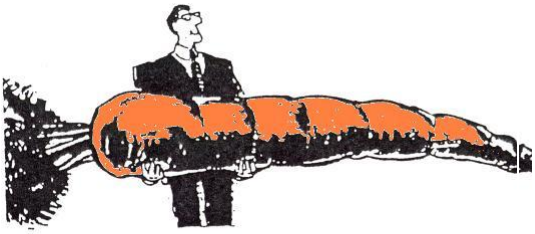

Carotenoid News

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August 2011

FROM THE EDITOR

« Gluttony kills more than the sword »
(Patricius, bishop of Gaeta, fl. 450 AD)

The consequences of excessive eating remain as dire in XXI century as they were in the V century. Worldwide, obesity is dramatically increasing. Severely obese people have 8-10 years shorter life expectancy since they are more likely to develop diabetes, cardiovascular disease, cancer and a host of other disorders. Unfortunately, we have a natural preference for a full stomach and a sweet taste in food. It may lead to excessive energy intake and accumulation of adipose tissue when accompanied by inactive lifestyle. However, an increased consumption of fruits and vegetables instead of energy-dense but micronutrient-poor food may prevent and reverse the development of obesity. We only have to follow another natural preference – the attraction to colorful food. The bright colors of fruits and vegetables are usually due to healthful micronutrients – carotenoids and anthocyanins, which are also implicated in prevention of many chronic diseases.

Recently, certain carotenoids (fucoxanthin, neoxanthin) were found to prevent obesity in laboratory rodents, possibly by increasing energy expenditure in mitochondria of white adipose tissue and by suppression of adipocyte differentiation. However, there are no indications that these carotenoids can be absorbed by humans and appear in plasma in measurable quantities, even in Japanese subjects consuming fucoxanthin-rich seaweed *(Kotake-Nara & Nagao, Marine Drugs 9:1024, 2011)*. Nevertheless, further research may reveal many surprising health effects of carotenoids and the existing data should already entice us to base our diet on colorful fruits and vegetables.

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 2012. 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'12, 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: Mario Ferruzzi, PhD, **email**: mferruzz@purdue.edu; tel: (765) 494-0625.

News from the CARIG Steering Committee

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

We are grateful to Mario Ferruzzi and Sherry Tanumihardjo for organizing very successful CARIG EB 2011 Symposium. The SIGHT AND LIFE Magazine (www.sightandlife.org) has published a report from this conference and a full text of James Olson memorial lecture in the latest issue (2/2011).

The Committee discussed plans for the next CARIG EB2012 conference. It will be again held on Friday before Experimental Biology 2012, on April 20th in San Diego, CA. The topic will be "Xanthophylls: Dietary Sources and Impact through the Life Cycle". We also hope to have four minisymposia on carotenoids at EB2012 (Carotenoids and Health, Molecular Mechanism of Action, Bioavailability and Metabolism, Eye and Brain Health). Further information will be available on ASN webpage (www.nutrition.org/meetings/annual) and in the next issue of Carotenoid News.

UPCOMING EVENTS

April 21 - 25, 2012
Experimental Biology 2012, San Diego, CA. Contact: EB2012, FASEB Office of Scientific Meetings & Conferences, 950 Rockville Pike, Bethesda, MD 20814-3998, **website**: www.experimentalbiology.org, **e-mail**: eb@faseb.org

RECENT / FORTHCOMING PUBLICATIONS

SIGHT AND LIFE Magazine 25 (1) and (2) 2011. PO Box 2116, 4002 Basel, Switzerland, **tel:** 41-61-815-8756, **website:** www.sightandlife.org
e-mail: klaus.kraemer@sightandlife.org
See especially:
Biesalski HK. The importance of vitamin A for the development and function of lungs in newborns. 25(1):16-27.
Engel, P. New developments in carotenoid research. Conference at Tufts University, Boston, USA, 11-12 March, 2011.25(1): 67-70.
Furr HC. Isotope dilution assessment of vitamin A status. James A. Olson Memorial Lecture at CARIG Conference, EB2011. 25(2):24-31.
Solomons NW. The Carotenoid Research Interaction Group (CARIG) Conference, Washington DC, 8 April, 2011. 25 (2): 62-63.

Acta Biologica Cracoviensia 53 Suppl 1 (2011) Series Botanica. Abstracts of the 16th International Symposium on Carotenoids. Website: www.ib.uj.edu.pl/abc/abc/htm

Absorption and metabolism of xanthophylls. Review. Kotake-Nara E, Nagao A. Marine Drugs 9:1024-37(2011).

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.

CONFERENCE REPORTS

Conference on Progress in Carotenoid Research at Tufts

The New Developments in Carotenoids Research Conference was held at the Jean Mayer USDA Human Nutrition Research Center on Aging (HNRCA) at Tufts University, on March 11-12, 2011, in Boston, MA. This meeting brought together investigators from various areas of carotenoid research for an in-depth discussion regarding the recent research and formulation advancements of carotenoids. The conference was developed by an International Organizing Committee, led by co-chairs Simin Nikbin Meydani, PhD, DVM, director of the HNRCA and Robert Russell, MD, president of the American Society for Nutrition and Professor Emeritus at Tufts University. Twenty international experts spoke about function and mechanisms of action of carotenoids in humans. Topics included discussions β-carotene metabolism and daily requirements to meet vitamin A requirements and reduce oxidative damage, genetic polymorphisms that may impact carotenoid requirements, analytical techniques to measure vitamin A activity from β-carotene, biological functions of lycopene and its role in regulating transcription systems and human health, and the role of lutein and zeaxanthin in visual and cognitive performance. In his keynote address, Alfred Sommer, MD, a professor at Johns Hopkins University and dean emeritus of the Bloomberg School of Public Health, spoke about the importance of vitamin A as an essential nutrient, and called for increased randomized clinical trials. “Adequate vitamin A is required for normal organogenesis, immune competence, tissue differentiation and the visual cycle,” he said. “Deficiency, widespread throughout the developing world, is responsible for a million or more instances of unnecessary death and blindness every year.” The following poster awards were presented:
Abdulkerim Eroglu, Ohio State University, “Some β-apocarotenoids function as antagonists of retinoic acid receptors by directly competing at the ligand binding site.”
Binxing Li, John Moran Eye Center, University of Utah, “Expression of β-carotene 9’,10’-oxygenase (BCO@) inhuman retina and RPE choroid.”
Chun Liu, Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, “β-Cryptoxanthin supplementation prevents cigarette smoke induced lung inflammation, oxidative damage and squamous metaplasia in ferrets.”

Elizabeth Johnson (Boston, MA)

Macular Carotenoids and AMD Conference Cambridge, UK

The first Macular Carotenoids & AMD Conference was held in Cambridge, England, at Downing College (July 12-15, 2011). The goal of the meeting was to explore up-to-date and evidence-based research data on the role of the macular carotenoids in age-related macular degeneration (AMD). The meeting brought together internationally recognized leaders in the field, with approximately equal distribution among academia, foundations and industry. Areas of discussion included various aspects on dietary sources of macular carotenoids,

measurement of macular pigment and the relationship of macular carotenoids with AMD. A highlight of the meeting was the poster session which featured the most recent advances in the field. Awards were presented at a gala dinner for the posters which were judged on the basis of novelty, scientific rigor, and the presenting author's knowledge of the research. The winners were:

1st place: Rohini Vishwanathan, Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University: "Macular lutein concentration is related to brain lutein concentration in primates."

2nd place: Katie Meagher, Waterford Institute of Technology: "Optimization of the method to quantify *meso*-zeaxanthin."

3rd place: Sarah O'Reagan, Sightrisk, Ltd. "Update on modifiable risk factors for age-related macular degeneration."

The conference was considered to be successful in bringing together new ideas and directions in macular carotenoid research. This is the first of many scheduled conferences which will take place over the coming years, with the next meeting planned for July 12, 2013, at the same site. The conference was organized by the Howard Foundation and received generous support from industrial sponsors.

Elizabeth Johnson (Boston, MA)

The 16th International Symposium on Carotenoids, Kraków, Poland

Central Europe had to wait long time for an important carotenoid meeting to be organized there. Finally, according to the decision taken during Okinawa meeting, Kraków, with its long and rich history and strong scientific and intellectual environment, was selected as the site of the 16th International Symposium on Carotenoids. The Local Organizing Committee with Kazimierz Strzałka as Chairman and Anna Wiśniewska-Becker as Secretary, with valuable advice of ICS Committee and Symposium Advisory Board, prepared the scientific program of the Symposium. The program was divided into 8 sessions covering all fields of carotenoid research and it included also novel, emerging areas, like computational and *in vitro* studies of carotenoids.

The Symposium gathered 259 participants, among them 67 plenary and session speakers. From the submitted abstracts, 27 have been selected as oral presentation, and 128 contributions were presented as posters. Support of the Symposium by 17 sponsors and exhibitors is also gratefully acknowledged.

There were participants from 37 countries, and from all continents except of Antarctica. The highest number of participants was from the US (45), Poland (43), and Japan (23). From the country most distant to Poland, New Zealand, we had 3 participants.

The 16th International Symposium on Carotenoids was an excellent platform to share the newest achievements and to discuss the future trends in carotenoid research. Moreover, the Symposium was a good occasion to honor eminent carotenoid scientists for their lifetime scientific achievements. Accordingly, Prof. John W. Erdman received the Norman Krinsky award, Prof. Johan Lugtenburg obtained the Otto Isler award and Prof. Joseph Hirschberg was presented with the Trevor Goodwin award.

Additionally, at the Symposium banquet in Wieliczka Salt Mine, Professors Synnøve Liaaen-Jensen, George Britton and Hanspeter Pfander received presidential awards for their enormous contributions to carotenoid science, particularly for writing, editing and publishing the **Carotenoids** book series. The 4th presidential award was given to Maria Sapuntzakis for her many years of contributions in writing and publishing the newsletter Carotenoid News.

A Commission chaired by George Britton and Wiesław Gruszecki evaluated all the displayed posters and selected four of them for grand awards. Authors of three other posters received diplomas. The authors and topics of these posters are listed below:

Alexander Betke, University of Potsdam, Germany, "Two-photon fluorescence excitation (TPF) spectroscopy of pigment-protein complexes and photosynthetic pigments."

Sarah Wagener, University of Duesseldorf, Germany, "Photoprotective effects of aromatic carotenoids in humandermal fibroblasts (hdF)"

Susanne Baldermann, Shizuoka University, Japan "Studies on carotenoids and their volative apocarotenoid products in flowers of *Osmanthus fragrans*."

Muhammad Zeeshan, Norwegian University of Science and Technology, Norway, "Carotenoid as antireductants."

Binxing Li, University of Utah, USA, "Transgenic expression of human macular zeaxanthin-binding protein in mouse retina."

Milan Durchan, Biology Centre of the Academy of Science, Czech Republic, "Spectroscopic properties of astaxanthin aggregates in hydrated solvents."

Jayong Chung and Xiang-Dong Wang, Kyung Hee University, Korea and Tufts University, Boston, USA. "Apo-10'-lycopenoic acid increases both nRNA and protein levels in Sirfl as well as decreasing the fat accumulation the livers of ob/ob mice."

During the Symposium Hideki Hashimoto took over as the ICS President. It is proper time to thank the former President Fred Khachik for his outstanding work for the Society.

The papers presented during the Symposium will be published in Acta Biochimica Polonica. The 15th of October 2011 is the deadline for submitting the manuscripts. For further details see ICS website.

The 17th International Symposium on Carotenoids will be held on June 29 – July 4, 2014, in Park City Resort, Salt Lake City, Utah, USA. This Symposium will be hosted and organized by Paul S. Bernstein, Moran Eye Center, University of Utah.

Kazimierz Strzałka (Krakow, Poland)

TECHNICAL NOTE

High hydrostatic pressure increases fruit carotenoid content

The technology also is known as “pascalization” in honor of the 17th century French scientist Blaise Pascal, famous for research on the effects of pressure on liquids. Applied evenly, the pressure does not squash the food, which can be fresh, processed, liquid or in other forms, but it kills bacteria, molds and viruses. High hydrostatic pressure (HHP) processing has been pointed to as an effective alternative to stabilize tropical fruit pulps due to retention of flavor and desirable sensory characteristics. Project objectives were to evaluate the HHP processing stability of carotenoids from avocado, papaya and mango pulps. HHP processing (600 MPa/3 min) caused an increase in total carotenoid concentrations (~56%) for avocado pulp. Neoxantin b showed the highest increase (513%), followed by α-cryptoxantin (312%), α-carotene (284%), β-cryptoxantin (220%), β-carotene (107%), and lutein (40%). Papaya pulp presented increases in phytofluene (224%), phytoene (222%), lycopene (207%), β-cryptoxanthin (145%) and β-carotene (131%), while mango carotenoids remained unchanged. Higher concentrations of extractable carotenoids were attributed to possible changes in the permeability of cells and chloroplast membranes induced by HHP processing. Additional evidence indicated that HHP application caused oxidative stress within the tissue, and intact RNA molecules were found in pressurized samples, suggesting that the cells were metabolically active and synthesizing carotenoids.

LabNews Daily (8/30/2011)

NEWS AND VIEWS

Metabolic syndrome and serum carotenoids

Potential antiinflammatory and antioxidant effects were recently ascribed to naturally occurring micronutrients. The extent and magnitudes of their differential effects on the metabolic syndrome (MetS) are still unknown. We examined the association between serum antioxidant status and MetS. NHANES 2001–2006 cross-sectional data among adults aged 20–85 y were analyzed (n = 3008–9099). MetS was defined with the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) and also by elevated homeostatic model assessment insulin resistance (HOMA-IR), C-reactive protein (CRP) and hyperuricemia. Serum antioxidants included retinol, retinyl esters, carotenoids [α-carotene, β-carotene (*cis*+*trans*), β-cryptoxanthin, lutein+zeaxanthin, total

lycopene], vitamin E, and vitamin C. MetS (NCEP ATP III) prevalence in U.S. adults was 32.0% among men and 29.5% among women. Adults with MetS had consistently lower serum carotenoid concentrations compared with those without MetS, even after controlling for total cholesterol and TG among other potential confounders. Vitamin E had no significant relationship with MetS in the full multiple logistic regression model, whereas retinol+retinyl esters were inversely related to MetS among men only. The latter were also inversely related to elevated CRP and positively associated with hyperuricemia. Vitamin C exhibited a similar pattern to serum carotenoids with an inverse linear association with MetS, HOMA-IR, and hyperuricemia. Future intervention studies of dietary and lifestyle change must be conducted to assess the utility of modifying serum antioxidant concentrations, especially carotenoids, given their suboptimal levels among U.S. adults with MetS, for the prevention of type 2 diabetes and various cardiovascular endpoints.

Beydoun MA, et al. J Nutr 141:903 (2011)

Racial differences in correlations between reported intakes of carotenoids and their plasma concentrations

The predictive abilities of 24-h dietary recalls and a food-frequency questionnaire in reporting dietary carotenoids when measured against concentration biomarkers were assessed in African Americans and compared with the findings in whites. Data were collected from 250 generally healthy, nonsmoking white and African American participants aged 21–69 y, who completed 8 self-administered online 24-h dietary recalls and one National Cancer Institute diet-history questionnaire in the University of California Los Angeles (UCLA) Energetics Study. Mean intakes from 4-d dietary recalls were correlated with plasma xanthophyll concentrations (lutein + zeaxanthin and β-cryptoxanthin) and hydrocarbon carotenoids (lycopene, α-carotene, and β-carotene). Adjusted correlations of plasma carotenoids with reported dietary intakes for African Americans in the 24-h dietary recall ranged from 0.03 for β-carotene to 0.40 for β-cryptoxanthin. For whites, the correlations ranged from 0.13 for lycopene to 0.51 for β-cryptoxanthin. Despite stronger validity in reported energy intakes for African Americans than for whites in the 24-h dietary recall in the Energetics Study, both recalls and food-frequency dietary assessment methods yielded lower correlations in African Americans than in whites. This finding might be attributable to reporting differences in both dietary sources and food preparation or to racially related genetic variants influencing circulating concentrations. The current findings support the need to account for differences in race, age, sex, and body mass index in regression calibrations of dietary reports and measurement error adjustments.

Arab L, et al. Am J Clin Nutr 93:1102 (2011)

Lycopene bioavailability and metabolism in humans: an accelerator mass spectrometry study

The objective of this study was to quantify the long-term human bioavailability of lycopene in plasma and skin after a single dose of ^{14}C-lycopene and to profile the metabolites formed. We preselected two male subjects as lycopene absorbers and gave them an oral dose of 10 mg synthetic lycopene combined with ≈6 μg [6,6',7,7'-^{14}C] lycopene (≈30,000 Bq; 92% trans lycopene). The appearance of ^{14}C in plasma, plasma triacylglycerol-rich lipoprotein (TRL) fraction, urine, expired breath carbon dioxide, and skin biopsies was measured over 42 d. The ^{14}C in lycopene-isomer fractions from plasma and TRL fraction was measured to assess the isomerization of lycopene *in vivo*. The time to maximum concentration (t_{max}) of total ^{14}C-lycopene in plasma was 6 h, and the elimination half-life ($t_{1/2}$) was 5 d, which were different from the t_{max} and $t_{1/2}$ of unlabeled lycopene (0.5 and 48 d, respectively). ^{14}C-lycopene was extensively isomerized after dosing as a 92% all-trans isomer at dosing, but changed to 50% trans, 38% 5 cis, 1% 9 cis, and 11% other cis isomers after 24 h. A similar pattern of isomerization was seen in plasma TRL fractions. Lycopene was rapidly metabolized into polar metabolites excreted into urine, with the rapid peak of $^{14}CO_2$ after dosing, which implies that β-oxidation was involved in the lycopene metabolism. Lycopene or its metabolites were detected in skin for up to 42 d.

Ross AB, et al. Am J Clin Nutr 93: 1263 (2011)

Yellow maize with high β-carotene is an effective source of vitamin A

The objective of this study was to determine the vitamin A value of yellow maize β-carotene in humans. High β-carotene–containing yellow maize was grown in a hydroponic medium with 23 atom% ^2H_2O during grain development. Yellow maize β-carotene showed the highest abundance of enrichment as [$^2H_9$] β-carotene. Eight healthy Zimbabwean men volunteered for the study. On day 1 after a fasting blood draw, subjects consumed 300 g yellow maize porridge containing 1.2 mg β-carotene, 20 g butter, and a 0.5-g corn oil capsule. On day 8, fasting blood was drawn, and subjects consumed 1 mg [$^{13}C_{10}$] retinyl acetate in a 0.5-g corn

oil capsule and 300 g white maize porridge with 20 g butter. Blood samples were collected from each subject over 36 d. Concentrations and enrichments of retinol and β-carotene in labeled doses and serum were determined with the use of HPLC, GC-MS, and LC-MS. The area under the curve (AUC) of retinol from 1.2 mg maize β-carotene was 72.9 nmol·d, and the AUC of retinol from 1 mg retinyl acetate $^{13}C_{10}$ was 161.1 nmol·d. The conversion factor of yellow maize β-carotene to retinol by weight was 3.2 ± 1.5 to 1. Therefore, in 8 healthy Zimbabwean men, 300 g cooked yellow maize containing 1.2 mg β-carotene, consumed with 20.5 g fat, showed the same vitamin A activity as 0.38 mg retinol and provided 40–50% of adult vitamin A RDA.

Muzhingi T, et al. Am J Clin Nutr 94:510 (2011)

Internet Addresses for Carotenoid Researchers

1. USDA Nutrient Database for Standard Reference (SR23) 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/car_tbl.pdf and www.nal. usda. gov/fnic/ foodcomp/Data/car98/zea_tbl.pdf
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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