



Carotenoid News

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FROM THE EDITOR

"If you can talk brilliantly about a problem, it can create the consoling illusion that it has been mastered."

Stanley Kubrick, American film director (1928-1999)

There are many brilliant speakers among carotenoid researchers, as we had observed during the 6th Gordon Research Conference on Carotenoids in January. However, they did not leave us with the consoling illusion that the problems of carotenoid functioning, especially in animals, are all mastered. The outstanding lectures were followed by lively discussions, which continued during poster sessions, where our youngest scientists displayed their curiosity and research skills, justly recognized later by special awards. Thanks are due to the Chair, Dr John Landrum, and the Vice Chair, Dr Susan Mayne, for the superb organization of this conference, which also included a wonderful field trip to Getty's Villa in Malibu, where the participants could taste the luxury and decadence of the Roman aristocracy in the times of Julius Caesar. The next GRC on Carotenoids in 2011 will be chaired by Dr Mayne, while Dr Eleanore Wurtzel was elected to be its Vice Chair.

We are convinced that the upcoming CARIG Annual Conference will give us again an opportunity to hear brilliant talks about carotenoid problems, as described below in the Highlights of Experimental Biology 2007 (April 28 – May 2, Washington, DC). We invite you to participate in this event, and also to submit material (news, meeting announcements and reports, letters to the editor) for publication in Carotenoid News, which is now distributed through the International Carotenoid Society (ICS) listserve. Since CARIG is now a formal affiliate of ICS, we are hoping to further encourage the worldwide interaction of carotenoid scientists, in accord with our mission (CARIG = Carotenoid Research Interactive Group).

Maria S. Sapuntzakis, Chicago, IL

CARIG Implements New Procedure for Distribution of Carotenoid News

This issue of Carotenoid News is also electronically distributed via the listserve of the International Carotenoid Society (ICS). Carotenoid News subscribers are urged to join ICS, if they have not already done so. By joining ICS, subscribers will be included in the ICS listserve and continue to receive Carotenoid News, as well as other important communications. ICS membership is currently free. The procedure to join ICS is outlined below:

International Carotenoid Society Membership Application Instructions

Enter the website <http://www.carotenoidsociety.org>

Go to Members button on the left side.

Not a member? Click HERE to join ICS.

Choose a username and a password. Submit.

Next screen will inform you if the username, which you requested, is available. Continue to apply for membership.

After submitting your application, you will get the answer from the Secretary of ICS. You may view the current newsletter and past issues (**News** button), as well as literature lists (**Articles** button), and other interesting information anytime on this website, even if you are not a member.

CARIG Travel Awards

CARIG will award one or more \$500 travel grants based on a poster competition to be held in conjunction with the CARIG/VARIG social at Experimental Biology 2007. Graduate students and postdoctoral trainees are eligible. Posters must address carotenoid and/or vitamin A research as described in an accepted abstract for Experimental Biology 2007. For those assigned an oral presentation rather than a poster at EB'07, printed copies of the slides may be used for the CARIG/VARIG poster competition. The CARIG/VARIG Social will take place at 7:00-9:00 PM, Saturday, April 28 in the Renaissance Hotel, Congressional Hall C. No advance registration is required to participate in the poster competition. Contact: Wendy S. White, Ph.D., Iowa State University, Ames, IA, USA. tel: (1) 515 294-3447; E-mail: wswwhite@iastate.edu.

UPCOMING EVENTS

April 11-13, 2007

The 2nd Symposium on Nutrition, Oxygen Biology and Medicine, Paris, France. Nutritional modulation of oxidative stress, anti-oxidants, anti-inflammatory, anti-aging strategies in health. Contact: Pr. J. Cillard, Faculté de Pharmacie, 2 Av. du Pr. L. Bernard, 35043 Rennes Cedex, France. tel: 33(0)2 2323 4888, fax: 33(0)2 2323 4886, E-mail: josiane.cillard@univ-rennes1.fr website: www.oxyclubcalifornia.org/nutrition-paris07

April 16-18, 2007

Micronutrient Forum, Istanbul, Turkey. Consequences and Control of Micronutrient Deficiencies: Science, Policy, and Programs—Defining the Issues. Contact: Micronutrient Forum Secretariat at the ILSI Research Foundation, One Thomas Circle, NW, Ninth Floor, Washington, DC 20005-5802, tel: 202-659-9024, fax: 202-659-3617, E-mail: mnforum@ilsi.org

April 28-May 2, 2007

Experimental Biology 2007, Washington, DC. Contact: EB2007, FASEB Office of Scientific Meetings & Conferences, 9650 Rockville Pike, Bethesda MD 20814-3998, website: www.eb2007.com [See CARIG Conference Program and other highlights below]

May 16-19, 2007

Diet and Optimum Health, Portland, Oregon. A conference organized by the Linus Pauling Institute at Oregon State University. Contact: Jamie LeGore, OSU Conference Services, 100 LaSells Stewart Center, Corvallis, OR 97331, E-mail: jamie.legore@oregonstate.edu, tel: 800-678-6311, fax: 541-737-9315, Website: <http://lpi.oregonstate.edu/conf2007/>

HIGHLIGHTS OF EXPERIMENTAL BIOLOGY 2007

Saturday, April 28. **CARIG Annual Conference, 1:00-4:30pm**

CARIG/VARIG Social and Graduate Student & Postdoc Poster Competition,
7:00-9:00pm, Renaissance Hotel,
Congressional Hall C

Sunday, April 29. **Vitamin A and Carotenoids I Minisymposium**

10:30-12:30, Convention Center Room 151B
Vitamin A and Carotenoids Poster Session
12:45-2:45 pm, Convention Center, Exhibit Hall

Wednesday, May 2. **NIST Micronutrient Measurement Quality Assurance Workshop** 9:00-3:30pm
Convention Center, Ballroom A

2007 CARIG Annual Conference Program
Saturday, April 28, 2007, 1:00-4:30 pm
Renaissance Hotel, Grand Ballroom North
Washington, DC

Chair: Julie Mares, University of Wisconsin-Madison

- 1:00-1:40 James Allen Olson Memorial Perspectives on Carotenoids Lecture: The Biochemical and Molecular Basis of Carotenoid Metabolism. *Johannes von Lintig, Albert-Ludwig University of Freiburg, Germany*
- 1:40-1:55 Discussion
- 1:55-2:25 Carotenoids and Maternal Health in South Asia. *Keith West, Johns Hopkins School of Hygiene and Public Health*
- 2:25-2:35 Discussion
- 2:35-2:55 Break
- 2:55-3:25 Transport of Lutein and Zeaxanthin into the Tissues and Their Role in the Prevention of Vascular Disease. *William Connor, Oregon Health and Science University*
- 3:25- 3:40 Discussion
- 3:40-4:10 Chronic Supplementation of Lutein and Zeaxanthin in the Female Rhesus Macaque. *Frederick Khachik, University of Maryland*
- 4:10-4:25 Discussion

NIST Micronutrients Measurement Quality Assurance Workshop
May 2, 2007

Washington Convention Center, Ballroom A
Washington, DC

- 9:00am Opening Remarks
- 9:15am Review of Results from Interlaboratory Comparison Exercise. *Jeanice Brown Thomas*
- 9:30am Measurement Trends: New and Old for Fat-Soluble Vitamins and Vitamin C in Serum. *Dave Duester*
- 10:00am The Determination of Oxidized and Reduced CoQ10 in Plasma by HPLC with Electrochemical Detection. *Paul Ullucci*
- 10:30am NHANES Trends for B Vitamins. *Christine Pfeiffer*
- 11:00am Vitamin B 6: Analytical Issues. *Michael Rybak*
- 11:30am Lunch (on your own)
- 1:00pm Analysis of Vitamin B6 and Vitamin D in Serum for Assessment of Vitamin Status. *Karen Phinney*
- 1:30pm The Expanding Role of Mass Spectrometry in Folate Research. *Bryant Nelson*
- 2:00pm Folate: Analytical Issues. *Zia Fazili Qari*
- 2:30pm Status of Forthcoming Serum-Based and Related SRMs. *Kathy Sharpless*
- 3:00pm Discussion of QA Program Needs
- 3:30pm Wrap-up

RECENT / FORTHCOMING PUBLICATIONS

SIGHT AND LIFE Magazine 3/2006, PO Box 2116, 4002 Basel, Switzerland, **web:** www.sightandlife.org, **tel:** 41-61-688-7494, **fax:** 41-61-688-1910.

Archives of Biochemistry and Biophysics (vol. 458, Issue 2, 2007), **Highlight Section: Carotenoids 2007**

(www.sciencedirect.com/science/journal/00039861). Original articles or minireviews stemming from 2007 Gordon Research Conference on Carotenoids:

Studies of carotenoid one-electron reduction radicals. Ruth Edge, Ali El-Agamey, Edward J. Land, Suppiah Navaratnam and T. George Truscott

Spectroscopy of the peridinin-chlorophyll-a protein: Insight into light-harvesting strategy of marine algae. Tomáš Polívka, Roger G. Hiller and Harry A. Frank

Vertebrate and invertebrate carotenoid-binding proteins. Prakash Bhosale and Paul S. Bernstein

Xanthophyll accumulation in the human retina during

supplementation with lutein or zeaxanthin – the LUXEA (Lutein Xanthophyll Eye Accumulation) study. Wolfgang Schalch, William Cohn, Felix M. Barker, Wolfgang Köpcke, John Mellerio, Alan C. Bird, Anthony G. Robson, Fred F. Fitzke and Frederik J.G.M. van Kuijk

Lycopene: Are lycopene metabolites bioactive? Brian L. Lindshield, Kirstie Canene-Adams and John W. Erdman

Carotenoids as protection against sarcopenia in older adults. Richard D. Semba, Fulvio Lauretani and Luigi Ferrucci

Escherichia coli as a platform for functional expression of plant P450 carotene hydroxylases. Rena F. Quinlan, Tahhan T. Jaradat and Eleanor T. Wurtzel

Tomatoes, Lycopene & Human Health. Preventing Chronic Diseases. Ed: A Venket Rao. Caledonian Science Press Ltd. 2006. www.caledoniansciencepress.com

Alphabetical Listing of Recent Publications

Prepared by Dr. Harold Furr, Department of Nutritional Sciences, University of Wisconsin-Madison

More extensive list may found at www.carotenoidsociety.org

Ross, A. C. Vitamin A and carotenoids. In: Shils, M. E., Shike, M., Ross, A. C., Caballero, B., & Cousins, R. J., eds. *Modern Nutrition in Health and Disease*. Philadelphia: Lippincott Williams & Wilkins; (2006). pp. 351-375.

Aeberli, I., Molinari, L., Spinaz, G., Lehmann, R., L'Allemand, D., & Zimmermann, M. B. Dietary intakes of fat and antioxidant vitamins are predictors of subclinical inflammation in overweight Swiss children. *Am.J.Clin.Nutr.* 2006; 84: 748-755.

Anantachoke, N., Makha, M., Raston, C. L., Reutrakul, V., Smith, N. C., & Saunders, M. Fine tuning the production of nanosized β -carotene particles using spinning disk processing. *J.Am.Chem.Soc.* 2006; 128: 13847-13853.

Aryana, K. J., Barnes, H. T., Emmick, T. K., McGrew, P., & Moser, B. Lutein is stable in strawberry yogurt and does not affect its characteristics. *J.Food Sci.* 2006; 71: S467-S472.

Balashov, S. P., Imasheva, E. S., & Lanyi, J. K. Induced chirality of the light-harvesting carotenoid salinixanthin and its interaction with the retinal of xanthorhodopsin. *Biochemistry.* 2006; 45: 10998-11004.

Ball, R. S. Issues to consider for preparing ferrets as research subjects in the laboratory. *ILAR.J.* 2006; 47: 348-357.

Baruah, T. & Pederson, M. R. Density functional study on a light-harvesting carotenoid-porphyrin-C(60) molecular triad. *J.Chem.Phys.* 2006; 125: 164706.

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Bleys, J., Miller, E. R., III, Pastor-Barriuso, R., Appel, L. J., & Guallar, E. Vitamin-mineral supplementation and the progression of atherosclerosis: a meta-analysis of randomized controlled trials. *Am.J.Clin.Nutr.* 2006; 84: 880-887.

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Bourre, J. M. & Galea, F. An important source of omega-3 fatty acids, vitamins D and E, carotenoids, iodine and selenium: A new natural multi-enriched egg. *J.Nutr.Health Aging.* 2006; 10: 371-376.

Briviba, K., Bornemann, R., & Lemmer, U. Visualization of astaxanthin localization in HT29 human colon adenocarcinoma cells by combined confocal resonance Raman and fluorescence microspectroscopy. *Mol.Nutr.Food Res.* 2006; 50: 991-995.

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stress in children with acute hepatitis A. *World J.Gastroenterol.* 2006; 12: 6212-6215.

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TECHNICAL NOTE

Production of High Purity Cryptoxanthin

β -Cryptoxanthin, found naturally in many citrus fruits, mango and papaya, is a provitamin A carotenoid. A growing number of studies have linked increased intake of this carotenoid to a

lower risk of many diseases, such as heart disease, skin cancer, prostate cancer, and arthritis. A team of researchers from the Department of Chemical and Biochemical Engineering at the Technological Institute of Celaya, Mexico, has reported a process to produce β -cryptoxanthin at high yields and purity, for use in dietary supplements.

The new production method uses fermentation technology with the *Flavobacterium lutescens* ITCB008, a bacterial strain that has been extensively studied for the production of the non-provitamin A carotenoid zeaxanthin. β -cryptoxanthin is known to be an intermediate in the production of this carotenoid. The researchers, added small concentrations of sodium chloride, magnesium sulphate, and potassium phosphate, because such salts have been proposed to inhibit the steps that convert cryptoxanthin to zeaxanthin, and lead to the accumulation of β -cryptoxanthin in the cells. The whole fermentation process was optimized in terms of agitation (190 rpm), aeration (0.086 VVM), temperature (27.6°C) and acidity (pH 7.3). An extraction with ethanol was used, since this solvent is suitable to products intended for human consumption, and 770 mg of β -cryptoxanthin per kg of cell mass (dry weight) was recovered after 28 hours. HPLC analysis of the extracted carotenoids showed that β -cryptoxanthin was the main carotenoid produced, accounting for 95% of the total carotenoid content.

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NEWS AND VIEWS

Lutein - Skin Beauty Agent?

Lutein, which is found in various foods, including green leafy vegetables and egg yolk, has a 10-year history in the dietary supplement market as a nutrient to reduce the risk of age related macular degeneration (AMD). Although some earlier studies have shown that a daily lutein supplement may help bolster the skin's natural antioxidant system and protect against sun damage, this is the first time it has been assessed for more specific, age-related skin benefits: hydration, elasticity and superficial skin lipids. The results were presented at the Beyond Beauty conference in Paris by Pierfrancesco Morganti, professor of applied cosmetic dermatology at the University of Naples, Italy. The study involved female Italian subjects aged 25- to 50-years, who were divided into different test groups and administered 10 mg of oral lutein and/or 50 ppm of lutein in a topical formulation each day over a 12-week period. Lutein was seen to decrease oxidation of lipids by 55%. In the group that received both oral and topical interventions, hydration increased by 60%, elasticity by 20%, and superficial skin lipids by 50%.

www.nutraingredients-usa.com, 9/13/2006

Tomato Extract May Reduce Risk of Blood Clots

Extracts from tomatoes offer heart health benefits by reducing the accumulation of platelets that lead eventually to blood clots, heart attacks and strokes, say two complimentary studies from the UK (*Am. J. Clin. Nutr.* 2006, 84:561-569 and 570-579). The first of the studies was a randomized, double-blinded, placebo-controlled crossover study using 90 healthy human subjects with normal platelet function. The volunteers were given either an extract-enriched or control supplement and measurements were made 3 hours after consumption. Significant reductions in the build-up of platelets (stimulated by administration of ADP and collagen) were observed 3 hours after supplementation with tomato extract equivalent to 2 or 6 tomatoes (by 21.3% for 6-tomato equivalents, and 12.7% for the 2-tomato equivalents for the ADP administered groups; and by 17.5% for 6-tomato equivalents, and 7.8% for the 2-tomato equivalents for the collagen administered groups), while no significant effects were observed in the control group. An *in vitro* study was also undertaken by the same researchers, in order to study the mechanism behind the apparent benefits. The tomato extract appears to work by inhibiting glycoprotein IIb/IIIa and platelet secretory mechanisms. Thus, by decreasing the

accumulation of platelets, the risk of forming a blood clot, that could lead to stroke or heart attack, is reduced.

www.nutraingredients-usa.com, 9/25/2006

An Egg a Day Could Keep Macular Degeneration at Bay

Making the point of getting a daily egg, the yolk of which is a rich source of lutein and zeaxanthin, could reduce the risk of developing age-related macular degeneration (AMD), suggest two new studies from the University of Massachusetts. As well as filling you up for longer (eggs are well known to have a 50% higher satiety index than regular breakfast cereals), an egg a day could boost blood levels of lutein and zeaxanthin, and reduce the risk of AMD. The first study (*J. Nutr.* 2006, 136: 2519-2524) investigated the effects on eating one egg every day on serum lutein and zeaxanthin concentrations in 33 men and women over the age of 60 in a randomized cross-over design. The volunteers were fed one egg or an egg substitute for 5 weeks before crossing over to the other intervention. Washout periods and a run-in period of no eggs separated the interventions. After 5 weeks of the one egg per day intervention, serum lutein and zeaxanthin had increased by 26% and 38%, respectively, compared to the no-egg run-in. Importantly, serum concentrations of total cholesterol, LDL cholesterol, HDL cholesterol, and triglycerides were not affected by the egg interventions. "These findings indicate that in older adults, 5 weeks of consuming one egg/day significantly increases serum lutein and zeaxanthin concentrations without elevating serum lipids and lipoprotein cholesterol concentrations." The second study (*J Nutr.* 2006, 136: 2568-2573) looked at the effect of a 12-week egg intervention on serum lutein and zeaxanthin levels, and the macular pigment optical density (MOPD) in 24 women (24-59 y old). The women were randomly assigned to eat 6 eggs every week, containing ~330 μ g (Egg1 - supermarket eggs) or ~965 μ g (Egg2 - organic farm eggs) of lutein and zeaxanthin per yolk, or a placebo (sugar capsule). Again, no changes in serum cholesterol levels were observed in the egg intervention groups, but total cholesterol and triglyceride increases were recorded in the placebo group. Unlike the other study, only serum zeaxanthin, but not lutein, increased in both Egg1 and Egg2 groups, while MPOD increased in both egg intervention groups, a result that suggests the egg diet offers some protection against potential AMD.

www.nutraingredients-usa.com, 9/26/2006

β -Carotene May Protect Certain People against Alzheimer's Disease

High levels of β -carotene may protect cognitive decline in people with a certain genotype which increases the risk of Alzheimer's disease. "Among high-functioning older persons, antioxidants, and β -carotene in particular, may offer protection from cognitive decline in persons with greater genetic susceptibility," (*J. Gerontol. Series A*, 2006, 61:616-620). Cognitive performance declines naturally with age, but genetics does play a part in the complex progression of Alzheimer's disease. People with a gene that codes for the blood lipoprotein, apolipoprotein E4 (apoE4), have a higher risk of developing Alzheimer's disease at an earlier age than people with apoE2 or apoE3. The new study used data from a 7-year cohort study of older people to investigate if serum β -carotene levels had an effect on cognitive decline in people with differing ApoE4 genotypes (homo- or heterozygous). Out of the sample population of 455 people, 9 people were ApoE4 homozygous, and 97 were ApoE4 heterozygous. Serum β -carotene levels were measured at baseline, and cognitive function assessed using a 9-item Short Portable Mental Status Questionnaire (SPMSQ). During the 7 years of follow-up, cognitive decline (as measured by falling SPMSQ scores) was documented in 249 people. The presence of at least one ApoE4 allele was linked

to a higher risk and larger decline in SPMSQ scores. High serum β -carotene levels were associated with a 89% reduction in the risk of cognitive decline in people with at least one ApoE4 allele. For those with no ApoE4 alleles, high serum β -carotene levels were associated with only a modest 11% reduction in the risk of cognitive decline.

www.nutraingredients-usa.com, 12/04/2006

Lycopene Microcapsules Protect Vitamins in Milk

Microencapsulated lycopene slowed the degradation of vitamins A and D₃ in skimmed milk. The research could have implications for both dairy and fortified dairy products, with the potential to prolong shelf-life and quality. Milk contains 15 vitamins and minerals, including significant amounts of calcium, vitamin D, riboflavin and vitamin B₁₂. However, riboflavin is susceptible to oxidation by light. The oxidation products of this process can then destroy other vitamins in the milk, leading to a significant loss of nutritional quality. Mariana Montenegro from Universidad Nacional de Santiago del Estero in Argentina and her coworkers report that by encapsulating small amounts of lycopene in gum arabic and sucrose, the resulting microcapsules can protect the riboflavin against photo-oxidation (*J. Agr. Food Chem.* 2007, 55:323-329). Using fluorescent white lights, the researchers tested the photo-degradation of riboflavin, vitamin A and vitamin D₃ in standard skimmed milk, and the skimmed milk containing the lycopene microcapsules. "The addition of lycopene microencapsulated by spray-drying with a gum arabic-sucrose mixture produced a reduction of ~45% in the photosensitized degradation rate of the three vitamins."

www.nutraingredients-usa.com, 1/16/2007

Orange Cauliflower

A gene from an orange cauliflower could be the key to making food crops more nutritious (*Agricultural Res. January 2007*, p.9). The USDA Agricultural Research Service is using cauliflower to identify genes and define molecular mechanisms that regulate nutrients in plant-based foods. A cauliflower gene – named 'Or' for color orange – could induce high levels of β -carotene in food crops. The Or gene originates from an orange cauliflower plant found in a Canadian field nearly 30 years ago. ARS and Cornell scientists in Ithaca have been studying its genetics for about 8 years. The 'Or' gene, isolated last year, has been described as a semi-dominant gene mutation, and promotes high β -carotene accumulation in various plant tissues that normally do not have carotenoids. "These studies can help researchers understand how carotenoid synthesis and accumulation are regulated in plants. This, in turn, can lead to strategies for increasing carotenoid content in food crops for improving human nutrition and health."

www.nutraingredients-usa.com, 1/18/2007

Tangerine Tomatoes - Better Source of Lycopene?

The lycopene content of orange tomatoes is more bioavailable than the form of lycopene found in the red variety. Lycopene is an antioxidant present in some red- and pink-coloured fruits and vegetables (*J. Agr. Food Chem.* 2007, 55:1597-1603). Red tomatoes typically contain about 95% of their lycopene as the all-trans-isomer. In tangerine tomatoes, the lycopene is present as tetra-cis-lycopene, a geometric isomer of all-trans-lycopene. Tomato sauce was prepared from the tangerine tomatoes with corn oil to improve palatability and absorption of the lycopene. The sauces (13 mg of lycopene per serving) were incorporated into a spaghetti meal and fed to 12 healthy young volunteers, and the researchers then measured intestinal absorption of lycopene for almost 10 hours after the meal. Comparing lycopene absorption from the tangerine variety and a high- β -carotene variety with lycopene existing predominantly in the all-trans-form, absorption of the cis-form was 2.5 times higher. However, the processing, particularly heating, appears to affect the lycopene

content of the tangerine tomatoes, with the tetra-cis-lycopene level decreasing, while the trans-isomer level was unaffected. The reason why the tangerine tomatoes predominantly contain the tetra-cis-lycopene is because they lack a specific enzyme that converts the cis-isomer to the more stable trans form. "In conclusion, this study supports the hypothesis of lycopene cis-isomers being highly bioavailable. The use of tangerine tomatoes provided a unique source to investigate absorption of cis-lycopene."

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Antioxidant Supplements and Mortality

A meta-analysis of randomized trials with antioxidant supplements has reported that vitamin A, E, and β -carotene may increase mortality risk (*JAMA* 2007, 297:842-857). The researchers started with 1201 references describing 815 trials. Of these, 747 trials were excluded for several reasons: no mortality in the study groups (405 trials), the studies were not randomized (69 trials), they did not fulfill inclusion criteria (245 trials), or the studies are ongoing (4). In the remaining 68 randomized trials, which were included, antioxidants were found to have no significant effect on mortality. This result did not hold when the reviewers looked at the individual nutrients and removed studies that they classed as having a 'high bias' in favor of the antioxidants. In the 47 trials classified as low-bias (180,938 participants), overall antioxidant supplements were associated with a 5% increased risk of mortality. When the reviewers classified vitamin A intake as "given singly or in combination with other antioxidants supplements after exclusion of high-bias risk and selenium trials," use of the vitamin was associated with a 16% increased risk of mortality. β -Carotene and vitamin E were associated with 7% and 4% increased risk of mortality, respectively, whereas there was no increased mortality risk associated with vitamin C, and selenium use was associated with a 9% decreased risk of mortality.

www.nutraingredients-usa.com, 2/28/2007

Internet Addresses for Carotenoid Researchers

1. USDA Nutrient Database for Standard Reference (SR17) 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) **Webpage:** www.carotenoidsociety.org
4. LIPID BANK for Web. Carotenoid Section of Bioactive 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.
5. Reference library prepared by LycoRed Natural Product; www.lycopene.com-references

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Chairperson:	Wendy White (Ames, IA)
Treasurer:	John Landrum (Miami, FL)
Editor:	Maria S. Sapuntzakis (Chicago, IL)
Address:	Human Nutrition, M/C 517 University of Illinois at Chicago 1919 West Taylor St. Chicago, IL 60612
Fax:	312-413-0319
E-mail:	msapuntz@uic.edu
Subscription:	\$10 per year (checks payable to CARIG)
Website:	www.carotenoidsociety.org

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CaroteNature GmbH

Im Budler 8
CH-4419 Lupsingen
Switzerland

E-mail: info@carotenature.com
Phone/Fax: +41 61 913 96 60 or
+41 31 351 18 74



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4344 Frank Price Church Rd.

Wilson, NC 27893

Tel: (252) 206-7071 Fax: (252) 206-1305

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