

### References for USDA-NCC Carotenoid Database for U. S. Foods - 1998

1. Brown, E. D., Micozzi, M. S., Craft, N. E., Bieri, J. G., Beecher, G., Edwards, B. K., Rose, A., Taylor, P., and Smith, J. C., Jr. (1989).  
Plasma carotenoids in normal men after a single ingestion of vegetables or purified beta-carotene.  
*Am J Clin Nutr.* **49**, 1258-65.  
tomato juice, broccoli, carrot  
HPLC  
beta-carotene, alpha-carotene, lycopene, lutein
2. Bureau, J. L., and Bushway, R. J. (1986).  
HPLC determination of carotenoids in fruits and vegetables in the United States.  
*J Food Sci.* **52**, 128-30.  
asparagus, beet greens, broccoli, carrot, green beans, green pepper, lettuce, okra, pea, spinach, sweet potato, swiss chard, apricot, blueberries, cantaloupe, grapefruit, nectarine, orange, peach, raspberries, strawberries, squash  
HPLC  
alpha-carotene, beta-carotene, beta-cryptoxanthin
3. Bushway, R. J., and Wilson, A. M. (1982).  
Determination of alpha- and beta-carotene in fruit and vegetables by high performance liquid chromatography.  
*Can Inst Food Sci Technol.* **15**, 165-9.  
carrot, fiddlehead green, potatoes, blueberries  
HPLC  
alpha-carotene, beta-carotene
4. Bushway, A. A., Setteze, D. V., McGann, D. F., True, R. H., Work, T. M., and Bushway, R. J. (1985).  
Effect of processing method and storage time on the nutrient composition of fiddlehead greens.  
*J Food Sci.* **50**, 1491-2.  
fiddlehead green  
HPLC  
alpha-carotene, beta-carotene

5. Bushway, R. J. (1986).  
Determination of alpha- and beta-carotene in some raw fruits and vegetables by high-performance liquid chromatography.  
*J Agr Food Chem.* **34**, 409-12.  
asparagus, beet greens, broccoli, carrot, green pepper, lettuce, spinach, squash, sweet potato, grapefruit, nectarine  
HPLC  
alpha-carotene, beta-carotene
6. Bushway, R. J., Yang, A., and Yamani, A. M. (1987).  
Comparison of alpha- and beta-carotene content of supermarket versus roadside stand produce.  
*J Food Qual.* **9**, 437-43.  
beet greens, broccoli, brussels sprouts, carrot, green bean, green pepper, green onion, pea, squash, swiss chard, tomato, cantaloupe  
HPLC  
alpha-carotene, beta-carotene
7. Chandler, L. A., and Schwartz, S. J. (1988).  
Isomerization and losses of trans-beta-carotene in sweet potatoes as affected by processing treatments.  
*J Agric Food Chem.* **36**, 129-33.  
sweet potato  
HPLC  
beta-carotene
8. Data generated by Arthur D. Little, Inc.  
DHHS/NIH/NCI, Contract No. No1-CN-55442, 1988.  
bananas, carrots (cooked), carrots (frozen), carrots (raw), collards, corn, tomato juice, tomato paste, tomato sauce, tomato (raw)  
HPLC  
alpha-carotene, beta-carotene, beta-cryptoxanthin, lycopene, lutein, zeaxanthin
9. Data generated at the USDA Food Composition Laboratory as part of NIH Grant No. 1 RO1-CA59791.  
These data are in the process of being summarized for publication in the Journal of Food Composition and Analysis.  
10 fruits, 23 vegetables, 3 dairy products, margarine, eggs, cornmeal  
HPLC  
alpha-carotene, beta-carotene, beta-cryptoxanthin, lycopene, lutein, zeaxanthin

10. FNS Contract (USDA sponsored nutrient analysis); Continued monitoring of the nutrient content of selected key foods; October 1, 1992 to September 30, 1992  
Dept. of Food Science and Technology, University of Georgia  
chicken noodle soup (Campbell, condensed ), vegetable beef soup (Campbell, condensed), whole ripe tomatoes (canned), green peas (frozen), baked beans, apples with skin, grapes (seedless)  
HPLC  
alpha-carotene
11. FNS Contract (USDA sponsored nutrient analysis); Continued monitoring of the nutrient content of selected key foods; October, 1992 to June 30, 1993.  
Dept. of Food Science and Technology, University of Georgia  
peaches with skin, bartlett pears with skin, plums with skin, broccoli (raw), broccoli (cooked), tomato (raw, unpeeled), iceberg lettuce, catsup, tomato soup (condensed), cabbage (cooked), chicken gravy (canned), pinto beans (dry), nectarine with skin, cucumber with and without skin  
HPLC  
alpha-carotene, beta-cryptoxanthin
12. Giuliano, A. R., Neilson, E. M., Kelly, B. E., and Canfield, L. M. (1992).  
Simultaneous quantitation and separation of carotenoids and retinol in human milk.  
*Methods in Enzymology*. **213**, 391-399.  
human milk  
HPLC  
beta-carotene, alpha-carotene, lutein, lycopene
13. Gregory, G. K., Chen, T. S., and Philip, T. R. (1987).  
Quantitative analysis of carotenoids and carotenoid esters in fruits by HPLC: red bell peppers.  
*J Food Sci*. **52**, 1071-3.  
pepper  
HPLC  
beta-carotene, lutein
14. Hidioglou, N., McDowell, L. R., and Boning, A. R. (1986).  
Liquid chromatographic determination of carotenes in cattle serum and liver.  
*Internatl J Vit Nutr Res*. **56**, 39-44.  
beef liver  
HPLC  
beta-carotene

- 15.** Homnava, A., Payne, J., Koehler, P., and Eitenmiller, R. (1990).  
Provitamin A (alpha-carotene, beta-carotene and beta-cryptoxanthin) and ascorbic acid content of Japanese and American persimmons.  
*J Food Quality*. **13**, 85-95.  
persimmons, astringent varieties (Aizumi shiraza, Saijo, Giambo, Hiratanenshi, Sheng, Tanehashi, Korean, American Type, Hachiya) and non-astringent varieties (Hana-Gosho, Hana-Fuyu, Jiro, Fuyu, Shogatsu, Ichi Kijiro). Obtained from the USDA Fruit and Nut Tree Laboratory, Byron Georgia, except for Hachiya which was obtained from California.  
HPLC  
beta-carotene, alpha-carotene, beta-cryptoxanthin
- 16.** Homnava, A., Payne, J., Koehler, P., and Eitenmiller, R. (1991).  
Characterization of changes during ripening of oriental persimmon.  
*J Food Quality*. **14** (5), 425-434.  
persimmons (Hana Fuyu, Sheng). Obtained from the USDA Fruit and Nut Tree Laboratory, Byron, Georgia  
beta-carotene, alpha-carotene, beta-cryptoxanthin, lycopene
- 17.** Homnava, A., Rogers, W., and Eitenmiller, R. R. (1990).  
Provitamin A activity of specialty fruit marketed in the United States.  
*J Food Comp Anal*. **3**, 119-133.  
(USDA Contract No. 53-3198-7-56)  
tamarillo, purple passion fruit, yellow passion fruit, mango (Keitt), melon (crenshaw), persimmons (dried), mango (Tommy Atkins), pummelo, kumquats, blood orange, melon (pepino), black sapote, avocado (variety II), white sapote, mamey sapota, avocado (variety I), melon (canary), apple banana, carambola (sweet), prickly pear, carambola (tart), red raspberry. Most of the fruits were grown in the United States except for the red raspberries analyzed in March 1988. These were grown in Chile, South America.  
HPLC  
beta-carotene, alpha-carotene, beta-cryptoxanthin
- 18.** Howard, L. R., and Dewi, T. (1996).  
Minimal processing and edible coating effects on composition and sensory quality of mini-peeled carrots.  
*J Food Sci*. **61**(3), 643-645, 651.  
baby carrots (raw and coated)  
HPLC  
beta-carotene, alpha-carotene

- 19.** Khachik, F., Beecher, G. R., and Whittaker, N. F. (1986).  
Separation, identification and quantification of the major carotenoid and chlorophyll constituents in extracts of several green vegetables by liquid chromatography.  
*J Agr Food Chem.* **34**, 603-16.  
broccoli, cabbage, spinach, brussels sprouts, kale  
HPLC  
beta-carotene, lutein
- 20.** Khachik, F., and Beecher, G. R. (1987).  
Application of C-45-beta-carotene as an internal standard for the quantification of carotenoids in yellow/orange vegetables by liquid chromatography.  
*J Agr Food Chem.* **35**, 732-8.  
carrot, sweet potato, pumpkin, red palm oil  
HPLC  
alpha-carotene, beta-carotene, lycopene
- 21.** Khachik, F., and Beecher, G. R. (1988).  
Separation and identification of carotenoids and carotenol fatty acid esters in some squash products by liquid chromatography 1. Quantification of carotenoids and related esters by HPLC.  
*J Agr Food Chem.* **36**, 929-37.  
squash  
HPLC  
lutein, alpha-carotene, beta-carotene
- 22.** Khachik, F., and Beecher, G. R., and Lusby, W. R. (1989).  
Separation, identification and quantification of the major carotenoids in extracts of apricots, peaches, cantaloupe, and pink grapefruit by liquid chromatography.  
*J Agric Food Chem.* **37**, 1465-73.  
apricot (fresh, dried, canned), peach (fresh, dried, canned), cantaloupe, pink grapefruit  
HPLC  
zeaxanthin, beta-cryptoxanthin, lycopene, beta-carotene, lutein
- 23.** Khachik, F., Goli, M.B., Beecher, G.R., Holden, J., Lusby, W. R., Tenoro, M. D., and Barrera, M. R. (1982).  
Effect of food preparation on qualitative and quantitative distribution of major carotenoid constituents of tomatoes and several green vegetables.  
*J Agric Food Chem.* **40**, 390-398.  
broccoli, spinach, green beans, tomatoes, tomato paste, (all vegetables raw, steamed and microwaved)  
HPLC  
beta-carotene, alpha-carotene

24. Landen, W. O., and Eitenmiller, R. R. (1979).  
Application of gel permeation chromatography and non aqueous reverse phase chromatography to high pressure liquid chromatographic determination of retinyl palmitate and beta-carotene in oil and margarine.  
*JAOAC*. **62**, 283-9.  
margarine  
HPLC  
beta-carotene
25. Lee, C. Y., McCoon, P. E., and LeBowitz, J. H. (1981).  
Vitamin A value of sweet corn.  
*J Agric Food Chem*. **29**, 1294-5.  
corn  
Column Chromatography  
alpha-carotene, beta-carotene, beta-cryptoxanthin
26. Lee, C. Y., Smith, N. L., and Robinson, R. W. (1984).  
Carotenoids and vitamin A value of fresh and canned winter squashes.  
*Nutr Rep Internatl*. **29**, 129-33.  
squash  
Column Chromatography  
beta-carotene, alpha-carotene, lycopene
27. Lee, C. Y. (1986).  
Changes in carotenoid content of carrots during growth and post-harvest storage  
*Food Chem*. **20**, 285-93.  
carrot  
Column Chromatography  
alpha-carotene, beta-carotene
28. Lester, G. E., and Eichen, F. (1996).  
Beta-carotene content of postharvest orange-fleshed muskmelon fruit: effect of cultivar, growing location and fruit size.  
*Plant Foods and Human Nutr*. **49** (3), 191-197.  
muskmelon (cantaloupe)-6 cultivars-orange-fleshed  
HPLC  
beta-carotene

- 29.** Ogunlesi, A. T., and Lee, C. Y. (1979).  
Effect of thermal processing on the stereoisomerization of major carotenoids and vitamin A value of carrots.  
*Food Chem.* **4**, 311-8.  
carrots (raw and canned)  
Column Chromatography  
alpha-carotene, beta-carotene, lycopene
- 30.** Philip, T., and Chen, T. S.  
Development of a method for the quantitative estimation of provitamin A carotenoids in some fruits.  
*J. Food Sci.* **53**, 1703-1707.  
apricots (canned), bell pepper (red), bell pepper (yellow), cantaloupe, grapefruit (Cochella, red), grapefruit (Texas, ruby red), mango (canned, Alfonso, India), orange concentrate (Valencia, CA), orange concentrate (Navel, CA), orange concentrate (Temple, CA), papaya (Hawaii), peach (canned, Elberta,), peach (canned, Cling), persimmon (CA), pineapple (canned), tangelo concentrate, tangerine concentrate (CA), tangor concentrate (murcott), tomato, watermelon  
HPLC  
beta-carotene, beta-cryptoxanthin
- 31.** Philip, T., and Chen, T. S. (1988).  
Quantitative analyses of major carotenoid fatty acid esters in fruits by liquid chromatography: Persimmon and Papaya.  
*J. Food Sci.* **53** (6), 1720-1722.  
persimmon, papaya  
HPLC  
beta-carotene, beta-cryptoxanthin, lycopene, zeaxanthin
- 32.** Produce Marketing Association  
banana, raspberry, blueberry, cherry, tangerine  
HPLC  
beta-carotene
- 33.** Quackenbush, F. W. (1987).  
Reverse phase HPLC separation of cis- and trans-carotenoids and its application to beta-carotenes in food materials.  
*J Liq Chrom.* **10**, 643-53.  
pear, carrot, sweet potato, kale, spinach, butternut squash, apricot, peach  
HPLC  
beta-carotene

- 34.** Rodriguez, D. B., Raymundo, L. C., Simpson, K. L., and Chichester, C. O. (1976). Carotenoid pigment changes in ripening *Momordica charantia* fruits. *Ann Bot* (London). **40**, 615-24.  
alpha-carotene, beta-carotene, lycopene, lutein, zeaxanthin
- 35.** Rouseff, R. L., Sadler, G. D., Putman, T. J., and Davis, J. E. (1992). Determination of beta-carotene and other hydrocarbon carotenoids in red grapefruit cultivars. *J Agric Food Chem.* **40**, 47-51.  
grapefruit (interior Florida, also called Ridge, Indian river, Flame, Ray ruby, Star ruby)  
HPLC  
beta-carotene, lycopene
- 36.** Simon, P. W., and Wolff, X. Y. (1987). Carotenes in typical and dark orange carrots. *J Agric Food Chem.* **35**, 1017-1022.  
carrot  
HPLC  
alpha-carotene, beta-carotene, lycopene
- 37.** Stewart, I. R. (1977). High performance liquid chromatographic determination of provitamin A in orange juice. *JAOAC.* **60**, 132-6.  
orange juice  
HPLC  
alpha-carotene, beta-carotene, beta-cryptoxanthin
- 38.** Stewart, I. R. (1977). Provitamin A and carotenoid content of citrus juices. *J Agric Food Chem.* **25**, 1132-7.  
orange juice, tangerine juice  
HPLC  
alpha-carotene, beta-carotene, beta-cryptoxanthin
- 39.** Sweeney, J. P., and Marsh, A. C. (1971). Effect of processing on provitamin A in vegetables. *J Am Diet Assoc.* **59**, 238-43.  
broccoli, brussels sprout, spinach, collard greens, kale, beet greens, endive, carrot, squash, red pepper, pumpkin  
Column Chromatography  
alpha-carotene, beta-carotene



40. Sweeney, J. P., and Marsh, A. C. (1971).  
Effects of selected herbicides on provitamin A content of vegetables.  
*J Agric Food Chem.* **19**, 854-6.  
carrot, squash  
Column Chromatography  
alpha-carotene, beta-carotene
41. Tonucci, L. H., Holden, J. M., Beecher, G. R., Khachik, F., Davis, C. S., and Mulokozi, G. (1995).  
Carotenoid content of thermally processed tomato-based food products.  
*J. Agric. Food Chem.* **43**, 579-586.  
tomato soup, vegetable soup, minestrone soup, vegetarian vegetable soup, tomato juice, vegetable juice, whole tomatoes, catsup, spaghetti sauce, tomato paste, tomato puree, tomato sauce  
HPLC  
beta-carotene, alpha-carotene, lutein, lycopene
42. USDA Contract  
Nutrient content of ethnic and geographic specific foods. October 1, 1992 to September 29, 1993.  
Southern Testing and Research Laboratories, Inc., Wilson, NC 27893.  
almond paste, atole (dry mix, corn based), napa cabbage, chinese broccoli, canned capers, cilantro, citronella (lemon grass), collard greens (raw, cooked), fava beans in pod, grape leaves (canned, raw), halvah (flaky confection of sesame seeds and syrup), hoisin sauce, horseradish, pink lentils (raw), lotus root (cooked), mangosteen (canned), mole poblano (recipe and canned), oyster sauce (canned), papad (prepared from urad dahl), pepper banana, pepper serrano, prickly pear (cactus), rambutan (canned), sofrito (seasoned lard), tofu  
HPLC  
beta-carotene, alpha-carotene, beta-cryptoxanthin
43. USDA Contract  
Nutrient content of ethnic and geographic specific foods. October 1, 1994 to September 30, 1995.  
Southern Testing and Research Laboratories, Inc. Wilson, NC 27896.  
arrowroot (raw), barley flour, malted barley flour, chayote, chrysanthemum leaves (Shungiku), cloud ears (black mushrooms, fungus), cream cheese (fat free), durian, hummus, straw mushrooms (raw), sunflower seed kernels (oil roasted), peppermint leaves (fresh), spanish olives, plum sauce, spearmint leaves (dried), spearmint leaves (fresh), tamarind, wasabi root, yautia (tannier), yucca (cassava)  
HPLC  
beta-carotene, alpha-carotene, beta-cryptoxanthin

44. USDA Contract  
Dept. of Food Science and Technology, University of Georgia; September 27,1991 to July 10, 1992.  
pound cake (fat-free), oatmeal raisin cookies (cholesterol-free-fat-free), cheddar cheese, butter (light)  
HPLC  
beta-carotene
45. USDA Contract  
Monitoring nutrient content of selected key foods; October 1, 1990 to May 30, 1992.  
Dept. of Food Science and Technology, University of Georgia  
salsa, corn (cooked and frozen), green beans (cooked and frozen), nopales (prickly pear), fresh thyme, hot pepper sauce  
HPLC  
alpha-carotene, beta-cryptoxanthin
46. Wu, J. Q., and Carrol, D. E. (1991).  
Chemical and physical sensory stabilities of prebaked frozen sweet potatoes.  
*J Food Sci.* **56** (1), 710-713.  
sweet potatoes (Jewel)  
HPLC  
beta-carotene
47. Wu, Y., Perry, A. K., and Klein, B. P. (1992).  
Vitamin C and beta-carotene in fresh and frozen green beans and broccoli in a simulated system.  
*J Food Qual.* **15** (2), 87-96.  
green beans (raw and frozen, Bush Blue Lake 1994), broccoli (raw and frozen, Packman and Premium Crop)  
HPLC  
beta-carotene
48. Zakaria, M., Simpson, K. L., and Brown, P. R. (1979).  
Use of reversed phase HPLC analysis for the determination of provitamin A carotenes in tomatoes.  
*J Chromatogr.* **176**, 109-17.  
tomato  
HPLC  
beta-carotene, lycopene

49. Zhao, Y. P., and Chang, K. C. (1995).  
Sulfite and starch affect color and carotenoids of dehydrated carrots (*Daucus carota*)  
during storage  
*J Food Sci.* **60** (2), 324-326.  
carrots (dehydrated)  
HPLC  
beta-carotene, alpha-carotene