Trends in the Nutrient and Antioxidant Content of Common Foods

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“The Dilution Effect in Plant Nutrition Studies”

- Jarrell WM, Beverly RB. Advances in Agronomy, 1981; 34:197–224 (101 refs.)
- Yield-enhancing methods tend to decrease nutrient concentrations
  - Fertilization, irrigation & timing (all environmental)
- The dilution effect is well known among agronomists & horticulturists, who seldom give a citation when they mention it
- 169 citations in Science Citation Index

Dilution Effect of Phosphorus in Red Raspberry Plants

Hughes, Chaplin & Martin, HortScience, 1979; 14:521

Ca & Mg Trends in Broccoli

Hughes, Chaplin & Martin, HortScience, 1979; 14:521

Dilution Effect of Yield in 27 Commercial Broccoli Hybrids

Farnham, Grusak & Wang, J Amer Hort Sci, 2000; 125:344

Dilution Effect of Yield in 14 Wheats, Intro. 1873 to 1995

Trends in 20 Vegetables, United King., 1930s to 1980s

Percent Decline

Geom. Mean (Adjusted to dry-weight basis)

0 10 20 30 40
Ca P Fe K Mg

* P < 0.05
** P < 0.01

Mayer AM. Br Food J. 1997; 99:207

Trends in 43 Garden Crops, USDA data, 1950 to 1999

Percent Decline

-10 0 10 20 30 40
Pro Ash Ca P Fe VitA Thi Rib Nia VitC

* P < 0.05
** P < 0.01

Davis, Epp & Riordan, J Am Coll Nutr, 2004; 23:669

Trends in 16-50 US Crops, 1930s to 2004 (reanalyzed)

Percent Decline

0 10 20 30 40
Ca P Fe K Mg Cu

↑ 78 (?)

* P < 0.05
** P < 0.01

White & Broadley, J Hen Sci Biotech, 2005; 80:660

Other Trends in Agriculture

- Chemical fertilizers
- Herbicides, pesticides
- Low soil organic matter
- Evidence for other nutritional effects
  - Decreased secondary plant metabolites
  - Probable decreased ability to help prevent CHD, cancer, diabetes, Alzheimer’s, aging
  - Increased nitrate levels

Emerging Evidence of Benefits of Organic Production Methods

- Average increases in antioxidants and secondary plant metabolites ~30%
- Probable enhanced disease prevention
  - CHD, cancer, diabetes, aging, Alzheimer’s disease

Antioxidants in 3 Organic Vs. 4 Conventional Strawberries

Organic Conv.

AA DMA AODMA Dihydroxy Acetic acid HCA Flavone Phenolics Anthocyanins

* P < 0.05
*** P < 0.001

Olsson, Andersson, Oredsson et al., J Agric Food Chem, 2006; 54:1248

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Suppression of Cancer Cell Growth by Strawberry Extracts

4 Varieties, Conventionally Grown

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<th>Colon, HT29</th>
<th>Breast, MCF-7</th>
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Olsson et al., J Agric Food Chem, 2006; 54:1248

3 Varieties, Organically Grown

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<td>0.50%</td>
<td>0.3</td>
<td>0.2</td>
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Olsson et al., J Agric Food Chem, 2006; 54:1248

Superior Suppression by Organic Strawberries

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<td>Cavendish</td>
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Organic vs. Conv.: * P < 0.05, ** P < 0.01, *** P < 0.001

Olsson et al., J Agric Food Chem, 2006; 54:1248

Trends Summarized

- Environmental dilution effects
- Genetic dilution effects
- Historical comparisons consistent with dilution effects
- Decline in secondary plant metabolites implied by higher levels in organic crops

Nutrition in the United States

- Low intakes of nutrients (NHANES 2005)
  - Vit. E 93%, Mg 56%, vit. A 44%, vit. C 31%
  - Most get < Adequate Intake of vit. K, Ca, K, fiber
- Low intakes of recommended foods
  - Fruits—70% eat < 2 servings/day
  - Vegetables—58% eat < 3 servings/day
  - Whole grains—few eat half whole grains
  - >50% calories from added sugars, added fats and white flour

Improving Nutrition

- Eat more fruits, vegetables, whole grains
- Eat less added sugars, added fats, flour
- Reduce the environmental and genetic dilution effects of high-yield crops
- Emphasize fruits & vegetables with high antioxidant levels (e.g., high ORAC)
- Eat foods grown & processed organically