Phytochemicals & Heart Healthy Eating

1. Where are phytonutrients found?
2. Cancer-protective properties
3. CVD protection
4. Their impact on diabetes and other diseases
Phytochemicals or Fighter Chemicals?

Where are they found?

Phytochemicals are food components found in plant foods (fruits, vegetables, whole grains, nuts & seeds, legumes, herbs).
Phytochemicals provide natural color and flavor to plants. They also provide a defense system for the plants.
2500 years ago
Hippocrates said:
“Let food be your medicine”.

The Healing Properties of Food
Western Diets are Typically Low in Phytochemicals

- Low intake of fruits and vegetables
- Low intake of whole-grain breads, cereals
- High intake of sugar-rich, junk food
- High intake of animal protein rather than beans, tofu
Color Means Protection

- Outer vs. inner leaves of vegetables
- Skins vs. pulp of fruits
- Dark skins of nuts
- Anthocyanins in seed coat of legumes
- Extra virgin vs. refined olive oil
- Whole grains vs refined grains
**Polyphenolic Content Varies**

**Quercetin in lettuce:**
- Outer leaves: 60-460 mg/kg
- Inner leaves: 3-8 mg/kg

**Ferulic acid in wheat:**
- Whole wheat: 490-521 ppm
- Refined wheat: 38-44 ppm
Polyphenolic Content Varies

**Ellagic acid content of walnuts:**
- Walnuts, with hulls: 210 mg/oz
- Blanched walnuts: 4 mg/oz

**Phloridzin (phloretin-2-glucose):**
- Apple peel: 80-420 ppm
- Apple pulp: 16-20 ppm
We should be eating more foods as near as possible to their natural state to get the phytochemicals we need for better health.
Antitumor activity:

- 60 flavonoids
- 40 liminoids (bitter principles)
- 20 carotenoids (pigments)
- Glucarates in albedo
- Terpenoids in skin
Flavonoids act as:

- suppressing agents to prevent formation of new cancers from procarcinogens
- blocking agents to prevent carcinogenic compounds reaching critical initiation sites
- transformation agents to facilitate the metabolism of carcinogenic components into less toxic materials
Apples contain powerful antioxidants, that inhibit tumor growth, decrease lipid oxidation, and lower cholesterol.

Boyer and Liu *Nutr J* 2004;3:5
Anticancer Activity of Mango

Mango juice inhibited the cell cycle of cancer cells. Mango juice was effective in reducing tumor growth in a dose-dependent manner.

Pomegranates for Chemoprevention and Chemotherapy of Prostate Cancer

Pomegranate fruit possesses strong antioxidant, anti-inflammatory, and anti-tumor properties. An extract inhibited the growth of highly aggressive prostate cancer cells, in a dose-dependent manner. It also induced apoptosis.

*Proc Natl Acad Sci* 2005;102:14813-8
Avocados and Cancer

Phytochemicals from avocado selectively induce cell cycle arrest, inhibit tumor growth, and induce apoptosis in precancerous and cancer cells.

The phytochemicals from avocado fruits target multiple signaling pathways, leading to apoptosis.

Ding et al.  
Semin Cancer Biol. 2007;17:386-94
What does all of this mean? What do the phytochemicals do for us?
Persons with a high fruit/vegetable intake have one-half the risk of cancer compared with those with a low intake.

Which cancers?

Stomach, colon, mouth, esophagus, pancreas, breast, cervix, bladder, ovarian, lung.
Fruit and Vegetable Intake and Risk of Breast Cancer

Trichopoulou, et al. JNCI 1995;87:110-6
Green Vegetables and Risk of Cancer

Reduction in Risk of Cancer

<table>
<thead>
<tr>
<th>Site</th>
<th>Medium vs. low intake</th>
<th>High vs low intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomach</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>Breast</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Prostate</td>
<td>20</td>
<td>70</td>
</tr>
<tr>
<td>Pancreas</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>Liver</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Bladder</td>
<td>10</td>
<td>70</td>
</tr>
</tbody>
</table>

More is better!
Intake of Tomatoes and Risk of Prostate Cancer

0.2
0.4
0.6
0.8
1.0

Relative Risk of Prostate Cancer

< 1 serving tomatoes/week
> 5 servings tomatoes/week


Other lycopene rich foods: guava, watermelon, papaya, pink grapefruit
Garlic and Cancer

Numerous studies report reduction of cancer risk associated with garlic consumption. Case-control studies suggest a protective effect. Risk is:

- 20-60% ↓ for stomach cancer
- 10-80% ↓ for colorectal cancer

for high intake of raw and/or cooked garlic. Cohort studies confirm this inverse relationship.

*J Nutr* 2001;131:1032S-40S
In elderly Dutch, stomach cancer was 50% less in those eating at least 1/2 onion/day compared with those eating no onions.

Variety is Key

There are >25,000 phytochemicals
<table>
<thead>
<tr>
<th>Phytochemical</th>
<th>Cancer-protective Foods</th>
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</thead>
<tbody>
<tr>
<td>Carotenoids</td>
<td>Yellow-orange, red fruits &amp; veggies., green, leafy vegetables</td>
</tr>
<tr>
<td>Curcumins</td>
<td>Turmeric, ginger</td>
</tr>
<tr>
<td>Ferulic acid</td>
<td>Whole grains</td>
</tr>
<tr>
<td>Indoles</td>
<td>Cabbage, broccoli, cauliflower</td>
</tr>
<tr>
<td>Isoflavones</td>
<td>Soybeans, tofu</td>
</tr>
<tr>
<td>Lignans</td>
<td>Flax seed, sesame</td>
</tr>
<tr>
<td>Lycopene</td>
<td>Tomato, watermelon, red grapefruit</td>
</tr>
<tr>
<td>Phthalides</td>
<td>Carrots, celery, cilantro, dill, parsley</td>
</tr>
<tr>
<td>Phytosterols</td>
<td>Seeds, legumes</td>
</tr>
<tr>
<td>Saponins</td>
<td>Beans, herbs</td>
</tr>
<tr>
<td>Sulfides</td>
<td>Garlic, onions, chives</td>
</tr>
<tr>
<td>Terpenes</td>
<td>Cherries, citrus, mint family</td>
</tr>
</tbody>
</table>
Mechanisms by Which Phytochemicals Prevent Cancer

- Antioxidant activity, scavengers of free radicals
- Inhibit cell proliferation
- Induction of cell differentiation
- Inhibit oncogene expression
- Induction of apoptosis
- Induction of cell-cycle arrest
- Inhibit signal transduction pathways
- Inhibit phase I enzymes (block activation of carcinogens)
- Induction of phase II enzymes (enhanced detoxification)
- Inhibit COX-2
- Inhibit cell adhesion and invasion
- Enhance immune function
- Inhibit DNA adduct formation
- Block activation of nuclear factor-kappaB (NF-κB)
- Anti-angiogenesis

A combination of broccoli and tomato was more effective at slowing prostate tumor growth than either tomato or broccoli alone.

*Cancer Res 2007;67:836-43*
Broccoli, Brussel sprouts, cauliflower, green cabbage are rich in glucosinolates which are metabolized to isothiocyanates. These are fairly stable in the refrigerator over 7 days. Cooking by steaming, microwaving, stir-fry did not cause significant losses of the glucosinolates whereas boiling causes significant losses by leaching into the water. Fine shredding of the vegetables also showed a marked decline in levels.

Food Chem Toxicol 2007;45:216-24
5+ servings of vegetables
Adults with stage 1 hypertension (av. 148/96 mmHg) were given 730 mg quercetin/day for 28 d, in a randomized, double-blind, placebo-controlled, crossover study.

Results:

systolic BP ↓7mm, and
diastolic BP ↓5mm.

Purple grape juice contains anthocyanins and flavonoid (antioxidant pigments) that decrease the risk of blood clots.

*Pharmaceut Biol* 1998;36(suppl):21-7
Red Grape Juice Reduces Risk of CVD

100 mL/d of conc. red grape juice taken for 14 days reduced both plasma inflammatory biomarkers and oxidized LDL cholesterol.

*Am J Clin Nutr* 2006;84:252-62

<table>
<thead>
<tr>
<th>Lipid</th>
<th>Percentage Change</th>
</tr>
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<tbody>
<tr>
<td>Total Chol.</td>
<td>6.2% ↓</td>
</tr>
<tr>
<td>LDL Chol.</td>
<td>13.4% ↓</td>
</tr>
<tr>
<td>HDL Chol.</td>
<td>15.7% ↑</td>
</tr>
</tbody>
</table>
21 healthy adults with normal cholesterol levels were fed a diet (for 3 wk) with no tomato products allowed, or a high tomato diet (400 ml tomato juice and 30 mg tomato ketchup daily).

On the high tomato diet:
- Total cholesterol levels ↓ 5.9%
- LDL cholesterol levels ↓ 12.9%
- Resistance to LDL cholesterol oxidation ↑ 13 %.

The flavonoids in strawberries lower risk of cardiovascular events:

- inhibit LDL cholesterol oxidation
- decrease tendency for thrombosis
- improve vascular endothelial function

Phytochemicals in Spices Protect Against Cardiovascular Disease

- garlic
- onions
- turmeric
- ginger

provide protection against cardiovascular disease, by lowering cholesterol or inhibiting blood clots or ↓ cholesterol ox.

- Allyl sulfides, ajoenes
- Flavonoids
- Curcumin
- Gingerols
Berry Power and CVD Risk

72 middle-aged subjects with CVD risk factors (but no medications) consumed moderate amounts of berries or control products for 8 weeks in RCT.

Platelet function was inhibited 11%. Total cholesterol and TG levels were unchanged but HDL ↑ 5.2%. Systolic BP ↓ significantly. The decrease occurred mostly in subjects with high baseline BP (7.3 mm Hg in highest tertile).

Am J Clin Nutr 2008;87:323-31
Berry Power and CVD Risk

120 middle-aged subjects with elevated blood lipids were given 160 mg anthocyanin supplements or placebo twice a day for 12 weeks.

The supplements

↑ HDL cholesterol 14%,
↓ LDL cholesterol 14%.

Cholesterol removal from cells increased about 20%.

Qin, Xia et al. *Am J Clin Nutr* August 2009
Protective Effects of Citrus Flavonoids

Decreased risk of CHD by 3 major actions:
• improving coronary vasodilatation
• decreasing the ability of platelets to clot
• preventing LDL from oxidizing.

The anti-inflammatory properties of citrus flavonoids are due to their inhibition of the synthesis and biological activities of different proinflammatory mediators, PGE2, PGF2, and TXA2.

J Agric Food Chem 2008
Fruit/Vegetable Intake and Risk of CVD

Fruits & Veg 3+ times/d vs. < 1/d

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Intake</th>
<th>Risk Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke incidence</td>
<td>3+</td>
<td>↓ 27%</td>
</tr>
<tr>
<td>Stroke mortality</td>
<td>&lt; 1</td>
<td>↓ 42%</td>
</tr>
<tr>
<td>IHD mortality</td>
<td>3+</td>
<td>↓ 24%</td>
</tr>
<tr>
<td>CVD mortality</td>
<td>3+</td>
<td>↓ 27%</td>
</tr>
<tr>
<td>All-cause mortality</td>
<td>3+</td>
<td>↓ 15%</td>
</tr>
</tbody>
</table>

Am J Clin Nutr 2002;76:93-9
Whole-grains Cut Risk of Heart Failure

Whole grain products reduces the risk of MI. In the Physicians’ Health Study, with 20 y follow-up:
• 2-6 svg. whole-grains associated with 21% ↓ in heart failure.
• 7+ svg. gave a 29%↓ risk compared to those with zero consumption.

Arch Intern Med 2007;167:2080-5
Nuts are Loaded With Phytochemicals

80-90% of fat is mono’s, poly’s. There is only 1-2.5 g satd fat/oz.

Nuts are rich in ellagic acid, flavonoids, phenolic acids, phytosterols, and tocotrienols.
Nuts Are Rich in Phytosterols

(Sunflower seeds = 151 mg/oz)

* New USDA Data
Effect of Different Nuts on LDL-Cholesterol Levels

- Walnuts, 1993
- Almonds*, 1998
- Peanuts, 1998
- Pistachios*, 1999
- Pecans, 1998, 1999
- Hazelnuts, 1998
- Macadamia, 1998

* subjects were hypercholesterolemic
Nurses’ Health Study, Boston

In middle-aged women, the age-adjusted risk of type 2 diabetes 38% lower for highest vs. lowest consumption of whole grain intake

Whole grains are rich in ferulic acid and other polyphenolics
Reduced Risk of Diabetes with Nut Consumption

-30 -20 -10 0

% change in risk of type 2 DM

Jiang, Willett, et al. JAMA 2002;288:2554-60
Whole grains, nuts, spices, legumes, fruits, & vegetables provide health-promoting phytochemicals that lower the risk of chronic diseases and ensure optimal health.
Do yourself a favor - enjoy a great phytochemical feast at your next meal and every meal thereafter.