia, which affects about 40 million children and can cause blindness. A further 250 million people suffer other health problems due to a lack of vitamin A. ARS has been researching corn with scientists from Purdue University and the International Maize and Wheat Improvement Center (CIMMYT) with a focus on provitamin A-carotenoids in crops. By isolating the two genes the researchers have developed tools to triple carotenoid levels in corn. The researchers identified specific genes and areas of the corn chromosomes that influence carotenoid production using a technique called *"association mapping",* which employs statistical analysis and DNA sequencing. Many corn varieties naturally contain β-carotene, but typically at very low levels. The new varieties may be able to be crossed with local varieties to get the best of both local resilience and boosted β-carotene levels. For instance, some African corn has only 0.1 µg of β-carotene per gram of corn, but the researchers think they could increase it to 15 µg/g or more.

Agricultural Research May/June (2010)

Lutein Safety for Infant Formula

While it is agreed that breastfeeding is the best way to ensure an infant receives the nutrients it needs in its first months, formulas are indispensable when mothers are unable to feed their children. The natural lutein content of breast milk varies by country, with a recent survey showing the highest levels in China (230 µg/L) and the lowest levels in the UK (3 µg/L). Carotenoids are currently not added to infant formula. The current study (*Capeding et al. Nutr J 9:22-31, 2010*) recruited 232 infants and randomly assigned them to receive either a control formula or an experimental formula with additional lutein at a level of 200 µg/L. The lutein used in the study was from Kemin. After 16 weeks of intervention, both groups demonstrated "appropriate growth", with no significant differences between the groups. Both study formulas were well tolerated. The findings support the previous conclusions of the European Food Safety Authority (EFSA) from 2008, which deemed lutein safe for use in infant formula in doses up to 250 - 300 µg/L, and 500 µg/L in follow-on formula.

www.nutraingredients-usa.com (5/25/2010)

Carotenoid-rich Probiotics May Offer Double Value as Functional Ingredients

Pigmented spores from strains of *Bacillus* (*B.indicus* HU36 and *B. firmus* GB1) may offer formulators gastric-stable carotenoids as food ingredients. Carotenoid-rich spores could be used commercially as dietary supplements providing a source of carotenoids as well as conferring probiotic properties. The complete genomes for both strains are known. Tests have shown that the spores are very stable, even with alcohol, and can survive mild heat treatments used to sterilize food. Because of their pigments – from yellow to orange to red – they could also be used as food colorings as well as functional ingredients. The spores could be added to beverages and foods, yet retain their probiotic properties *(Cutting SM, Food Microbiol 2010, in press)*.

www.nutraingredients-usa.com (4/22/2010)

Internet Addresses for Carotenoid Researchers

1. USDA Nutrient Database for Standard Reference (SR22) is a major source of food composition data for epidemiologists and nutritionists. Carotenoid Food Database contains best available estimates of carotenoid content in foods: www.nal.usda.gov/fnic/foodcomp/Data/car98/car98.html
2. Agricultural Research Service (ARS) prepared searchable database to view 60-nutrient profile (including carotenoids) for more than 13,000 foods: www.ars.usda.gov/foodsearch
3. International Carotenoid Society (ICS) **Website**: www.carotenoidsociety.org.
4. LIPID BANK for Web. Carotenoid Section of Lipid Database developed by Research Institute, International Medical Center of Japan, http://lipidbank.jp. Also available on ICS webpage: www.carotenoidsociety.org through Articles button.

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