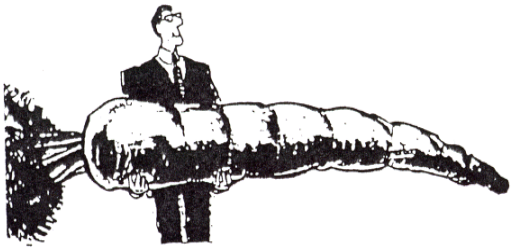

Carotenoid

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FROM THE EDITOR

"Results! Why, man, I have gotten a lot of results, I know several thousand things that won't work." (Thomas A. Edison)

Carotenoid researchers are very familiar with the sentiments expressed by the great American inventor, in pursuit of a light bulb filament. Many of us have shelves and drawers full of negative results which were never published. Established journals tend to reject negative studies, and our own pride censors such research.

The epidemiologists first started to lament this publication bias, which severely impairs the meta-analysis of multiple trials, since negative outcomes are underrepresented. However, other researchers, who study carotenoids in cell cultures, animals and plants, performing extractions and chromatography of these notoriously fickle compounds, would also love an opportunity to learn from one another's mistakes. Considering our present tight budgets due to a change in global economical priorities, it is even more necessary to avoid duplicating unsuccessful experiments and to direct the available funding toward new approaches.

The Internet presents an ideal venue for rapid dissemination of such valuable information about "things that won't work." There is already a *Journal of Negative Observations in Genetic Oncology* (www.path.jhv.edu/nogo/) focusing on gene mutation studies and cancer, *Journal of Articles in Support of the Null Hypothesis* (www.jasnh.com) for psychological studies, and *Journal of Negative Results in Biomedicine* (www.jnrbm.com), just announced. We all should be encouraged to publish our negative results in the established journals, or in the above mentioned online journals. Carotenoid News also welcomes short notes of this nature in our columns (Technical Note, Letter to the Editor). Let us not forget that *"Research serves to make building stones out of stumbling blocks" (Arthur D. Little)*.

Maria S. Sapuntzakis (Chicago, IL)

News from the CARIG Steering Committee

The CARIG Steering Committee met at EB'02 in New Orleans to decide on our future plans and election of new members. We accepted the resignation of Harold Furr from the Chair and elected Dale Cooper (Procter & Gamble Co.) in his place. Dr. Furr deserves our gratitude for his unflinching support of all CARIG ventures during his term on the Committee, and we wish him success and fulfillment in his new position at Craft Technologies. Steve Clinton (Ohio State University) also ended his term, but three new members were elected. The membership of the CARIG Steering Committee now includes:

Dale Cooper (chair) – Procter & Gamble Co.
Boon Chew (treasurer) – Washington State University
Neal Craft (fundraising) – Craft Technologies, Inc.
John Landrum – Florida International University
Julie Mares-Perlman – University of Wisconsin-Madison
Cheryl Rock (Conference coordinator) – University of California - San Diego
Noel Solomons (fundraising) – CeSSIAM, Guatemala
Maria Stacewicz-Sapuntzakis (newsletter editor) – University of Illinois at Chicago
Sherry Tanumihardjo – University of Wisconsin-Madison
Wendy White (Conference coordinator) – Iowa State University

Among other topics discussed was the question of whether CARIG should become a Research Interest Section (RIS) within the American Society of Nutritional Sciences (ASNS). However, one of the current requirements of ASNS is that all members of a RIS must be members of ASNS; it was decided this would be too restrictive, since a number of members of CARIG are not members of ASNS. Meanwhile, ASNS has been very supportive of CARIG, and very helpful in making arrangements for the meetings held in conjunction with Experimental Biology.

Carotenoids Minisymposium at EB'02

CARIG did not host a Conference this year because the International Carotenoids Society had its 13th Symposium in January. However, CARIG served as co-sponsor of the EB Carotenoids Minisymposium, and sponsored the James Allen Olson Memorial Perspective on Carotenoids: "Carotenoids as Dietary Precursors of Vitamin A: Their Past and Their Future," a lecture presented by Dr. Noel Solomons (see REPORT).

Other papers presented at the Carotenoids Minisymposium included: A. B. Barua et al., "Absorption and metabolism of 11,12-^{3}H-∃-carotene in rats with different vitamin A status"; M. A. Horvitz et al., "Bioavailability of lycopene from lycopene 'red' carrots"; S. Zaripheh et al., "The biodistribution of lycopene in the F344 rat model" ; V. Diwadkar-Navsariwala et al., "Compartmental analysis of the dynamics of lycopene metabolism in healthy men"; M. Root et al., "Carotenoid status of middle-aged women in five counties in rural China"; K.-J. Yeum et al. "Dietary modification of antioxidant capacity in the lipid compartment of serum. "

The James Olson Student Travel Award, sponsored by CARIG, was awarded to Veda Diwadkar-Navsariwala, University of Illinois at Chicago.

Advance Notice of CARIG EB 2003 Conference

As it has in past years, CARIG will sponsor our annual Conference concurrent with the EB2003 meeting in San Diego. The Conference will be held Saturday, April 12 from 12:30-4:30 and will feature topics of current interest to carotenoid researchers. Meeting details, including speakers, topics and location, will be posted on the Internation Carotenoid Society website (http://carotenoidsociety.org) in the near future, and will be included in the next issue of Carotenoid News. We hope to see you there!

CARIG plans to provide Student Travel Awards to Experimental Biology 2003. Details will be published in the February newsletter. We also plan a display of graduate student posters at the CARIG EB Conference.

UPCOMING EVENTS

October 19-22, 2002
American Dietetic Association 85th Annual Meeting. Philadelphia, PA. 2002 Food & Nutrition Conference and Exhibition. Research Symposium on latest phytochemical issues includes " Carotenoids and smoking: What's new in β-carotene and lycopene" (Dr. Robert Russell). Contact: ADA FNCE Registration **tel**:866-451-6444, **website**: www.eatright.org/fnce

November 20-24, 2002

9th Annual Meeting of The Oxygen Society. San Antonio, Texas. Contact: The Oxygen Society, 2950 Buskink Ave, Ste 170, Walnut Creek, CA 94596, **tel**:925-472-5904, **fax**:925-472-5901, **website**: www.oxygensociety.org

February 3-4, 2003
XXI International Vitamin A Consultative Group Meeting. Marrakech, Morocco. Tentative theme: Improving the Vitamin A Status of Populations. Contact: IVACG Secretariat, ILSI Research Foundation, One Thomas Circle, NW, 9th floor, Washington DC 20005-5802, **tel**:202-659-9024, **fax**:202-659-3617, **website**: www.ivacg.ilsi.org

April 11-15, 2003
Experimental Biology 2003, San Diego, CA. Contact: EB 2003, c/o FASEB Office of Scientific Meetings, 9650 Rockville Pike, Bethesda MD 20814-3998, **tel:** 301-530-7010, **fax:** 301-530-7014, **E-mail:** eb@faseb.org **website:** www.faseb.org/meetings/eb2003

May 21-24, 2003
Diet and Optimum Health, Portland, Oregon. Prevention and treatment of human diseases by vitamins, micronutrients and phytochemicals. Role of oxidative stress and antioxidants in health and disease. A conference organized by Linus Pauling Institute, and co-sponsored by Oxygen Club of California. Contact: Linus Pauling Institute, Oregon State University, 571 Weniger Hall, Corvallis, OR 97331-6512, **tel**:541-737-5075, **fax**:541-737-5077, **website**: http://lpi.orst.edu

RECENT / FORTHCOMING PUBLICATIONS

Can Lutein Protect Against Chronic Disease? Proceedings of Symposium given at EB '01 Orlando, FL, on April 2, 2001. Eds J. A. Mares-Perlman, J. W. Erdman Jr. *J Nutr* 132:517S-542S, 2002. Cross-disciplinary presentations, ranging from studies of experimental animals and cell cultures to epidemiology.

Proceedings of the 13th International Carotenoid Symposium will be published later this year in Pure and Applied Chemistry (15 plenary and invited lectures from the conference). To order, contact IUPAC Secretariat, P.O.Box 13757, Research Triangle Park, NC 27709. **tel**: 919-485-8700, **fax**: 919-485-8706,
E-mail: secretariat@iupac.org and ask to purchase the carotenoids issue (USD $50). The order form can be found at the **website**: www.iupac.org/publications/books/order.html The participants of the Symposium can order the proceedings in advance for $30 by contacting Dr John Bertram, **E-mail**: John@crch.hawaii.edu

SIGHT AND LIFE Newsletter 2002, publication of the Task Force SIGHT AND LIFE, PO Box 2116, 4002 Basel, Switzerland, **tel**: 41-61-688-7494; **fax**: 41-61-688-1910, **website**: www.sightandlife.org. Devoted to combat nutritional blindness and all forms of vitamin A deficiency.

Carotenoid-Derived Aroma Compounds. Winterhalter, P. & Rouseff, R. L. (eds), American Chemical Society, Washington DC, 336pp. 2001. Contact: Oxford University Press, **website**: www.oup-usa.org. This volume highlights the importance of carotenoid metabolites in the flavor and fragrance industry. It provides state-of-the art coverage of analytical and sensory characteristics of carotenoid-derived aroma compounds. The book includes discussion of biotechnological and thermal formation, as well as the occurrence and generation of carotenoid-derived aroma compounds in tobacco, tea, flower scents, fruits, spices and wine.

Alphabetical Listing of Recent Publications from March 2002

This issue of the Carotenoids Literature Citations is not complete because of Dr. Furr's recent move from the University of Connecticut to Craft Technologies, Inc. Future issues will bring the Literature Citations up to date. More complete list will be available at ICS website:
http:// www.carotenoid.uconn.edu

Alaluf, S., Heinrich, U., Stahl, W., Tronnier, H. & Wiseman, S. (2002) Dietary carotenoids contribute to normal human skin color and UV photosensitivity. *J. Nutr.* **132**: 399-403

Anderson, P.O., Takaichi, S., Cogdell, R.J., & Gillbro, T. (2001) Photophysical characterization of normal cis-carotenoids. Photochem. Photobiol. 74 (4): 549-557

Arab, L., Steck-Scott, S., & Bowen, P. (2001) Participation of lycopene and β-carotene in carcinogenesis: Defenders, aggressors, or passive bystanders? *Epidemiologic Reviews* **23**: 211-230

Barua, A. B. (2001) Improved normal-phase and reversed-phase gradient HPLC procedures for the analysis of retinoids and carotenoids in human serum, plant and animal tissues. *J. Chromatogr. A.* **936**: 71-82

Beyer, P., Al-Babili, S., Ye, X., Lucca, P., Schaub, P., Welsch, R. & Potrykus, I. (2002) Golden Rice: Introducing the β-carotene biosynthesis pathway into rice endosperm by genetic engineering to defeat vitamin A deficiency. *J. Nutr.* **132**: 506S-510S

Brown Thomas, J., Kline, M. C., Gill, L. M., Yen, J. H., Duewer, D. L., Sniegoski, L. T. & Sharpless, K. E. (2001) Preparation and value assignment of Standard Reference Material 968c Fat-Soluble Vitamins, Carotenoids, and Cholesterol in Human Serum. *Clin. Chim. Acta* **305**: 141-155

Curran Celentano, J., Burke, J. D. & Hammond, B. R.,Jr. (2002) *In vivo* assessment of retinal carotenoids: macular pigment detection techniques and their impact on monitoring pigment status. *J. Nutr.* **132**: 535S-539S

De Roos, A. J., Arab, L., Renner, J. B., Craft, N., Luta, G., Helmick, C. G., Hochberg, M. C. & Jordan, J. M. (2001) Serum carotenoids and radiographic knee osteoarthritis: the Johnston County Osteoarthritis Project. *Public Health Nutr.* **4**: 935-942

den Heijer, T., Launer, L. J., de Groot, J. C., de Leeuw, F. E., Oudkerk, M., van Gijn, J., Hofman, A. & Breteler, M. M. (2001) Serum carotenoids and cerebral white matter lesions: the Rotterdam scan study. *J. Am. Geriatr. Soc.* **49**: 642-646

Edwards, A. J., Nguyen, C. H., You, C. S., Swanson, J. E., Emenhiser, C. & Parker, R. S. (2002) α- and β-carotene from a commercial puree are more bioavailable to humans than from boiled-mashed carrots, as determined using an extrinsic stable isotope reference method. *J. Nutr.* **132**: 159-167

El-Satedm W.S.M., Takaichi, S., Saida, H., Kamekura, M., Abu-Shady, M., Seki, H., Kuwabara, T. (2002) Effects of light and low oxygen tension on pigment biosynthesis in *Halobacterium salinarum*, revealed by a novel method to quantify both retinal and carotenoids. *Plant Cell Physiol.* **43** (4): 379-383

Fleischmann, P., Studer, K. & Winterhalter, P. (2002) Partial purification and kinetic characterization of a carotenoid cleavage enzyme from quince fruit (*Cydonia oblonga*). *J. Agric. Food Chem.* **50**: 1677-1680

Gellermann, w., Ermakov, I. V., & McClane, R. W. (2002) Raman imaging of human macular pigments. *Optics Letters* **27**: 833-835

Harada, J., Nagashima, K.V.P., Takaichi, S., Misawa, N., Matsuura, K., Shimada, K. (2001) Phytoene desaturase, CrtI, of the purple photosynthetic bacterium, *Rubrivivax gelatinosus*, produces both neurosporene and lycopene. *Plant Cell Physiol.* **42** (10): 1112-1118

Henry, L. K., Puspitasari-Nienaber, N. L., Jaren-Galan, M., van Breemen, R. B., Catignani, G. L. & Schwartz, S. J. (2002) Effects of ozone and oxygen on the degradation of carotenoids in an aqueous model system. *J. Agric. Food Chem.* **48**: 5008-5013

Herrero, C., Granado, F., Blanco, I. & Olmedilla, B. (2002) Vitamin A and E content in dairy products: their contribution to the recommended dietary allowances (RDA) for elderly people. *J. Nutr. Health Aging* **6**: 57-59

Hickenbottom, S. J., Follett, J. R., Lin, Y., Dueker, S. R., Burri, B. J., Neidlinger, T. R. & Clifford, A. J. (2002) Variability in conversion of β-carotene to vitamin A in men as measured by using a double-tracer study design. *Am. J. Clin. Nutr.* **75**: 900-907

Huang, D., Ou, B., Hampsch-Woodill, M., Flanagan, J. A. & Deemer, E. K. (2002) Development and validation of oxygen radical absorbance capacity assay for lipophilic antioxidants using randomly methylated β-cyclodextrin as the solubility enhancer. *J. Agric. Food Chem.* **50**: 1815-1821

Hwang, E.-S., Bowen, P. E. (2002) Can the consumption of tomato or lycopene reduce cancer risk? *Integrative Cancer Therapies* **1**: 121-132

Krinsky, N. I. (2002) Possible biologic mechanisms for a protective role of xanthophylls. *J. Nutr.* **132**: 540S-542S

Lee, H. S. (2002) Objective measurement of red grapefruit juice color. *J. Agric. Food Chem.* **48**: 1507-1511

Li, H. B., Jiang, Y. & Chen, F. (2002) Isolation and purification of lutein from the microalga *Chlorella vulgaris* by extraction after saponification. *J. Agric. Food Chem.* **50**: 1070-1072

Lyan, B., Azais-Braesco, V., Cardinault, N., Tyssandier, V., Borel, P., Alexandre-Gouabau, M. C. & Grolier, P. (2001) Simple method for clinical determination of 13 carotenoids in human plasma using an isocratic HPLC method. *J. Chromatogr. B. Biomed. Sci. Appl.* **751**: 297-303

MacTavish, H., Davies, N. W. & Menary, R. C. (2001) Bound volatiles in brown boronia flowers (*Boronia megastigma*). In: *Carotenoid-Derived Aroma Compounds* (Winterhalter, P. & Rouseff, R. L., eds) pp. 183-193. American Chemical Society, Washington,DC.

Mares-Perlman, J. A. & Erdman, J. W.,Jr. (2002) Can lutein protect against chronic disease? A multidisciplinary approach involving science and epidemiology to weigh evidence and design analytic strategies. Intro. *J. Nutr.* **132**: 517S.

Mares-Perlman, J. A., Millen, A. E., Ficek, T. L. & Hankinson, S. E. (2002) The body of evidence to support a protective role for lutein and zeaxanthin in delaying chronic disease. Overview. *J. Nutr.* **132**: 518S-524S

McGraw, K. J., Adkin-Regan, E., & Parker, R. S. (2002) Anhydrolutein in the zebra finch: a new metabolically derived carotenoid in birds. *Comparative Biochemistry and Physiology Part B* **132**: 811-818

Perkins-Veazie, P., Collins, J. K., Pair, S. D. & Roberts, W. (2001) Lycopene content differs among red-fleshed watermelon cultivars. *J. Sci. Food Agric.* **81**: 983-987

Prakash, P., Manfredi, T. G., Jackson, C. L. & Gerber, L. E. (2002) β-Carotene alters the morphology of NCI-H69 small cell lung cancer cells. *J. Nutr.* **132**: 121-124

Rock, C. L., Thornquist, M. D., Neuhouser, M. L., Kristal, A. R., Neumark-Sztainer, D., Cooper, D. A., Patterson, R. E. & Cheskin, L. J. (2002) Diet and lifestyle correlates of lutein in the blood and diet. *J. Nutr.* **132**: 525S-530S

Rozzi, N. L., Singh, R. K., Vierling, R. A. & Watkins, B. A. (2002) Supercritical fluid extraction of lycopene from tomato processing byproducts. *J. Agric. Food Chem.* **50**: 2638-2643

Steiger, S., Takaichi, S., Sandmann, G. (2002) Heterologous production of two novel acyclic carotenoids, 1,1'-dihydroxy-3,4-didehydrolycopene and 1-hydroxy-3,4,3',4' tetradehydrolycopene by combination of the crtC and crtD genes from *Rhodobacter* and *Rubrivivax*. J. Biotechnol. 97 (1): 51-58

Sulaeman, A., Giraud, D. W., Naslund, M. M. & Driskell, J. A. (2002) Mongolian gerbils can utilize provitamin-A carotenoids in deep-fried carrot chips. *J. Nutr.* **132**: 211-217

Takaichi, S., Maoka, T., Yamada, M., Matsuura, K., Haikawa, Y., Hanada, S. (2001) Absence of carotenes and presence of a tertiary methoxy group in a carotenoid from a thermophilic filamentous photosynthetic bacterium *Roseiflexus castenholzii*. Plant Cell Physiol. 42 (12): 1335-1362

Takeoka, G. R., Dao, L., Flessa, S., Gillespie, D. M., Jewell, W. T., Huebner, B., Bertow, D. & Ebeler, S. E. (2002) Processing effects on lycopene content and antioxidant activity of tomatoes. *J. Agric. Food Chem.* **49**: 3713-3717

Tang, G., Qin, J., Dolnikowski, G. G. & Russell, R. M. (2000) Vitamin A equivalence of β-carotene in a woman as determined by a stable isotope reference method. *Eur. J. Nutr.* **39**: 7-11

Toyoda, Y., Thomson, L. R., Langner, A., Craft, N. E., Garnett, K. M., Nichols, C. R., Cheng, K. M. & Dorey, C. K. (2002) Effect of dietary zeaxanthin on tissue distribution of zeaxanthin and lutein in quail. *Invest. Ophthalmol. Vis. Sci.* **43**: 1210-1221

Tyssandier, V., Lyan, B. & Borel, P. (2001) Main factors governing the transfer of carotenoids from emulsion lipid droplets to micelles. *Biochim. Biophys. Acta* **1533**: 285-292

Vagi, E., Simandi, B., Daood, H. G., Deak, A. & Sawinsky, J. (2002) Recovery of pigments from *Origanum majorana L.* by extraction with supercritical carbon dioxide. *J. Agric. Food Chem.* **50**: 2297-2301

van Breemen, R. B., Xu, X., Viana, M. A., Chen, L., Stacewicz-Sapuntzakis, M., Duncan, C., Bowen, P. E. & Sharifi, R. (2002) LC-MS of *cis*- and all-*trans*-lycopene in human serum and prostate tissue after dietary supplementation with tomato sauce. *J. Agric. Food Chem.* **50**: 2214-2219

Van Hoydonck, P. G., Temme, E. H. & Schouten, E. G. (2002) A dietary oxidative balance score of vitamin C, β-carotene and iron intakes and mortality risk in male smoking Belgians. *J. Nutr.* **132**: 756-761

van Stuijvenberg, M. E., Dhansay, M. A., Lombard, C. J., Faber, M. & Benade, A. J. (2001) The effect of a biscuit with red palm oil as a source of β-carotene on the vitamin A status of primary school children: a comparison with β-carotene from a synthetic source in a randomised controlled trial. *Eur. J. Clin. Nutr.* **55**: 657-662

Vuong le, T., Dueker, S. R. & Murphy, S. P. (2002) Plasma β-carotene and retinol concentrations of children increase after a 30-d supplementation with the fruit *Momordica cochinchinensis (gac)*. *Am. J. Clin. Nutr.* **75**: 872-879

Yoshii, Y., Takaichi, S., Maoka, T., Hanada, S., Inouye, I. (2002) Characterization of two unique carotenoid fatty acid esters from *Pterosperma cristatum* (*Prasinophyceae, Chlorophyta*). J. Phycol. 38 (2): 297-303

Zaripheh, S. & Erdman, J. W.,Jr. (2002) Factors that influence the bioavailablity of xanthophylls. *J. Nutr.* **132**: 531S-534S

MEETING REPORT

"Carotenes as dietary precursors of vitamin A: their past and their future"

Lecture presented by Noel W. Solomons, MD, CeSSIAM, Guatemala, at the Carotenoids Minisymposium, EB'02

Dr. Solomons presented a provocative talk on the role of provitamin A carotenoids in meeting human vitamin A requirements, approaching the topic in terms of carotenoid functions (dietary precursors of vitamin A) and carotenoid actions (preservation of physiology and prevention of illness). He first considered the evolutionary determinants of vitamin A requirements, and of conversion of provitamin A carotenoids to retinoids. He then addressed the sticky issue of defining retinol equivalency of provitamin A sources, with a brief review of conversion factors and the dietary factors that affect bioefficacy of carotenoids. Approaches to improving provitamin A intake (genetic engineering of rice, carotene-pigmented oils) were discussed. In conclusion, Dr. Solomons raised these challenges to the carotenoid research community: 1) to extend the use of stable isotope methods for determining vitamin A status to developing countries; 2) to determine if "low response" of plasma carotenoid concentrations to dietary doses of carotenoid is a result of genetic polymorphisms in the carotenoid cleavage enzyme or if other factors are responsible; 3) to study carotenoid actions (not only carotenoid functions) in human health in developing countries.

Harold Furr (Wilson, NC)

TECHNICAL NOTE

Measurement of Macular Pigment by Resonance Raman Spectroscopy

A new device developed by University of Utah ophthalmology and physics researchers could eventually help physicians to slow and possibly prevent the onset of age-related macular degeneration in some patients. Macular degeneration is the leading cause of blindness in the people over age 65; it affects more than 13 million Americans. The new device uses a low-energy laser method, known as resonance Raman spectroscopy, to measure the levels of two macular carotenoid pigments called lutein and zeaxanthin, according to Paul S. Bernstein, assistant professor of ophthalmology and visual sciences at the University of Utah's Moran Eye Center. The pigments, which are found in dark green leafy vegetables (such as spinach, broccoli, collard greens and kale) and yellow and orange colored fruits and vegetables (such as peaches, nectarines, persimmons and corn), are widely thought to protect the eye from light-induced oxidative damage and aging. "Both lutein and zeaxanthin are potent antioxidants. They effectively absorb the blue region of the visible spectrum, the most damaging wavelengths of light to which the retina is routinely exposed," said Bernstein. "This new test will allow us to determine whether raising a patient's macular pigment levels through diet and nutritional supplements translates into a lower risk for macular degeneration."

Bernstein says that the non-invasive test, which takes less than one second, could become as common as tests for high cholesterol and blood glucose levels. "If, based on the results of this test, a physician determines a patient has low levels of macular pigment, that patient could be encouraged to increase consumption of foods or nutritional supplements containing lutein and zeaxanthin. It is possible that we could slow, or

even prevent, onset of macular degeneration," he said. The new test is unique because it uses Raman spectroscopy, a technology traditionally considered unsuitable for routine measurements in living tissue, according to Werner Gellermann, research professor in the University of Utah's Department of Physics and associate director of the university's Dixon Laser Institute where the technique was developed. "Raman signals are typically of weak intensity and therefore we usually need to use lasers in combination with sophisticated light collection and analysis instrumentation," he said. What Gellermann and Bernstein found, however, was that macular pigments in the eye exhibit extremely strong Raman signals when excited with blue laser, a phenomenon termed resonance enhancement. "Lutein and zeaxanthin seemed uniquely suited for Raman spectrometry. The pigments literally glow green when a blue laser light shines on them. Under proper conditions, this resonance amplification can be as high as a factor of 10,000, turning a weak signal into a readily measured strong signal many times higher than background signals from other cells in the retina. This allows us to expose the retina to light exposure levels that are well within established safety ranges," he said. "As physicists, we're trained to not to stare into lasers. But, when our colleagues at the Moran Eye Center pointed out the strong need to measure macular pigments in a non-invasive and objective way, we decided to take this unique laser approach," said Gellermann. Bernstein says the new technique also can be used with higher reliability in patients with significant visual loss from macular degeneration or other diseases unlike heterochromatic flicker photometry (the most commonly used test to measure macular pigments).

University of Utah Press Release
March 14, 2001

NEWS AND VIEWS

A Yellow-Faced Vulture Obtains Carotenoids from Dung

The rare Egyptian vulture (*Neophron percnopterus)* stands out among the Old World vultures (Family *Accipitridae)* because of its brightly ornamented head, which is coloured yellow by carotenoid pigments, and its practice of feeding on faeces. The Egyptian vulture has earned the nickname in Spain of 'churretero' or 'moniguero', meaning 'dung-eater'. Here we show that Egyptian vultures obtain these pigments from the excrement of ungulates. To our knowledge, this is the first demonstration that faeces can be used as a source of carotenoids by a vertebrate.

We used HPLC to analyse the carotenoid content of ungulate faeces and to identify the carotenoids that are transported in the plasma and deposited in the yellow facial skin of *N. percnopterus*. A single peak for lutein (which co-eluted with small quantities of zeaxanthin) was observed in all samples, accounting for over 95% of the total main carotenoid content. Lutein concentration in vulture skin (sampled from a freshly dead adult bird found in the wild) was 98 μg/g, and a mean concentration of 6.5 μg/ml was found in plasma (0.3-42.1μg/ml, n=196). Mean lutein concentrations in faeces were 35.7 μg/g in cow dung, 185.8 μg/g in sheep droppings, and 36.6 μg/g in goat droppings (two samples were analysed from each species of ungulate). We confirmed that *N. percnopterus* obtains carotenoids from cow dung by conducting a food trial on four adult birds at Jerez Zoo, Spain.

This excessive consumption of pigment suggests a possible evolutionary mechanism for the development of carotenoid-dependent ornaments in *N. percnopterus*. The resulting yellow coloration could have become a useful signal in mating displays, for advertising dominant status, or both.

J.J Negro, J. M. Grande, J. L. Tella, J. Garrido, D. Hornero, J. A. Donazar, J. A. Sanchez-Zapata, J. R. Benites, M. Barcell
Nature, vol 416: 807-808, April 25, 2002

Purple Carrots

LONDON, England (CNN) -- The carrot is to return to its roots when it goes on sale in what's said to be its true colour of purple.

Growers say they have dug up the vegetable's original colour and will revert to the new hue this summer for the first time in Europe in five centuries. Purple carrots, which will retain their orange-coloured centre, will appear on the shelves of Sainsbury's supermarkets at a slightly higher price than the more familiar version. Purple-coloured carrots, which contain purple-red pigments called anthocyanins, were first grown in the Middle and Far East, along with white, red, yellow, green and black versions. The Dutch then introduced the orange carrots in honour of its national colour in the 16th century.

The purple carrots are being grown in Ely, Cambridgeshire. Sainsbury's hopes the bright colours and sweet flavour will encourage children to eat more carrots.

Orange carrots have some health advantages thanks to beta carotene, precursor of Vitamin A, essential for vision in dim light and for healthy skin. It is believed that purple carrots provide extra protection against some forms of cancer and heart disease. A recent study concluded they contain pigments that act as antioxidants.

CNN.com/World
May 16, 2002

Watermelon Packs a Powerful Lycopene Punch

Imagine eating a crisp, juicy slice of watermelon on a hot summer day and receiving great health benefits at the same time! An all-American favorite, watermelon is highly nutritious and packed full of the phytochemical lycopene. It's one of the few foods that contain it in large amounts. Other good sources include tomatoes, red and pink grapefruit, and guava. Studies have shown that a cup and a half of watermelon contains about 9 to 13 mg of lycopene. On average, watermelon has about 40 percent more lycopene than raw tomatoes.

Scientists have found that lycopene in the diet correlates with reduced incidence of certain types of cancer. And lycopene levels in fat tissue — an indicator of lycopene consumption — have been linked with reduced risk of myocardial infarction (heart attack).

In late summer of 2000, the Agriculture Research Service nutritionist Beverly Clevidence and chemist Alison Edwards of the Phytonutrients Laboratory began a 19-week study of 23 healthy adults to assess the bioavailability of lycopene from watermelon. In a random order, all volunteers received the W-20 treatment (20 mg of lycopene a day from watermelon juice) and the C-0 treatment (control, no juice). In addition, they received either the W-40 treatment (40 mg of lycopene a day from watermelon juice) or T-20 treatment (20 mg of lycopene a day from tomato juice). The investigators found that all juice treatments increased the plasma concentration of lycopene. Lycopene concentration was similar regardless of whether subjects consumed 20 mg of lycopene from tomato juice or from watermelon juice, which was not heat-processed.

"To our knowledge, this is the first study to show that lycopene from watermelon is bioavailable." says Clevidence. " Next, we would like to find out if plasma lycopene levels are higher when people eat watermelon with a meal containing fat than when they eat it by itself."

Jennifer Arnold,
Agricultural Research, June 2002

Isolation and Characterization of a Carotenoid-binding Protein from Silk Worm

A carotenoid binding protein (CBP) has been isolated from the silk glands of *Bombyx mori* larvae. The protein has an apparent molecular mass of 33KDa and binds carotenoids in a 1:1 molar ratio. Lutein accounts for 90% of the bound carotenoids. Immunological analysis demonstrated the presence of CBP only in the yellow colored tissues of the silk gland, midgut, testis and ovary. Immunohistochemistry verified the localization of CBP in the villi of the midgut epithelium, indicating that CBP might be involved in absorption of carotenoids. A cDNA clone for CBP encoding a protein of 297 amino acids has been isolated from the *B. mori* silk gland cDNA library. The deduced amino acid sequence revealed that CBP is a novel member of the steroidogenic acute regulatory (StAR) protein family with its unique structural feature of a StAR-related lipid transfer domain, known to aid in lipid transfer and recognition. Sequence analyses coupled with binding specificity suggest that CBP is a new member of the StAR protein family that binds carotenoids rather than cholesterol.

Tabunoki H, Sugiyama H, Tanaka Y, Fujii H, Banno Y, Jouni ZE, Kobayashi M, Sato R, Maekawa H, Tsuchida K. J Biol Chem, vol 277:32133-40, June 6, 2002

Molecular Mechanism of Carotenoid Cellular Uptake in *Drosophila*

Carotenoids are currently being intensely investigated regarding their potential to lower the risk of chronic disease and vitamin A deficiency. Invertebrate models, in which vitamin A deficiency is not lethal, allow the isolation of blind but viable mutants affected in the pathway leading from dietary carotenoids to vitamin A. Using a mutant in one of these model systems, *Drosophila*, the vitamin A-forming enzyme has recently been molecularly identified. We now show that the molecular basis for the blindness of a different *Drosophila* mutant, *ninaD*, is a defect in the cellular uptake of carotenoids. The *ninaD* gene encodes a class B scavenger receptor essential for the formation of the visual chromophore. A loss of this function results in a carotenoid-free and thus vitamin A-deficient phenotype. Our investigations provide molecular insight into how carotenoids may be distributed into cells of target tissues in animals and indicate a crucial role of class B scavenger receptors rendering dietary carotenoids available for subsequent cell metabolism, as needed for their various physiological functions.

Kiefer C, Sumser E, Wernet MF, Von Lintig J. Proc Natl Acad Sci USA, vol 99, 10581-6, Aug 6, 2002

ANNOUNCEMENTS

Election News from the International Carotenoid Society

As of the date of this newsletter, the on-line election for the President-elect and Councillors of the International Carotenoid Society is being programmed. Please log onto your account at http://carotenoidsociety.org and make sure your Society profile is up-to-date. Please also visit the Society discussion forum (bulletin board) inside the "Members" link for information on the candidates and for a message from the outgoing President, George Britton. Detailed information on how to cast your vote will be forthcoming shortly by e-mail. If you have any questions please send an e-mail to the incoming President, Harry Frank, at harry.frank@uconn.edu.

Current Topics in Nutraceutical Research

A new quarterly journal devoted to all aspects of nutraceutical research will appear in December 2002.
Current Topics in Nutraceutical Research is an international, interdisciplinary, broad based peer reviewed scientific journal for critical evaluation of research on nutraceuticals. The major goal of this journal is to provide peer reviewed unbiased scientific data to the decision makers in the nutraceutical industry to help make informed choices about new products. To this end, the journal will publish two types of review articles. First, a review of preclinical research data coming largely form animal, cell culture and other experimental models. Such data will provide the basis for future product development and/or human research initiatives. Second, a critical evaluation of current human experimental data to help market and deliver the product for medically proven use.
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Current Diet History Questionnaire (DHQ-1) Carotenoid Data Released April 2002

http://riskfactor.cancer.gov/DHQ/dietcalc/databases.html
See Data Files to download the current DHQ Foods Database containing carotenoid values. The individual carotenoids (µg) that have been added are:

- alpha-carotene (provitamin A carotenoid)
- beta-carotene (provitamin A carotenoid)
- beta-cryptoxanthin (provitamin A carotenoid)
- lutein + zeaxanthin
- lycopene

The methods used to add carotenoids to the DHQ database are the result of the efforts of Dr. Lori Beth Dixon at New York University and Thea Zimmerman at Westat and will be presented in detail in a forthcoming paper. To summarize, however, these values are the result of matching CSFII food codes to similar foods in the nutrient database of the Nutrition Data Systems for Research (NDS-R) from the University of Minnesota, which has carotenoid values. The values for the DHQ were then computed using the databased approach described in:

Subar AF, Midthune D, Kulldorff M, Brown CC, Thompson FE, Kipnis V, Schatzkin A. An evaluation of alternative approaches to assigning nutrient values to food groups in food frequency questionnaires. *Am J Epidemiol* 2000;152:279-286.

Internet Addresses for Carotenoid Researchers

1. USDA Nutrient Database for Standard Reference (SR13) is a major source of food composition data for epidemiologists and nutritionists. Carotenoid Food Database contains best available estimates of carotenoid content in foods, also used in NDS-R: www.nal.usda.gov/fnic/foodcomp/data/index.html

2. This list is intended to be an open forum for carotenoid researchers from around the world to discuss recent developments in this field: CARIG.Forum@lists.unh.edu. To subscribe, send e-mail to: listproc@lists.unh.edu. In the body of the message write: subscribe CARIG Forum, your name.

3. International Carotenoid Society Web Page: www.carotenoidsociety.org Anyone wishing to join the society and be listed in the web directory, please contact Harry A. Frank at harry.frank@uconn.edu

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