What Color Is Your Product? The Future of Raspberry Science & Marketing

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PERSONAL HEALTH

The Color of Nutrition: Fruits and Vegetables

By JANE E. BRODY

Colorize your diet. That is the latest advice from nutrition experts who have studied the health-promoting properties of the vast spectrum of colorful fruits and vegetables now available throughout the country.

Two recently published books — "What Color Is Your Diet?" (Regan Books, $25), by Dr. David Heber, director of the Center for Human Nutrition at the University of California at Los Angeles, with Susan Bowerman, a dietitian, and "The Color Code" (Hyperion, $22.95) by Dr. James A. Joseph, Dr. Daniel A. Nadeau and Anne Underwood — emphasize the importance of increasing consumption of fruits and vegetables, and the need to choose broadly

Naum Kazhdan/The New York Times

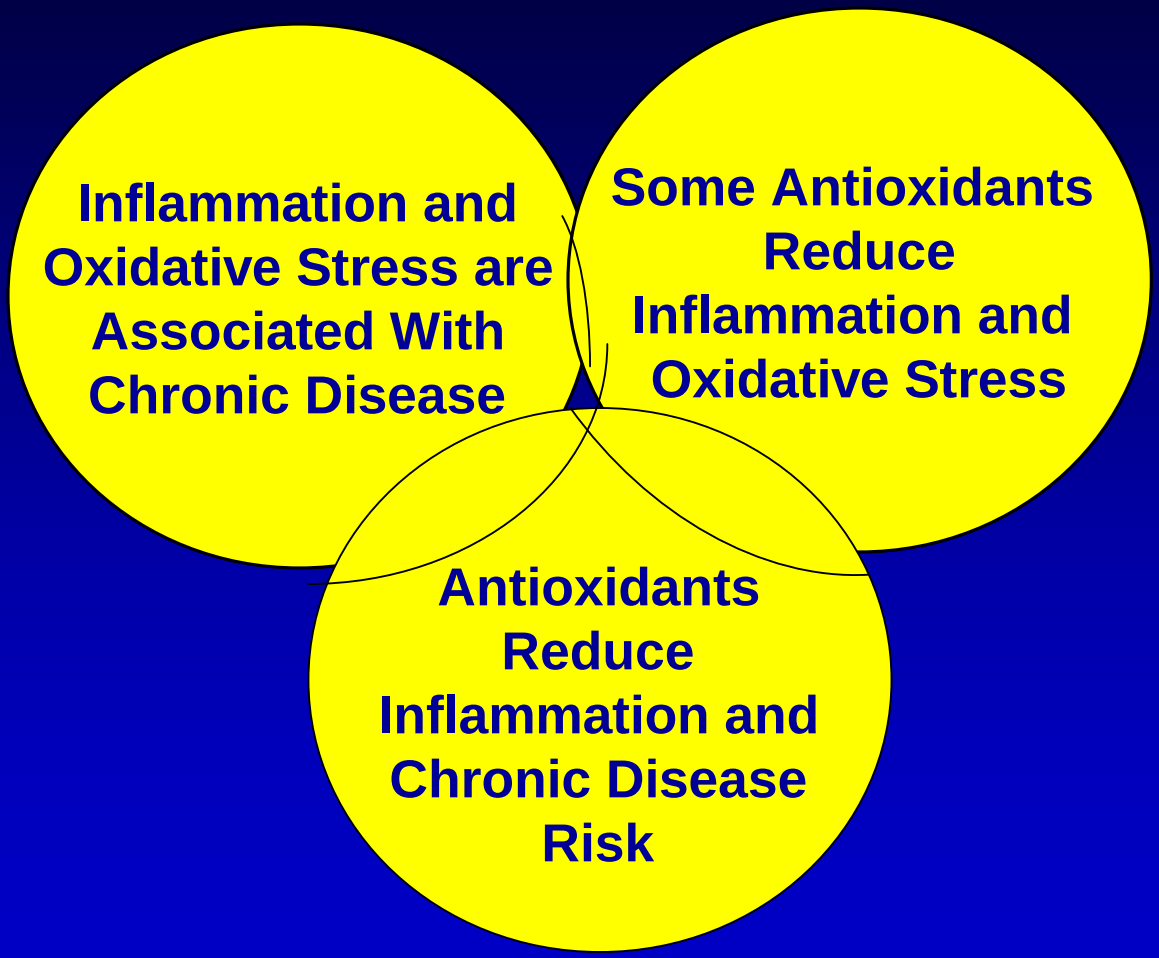
These are rich in cancer-blocking chemicals like sulforaphane, isocyanate and indoles, which inhibit the action of carcinogens.

White/green, including garlic, onions, leeks, celery, asparagus, pears and green grapes. The onion family contains allicin, which has antitumo properties. Other foods in this group contain antioxidant flavonoids like quercetin and kaempferol. Dr. Hebe includes white wine in this category

Eating by Color

The trick, these experts say, is to include as many plant-based colors in your daily diet as possible. In many cases, that means eating the colorful skins, the richest sources of protective phytonutrients, along wi the paler flesh. So try to avoid peeling foods like apples, peaches and

How Plant Nutrients Work



Chronic Degenerative Diseases Associated With Free Radical Damage

- Adult respiratory distress syndrome
- Age-related macular degeneration
- Alcoholism
- Aluminum neurotoxicity
- Alzheimer's disease
- Cancer
- Cardiovascular disease
- Cataracts
- Diabetes
- Down syndrome
- Familial amyotrophic lateral sclerosis
- Hemorrhagic shock
- Inflammation
- Ischemia
- Pancreatitis
- Parkinson's disease
- Porphyria
- Rheumatoid arthritis

Institute of Medicine
Food and Nutrition Board
Panel on Dietary Antioxidants and Related Compounds

Criteria for defining an antioxidant:

1. The substance is found in human diets.

2. The content of the substance has been measured in foods commonly consumed and can be calculated from available national databases.

3. In humans, the substance decreases the adverse effects of ROS and RNS *in vivo*.

National Academy Press 1998

SIMPLE PLANT PHENOLS

phenols, phenolic acids, aldehydes, benzoquinones, acetophenones, phylacetic acids, phenylpropanoids

PLANT POLYPHENOLS

coumarins, chromones, naftoquinones, xanthones, stilbenes, anthraquinones, lignans, lignins, flavonoids

Flavonoid Classes

Class	Color	Example	Comment
Anthocyanins	blue, red, violet	cyanidin delphinidin peonidin	predominant in fruit and flowers
Flavanols	colorless	catechin luteoforol procyanidin	in fruits, hops, nuts, tea; astringent taste
Flavanones	colorless to very pale yellow	hesperidin naringin neohesperidin	nearly exclusive to citrus fruits

Flavonoid Classes

Class	Color	Example	Comment
Flavones	pale yellow	apigenin luteolin tangeretin	in cereals, fruits, herbs, vegetables bitter taste
Flavonols	pale yellow	kaempferol myricetin quercetin	ubiquitous but predominant in fruits, vegetables
Isoflavones	colorless	daidzein genistein	in legumes, esp. soybeans

Flavonol Contents of Common Vegetables, Fruits and Beverages

Flavonol Content	Foods
Low (<10 mg/kg or 10 mg/L)	• cabbage, spinach, carrots, peas, mushrooms, peaches, strawberries orange juice, white wine, brewed coffee
Medium (<50 mg/kg or 50 mg/L)	• lettuce, broad beans, red pepper, tomato , apples, grapes, cherries, tomato juice, red wine, tea beverages
High (>50 mg/kg or 50 mg/L)	• broccoli, endive, kale, French beans, celery, onions, cranberries

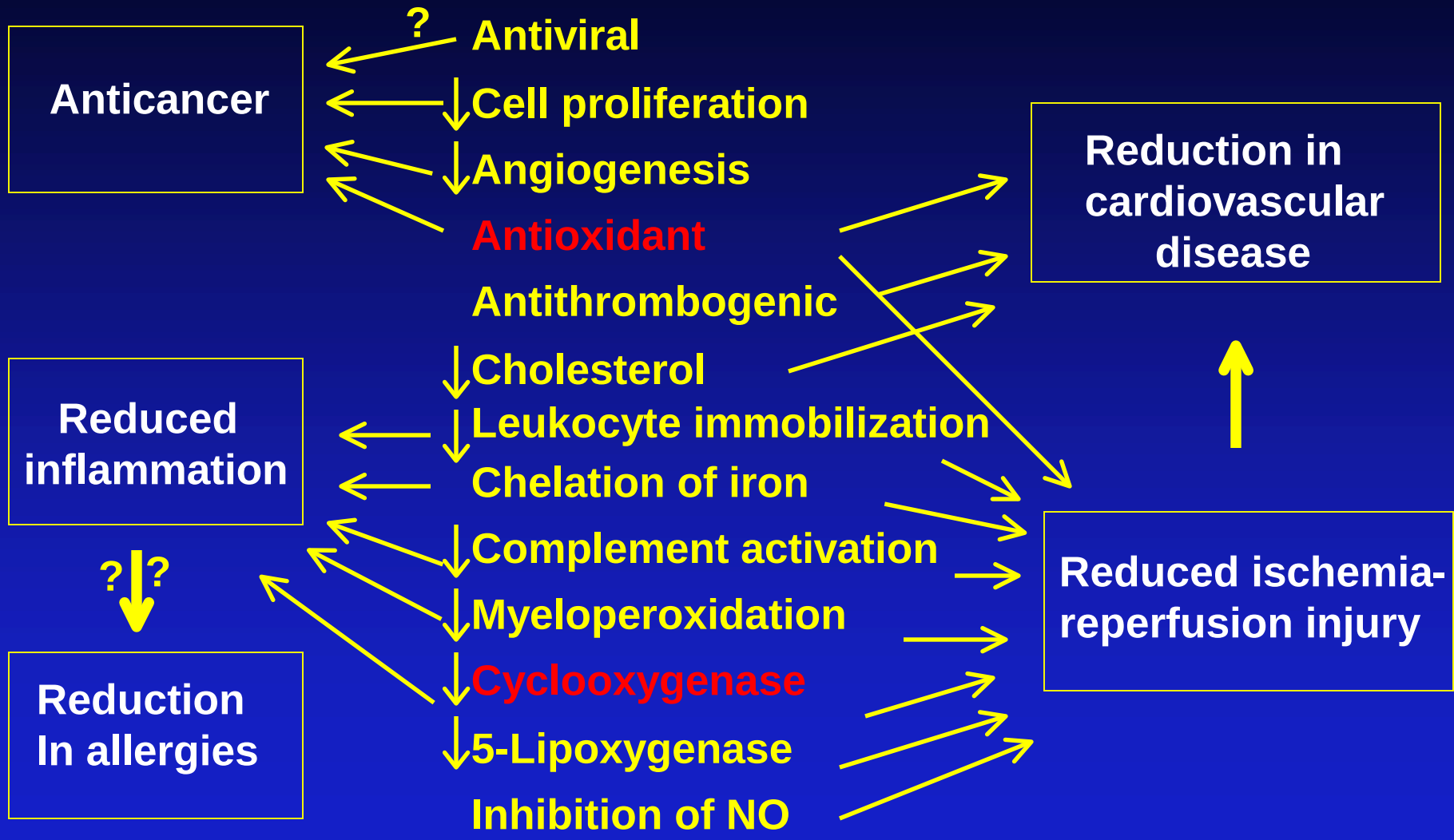
Hollman et al. *PSEBM* 1999

Intake and Sources of Flavonols

Population	Intake (mg/d)	Dietary Sources
Finland	4	Apples, onions (64%); fruits, juices, berries (36%)
United States	20	Black tea (25%); onions (25%); apples (10%); broccoli (7%)
The Netherlands	26	Black tea (61%); onions (13%); apples (10%)
United Kingdom	26	Black tea (82%)
Croatia	58	Mainly onions and apples
Japan	68	Green tea (>80%)

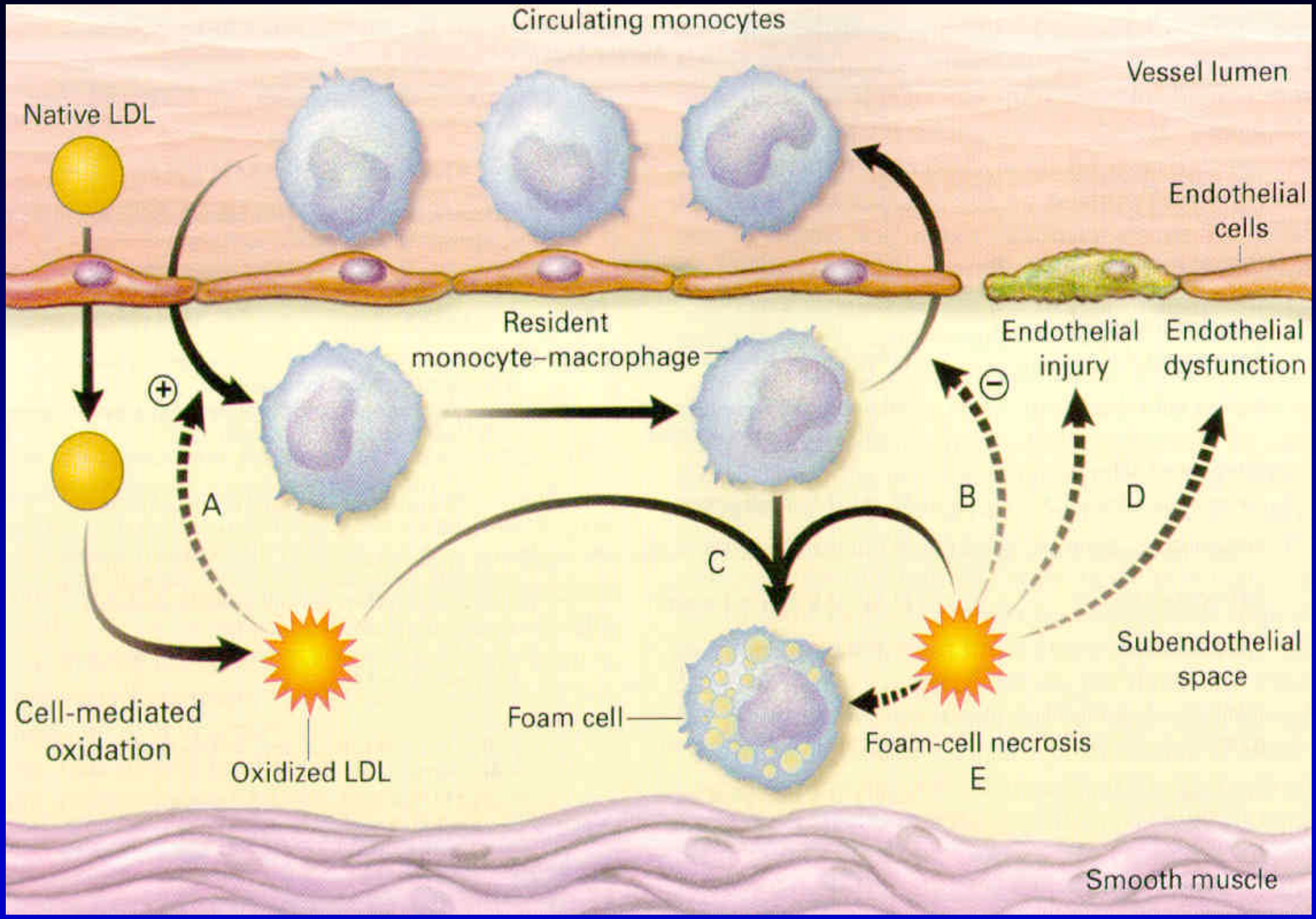
Hollman et al. *PSEBM* 1999

Potential Links between Flavonoid Mechanisms and Prevention

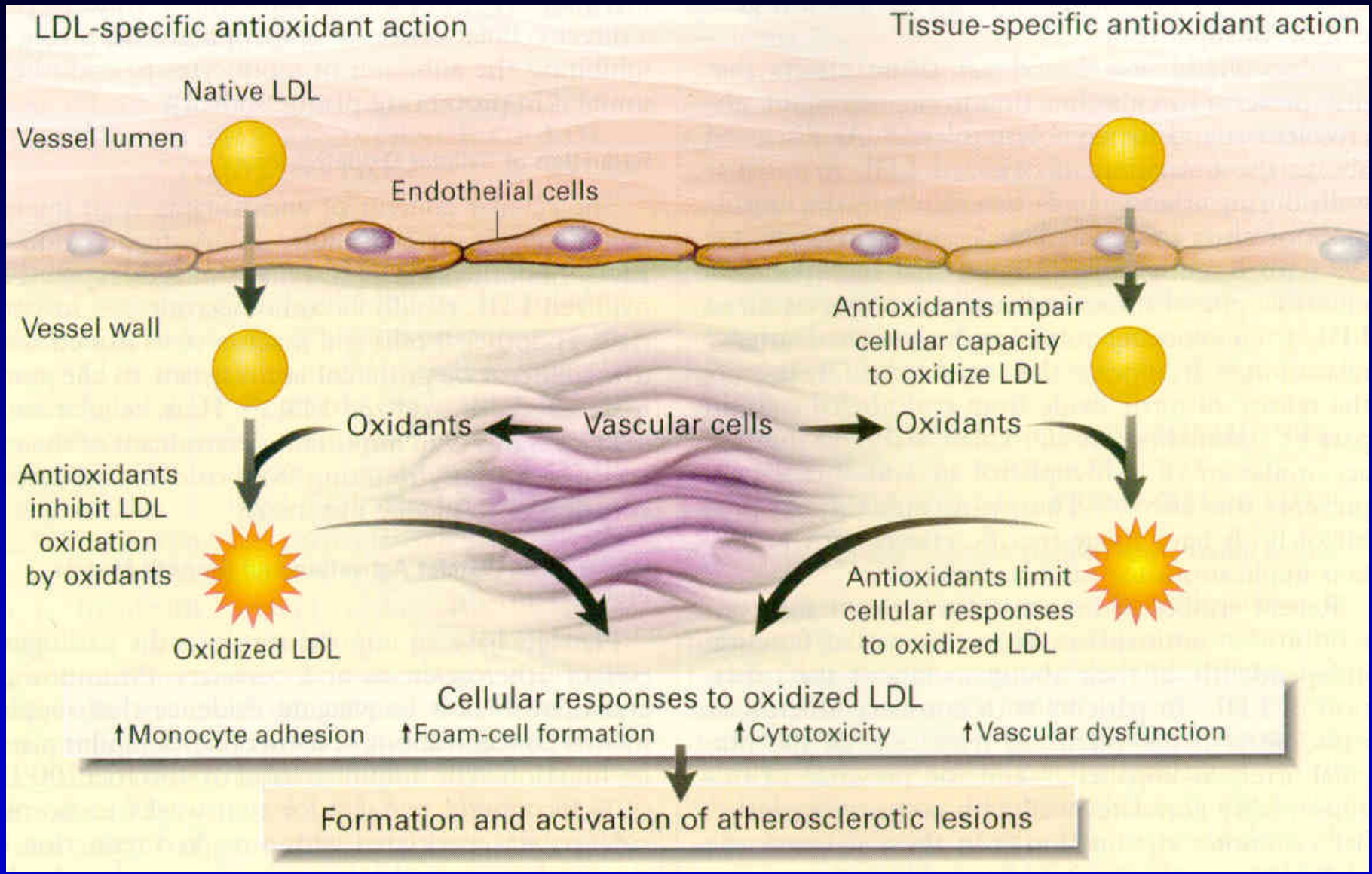


Nijveldt et al. *Am J Clin Nutr* 2001

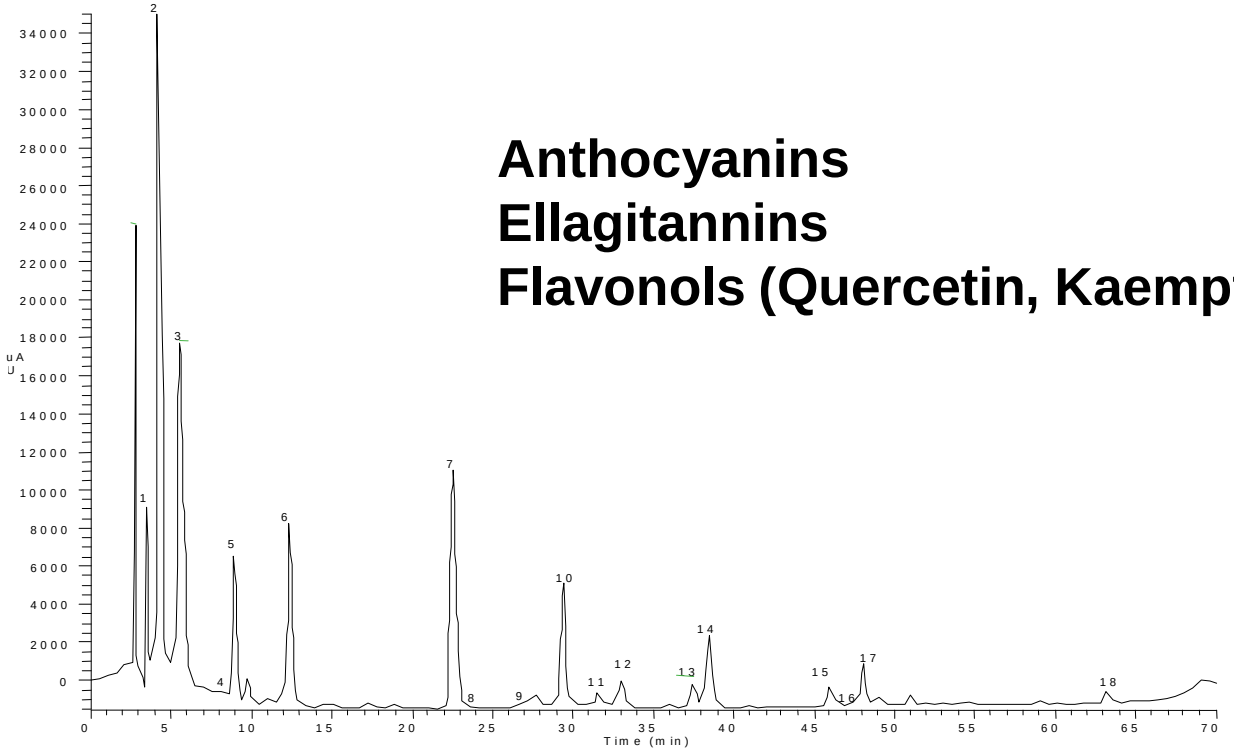
Oxidized LDL Contributes to Atherogenesis



Antioxidants May Slow Atherogenesis



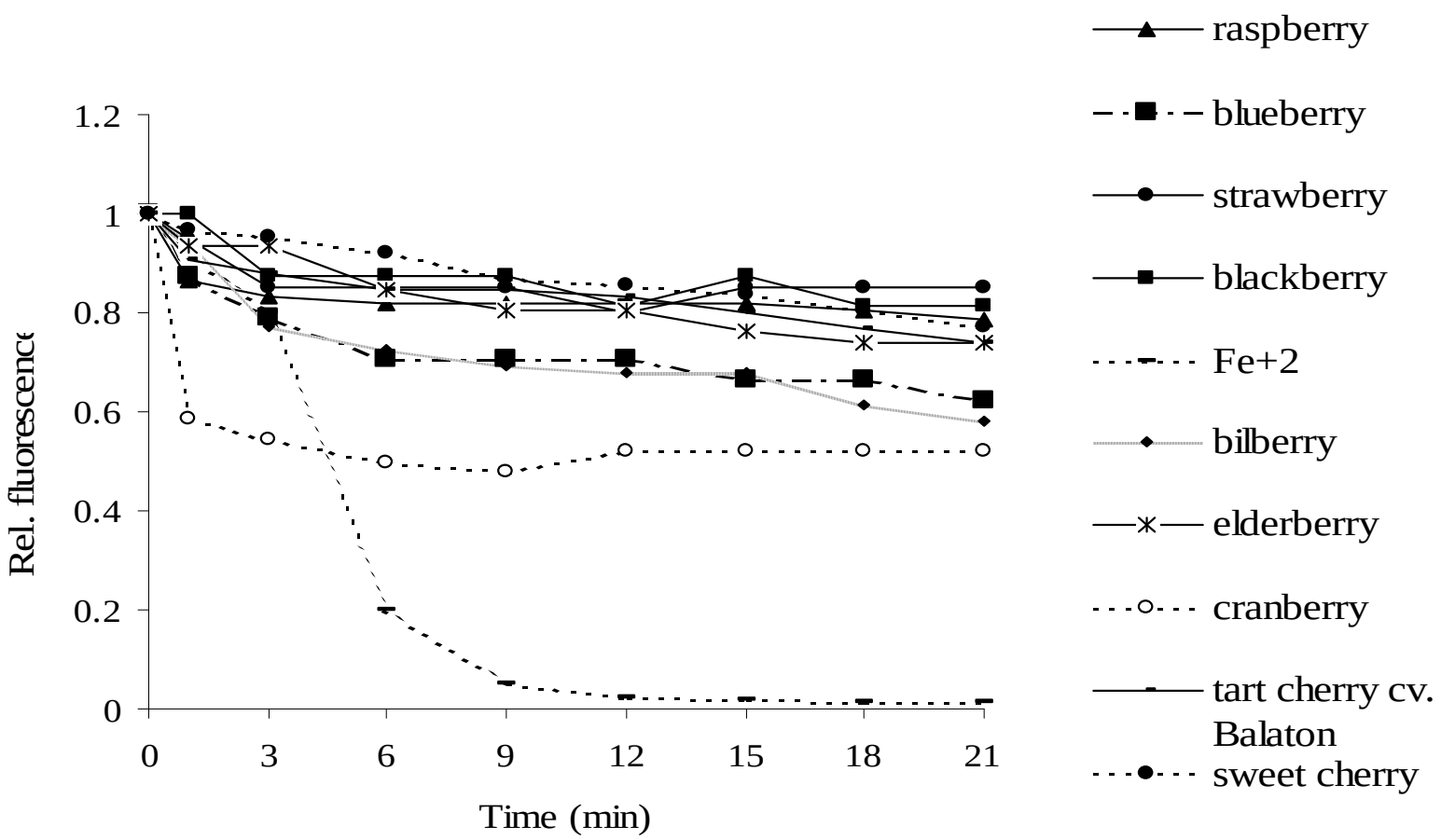
HPLC of Red Raspberry



Anthocyanins
Ellagitannins
Flavonols (Quercetin, Kaempferol)

Seeram NP, Adams LS, Zhang Y, Lee R, Sand D, Scheuller HS, Heber D. Blackberry, black raspberry, blueberry, cranberry, red raspberry, and strawberry extracts inhibit growth and stimulate apoptosis of human cancer cells in vitro. J Agric Food Chem. 2006;54:9329-39.

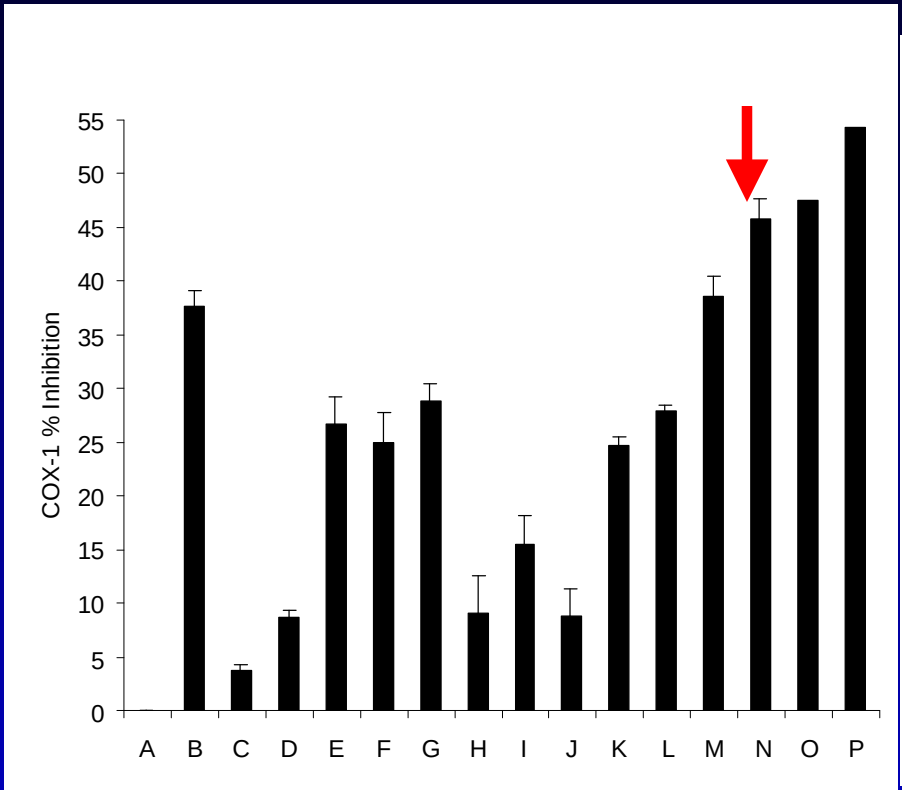
Inhibition of Lipid Peroxidation

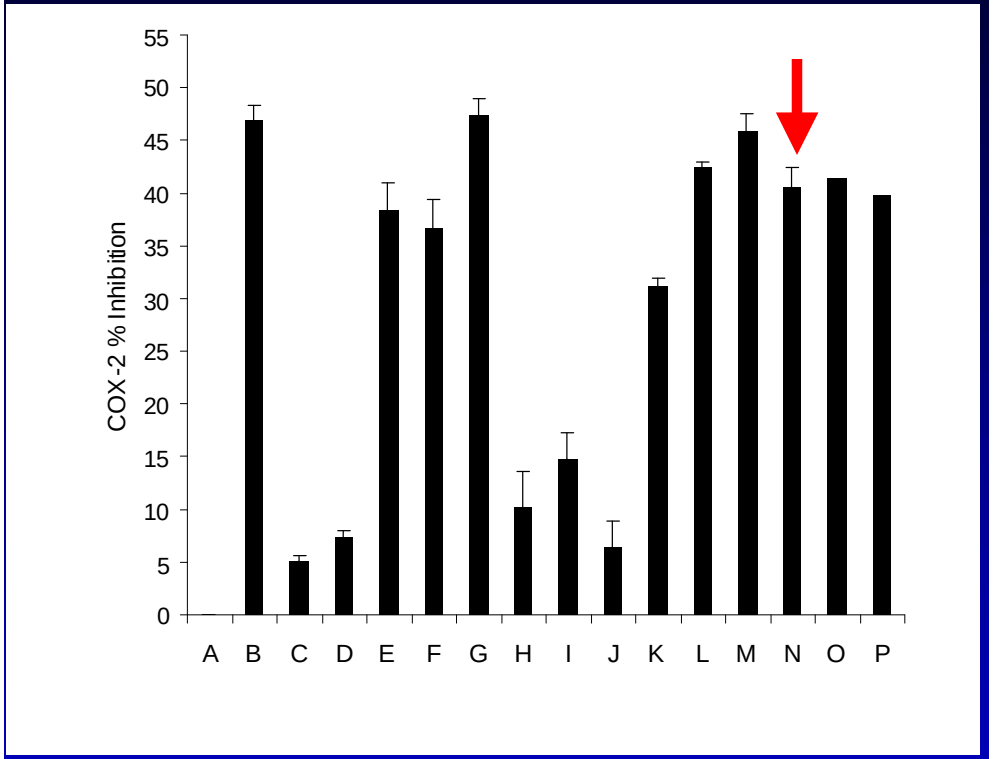


Seeram NP et al; Cycylooxygenase inhibitory and antioxidant Cyanidin glycosides from cherries and berries; Phytomedicine, 2001.

CYCLOXYGENASE 1 AND 2 INHIBITION

Inhibition of COX-1 and 2 Enzymes by Berries





A = DMSO; B = cyanidin 4; C = anthocyanin 1; D = anthocyanin 2; E = tart cherry cv. Balaton™; F = tart cherry cv. Montmorency; G = sweet cherry; H = blueberry var. Jersey; I = cranberry var. Early Black; J = bilberry; K = elderberry; L = strawberry var. Honeoye; M = blackberry; N = raspberry; O = naproxen; P = ibuprofen.

Seeram NP et al; Cycylooxygenase inhibitory and antioxidant cyanidin glycosides from cherries and berries; Phytomedicine, 2001.

OPPORTUNITY KNOCKS

FDA Advisory Panel Votes "No" to Etoricoxib

….given the known risk of this class of drugs, panel members grappled with the difficulty of approving another drug of the same ilk

"Usually I vote with my stomach, but I'm going to vote with my heart and say no," Dr Louis Morris (Drug Safety and Risk Management Advisory Committee member, Dix Hills, NY) stated to lead off the vote.

Zutphen Elderly Study
Flavonoid Intake and Risk of Coronary Heart Disease

Event	Flavonoid Intake (mg/d)*			*P* for trend
	0-19.0	19.1-29.9	>29.9	
CHD mortality	1.00	0.32	0.32	0.003
MI incidence	1.00	0.89	0.52	0.15
All cause mortality	1.00	0.75	0.72	0.084

RR adjusted for age, diet and risk factors

*flavonols: kaempferol, myricetin, quercetin

flavones: apigenin, luteolin

Hertog et al. *Lancet* 1993

Zutphen Elderly Study
Risk of Ischemic Heart Disease Mortality

	Tertile of total catechin intake (mg/d)		
	0 - 49	50 - 85	86 - 355
Men	268	269	269
Person-years	1908	2039	2078
RR	1.00	0.76	0.49
95%CI		0.46 - 1.26	0.27 - 0.88

Adjusted for prevalent MI or angina pectoris, age, physical activity, BMI, alcohol intake smoking status, intakes of fish, coffee, saturated fatty acids, PUFA, dietary cholesterol, fiber, vitamin C, vitamin E, and β-carotene, alcohol, energy

Arts et al. *Am J Clin Nutr* 2001

Rotterdam Study
Flavonols and Risk of a First MI

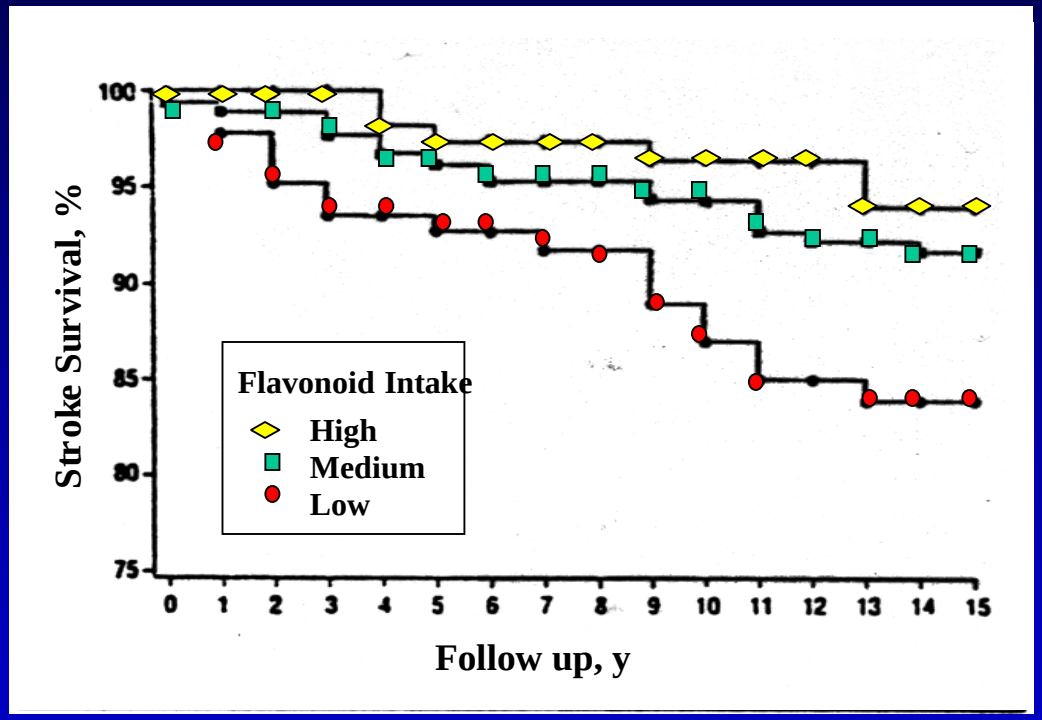
	Tertile Flavonol Intake (mg/d)*		
	≤22.8	22.8 - 32.9	>32.9
Number subjects	1602	1603	1603
RR: Incident MI	1	0.74	0.76
95% CI		0.49 - 1.11	0.49 - 1.18
RR: Nonfatal MI	1	0.85	0.93
95% CI		0.54 - 1.34	0.57 - 1.52
RR: Fatal MI	1	0.42	0.35
95% CI		0.17 - 1.06	0.13 - 0.98

Flavonoids: quercetin + kaempferol + myricetin

Adjusted for age, sex, BMI, smoking, education, alcohol, fat, vitamin E, fiber, energy

Geleijnse et al. *Am J Clin Nutr* 2002

Zutphen Elderly Study
Mean Flavonoid Intake and 15-year Stroke Incidence



Keli et al. *Arch Intern Med* 1996

Hypothesis

- **Polyphenolic compounds extracted from berries possess antioxidant activity**
  - **are bioavailable**
  - **inhibit oxidation**
  - **Inhibit inflammation**

Implications

- **Biological effects of whole food ingredients can easily be overlooked when components are studied individually in isolation.**
- **Synergistic relationships can be utilized *in vitro* to unmask the presence of very low concentrations of bioactive food components in *ex vivo* analysis**