Eat Your Veggies: Anti-Cancer Crops

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Eat Your Veggies and Fight Cancer, Too
Anticancer shopping list: broccoli sprouts, cabbage, garlic

By Daniel J. DeNoon
WebMD Weight Loss Clinic - Medical News

Oct. 31, 2005 -- Simple foods carry the most scientifically advanced anticancer compounds, scientists say.

The reports come from the fourth annual Frontiers in Cancer Prevention Research Research meeting, held by the American Association for Cancer Research.

At the cutting edge of these new frontiers is the finding that, well, that your mother was right. You really should eat your vegetables. They're full of newly discovered cancer-fighting compounds, says conference program chairman William G. Nelson, MD, PhD, of Johns Hopkins University.

"Basic research is discovering more and more about the cancer-preventing properties of things we are eating," Nelson said at a news conference. "The idea of having more fruits and vegetables in the diet has more and more evidence to support it."

This year a Nobel Prize went to the scientists who in 1982 discovered H. pylori, the bacterium that causes most stomach ulcers. But stomach ulcers aren't all this nasty bug does to us.

H. pylori causes a condition called gastritis, in which the walls of the stomach become red and swollen. Gastritis enormously increases a person's risk of stomach cancer.

A compound called sulforaphane protects cells from injury. It also happens to kill H. pylori. As it turns out, there is a natural way to protect the stomach lining from injury...
Cabbage family boasts nutrients, fights cancer

SUNDAY, APRIL 15, 2012

THE RECORD

Cruciferous vegetables are packed with so many nutrients it's tough to keep count. They contain fiber, vitamins A and C, riboflavin, B6, folic acid, magnesium, potassium and omega-3 fats. What's more, they have plant chemicals known as glucosinolates that have been shown to help reduce the risk of various types of cancer.
What do WE do at the SROC?

- Feed Vegetables to Humans
  - Masonic Cancer Center
- Study Cancer
  - Hormel Institute, MCC

- Grow vegetables that contain MORE phytonutrients
- Collaborate
Brassicas
Vegetables fight cancer

• Evidence?
Blueberries

- Antioxidants

R. Prior, USDA-ARS
Blueberries

• Antioxidants
  – “…[ORAC] values indicating antioxidant capacity have no relevance to the effects of…polyphenols on human health”

USDA ARS, ORAC of Selected Foods, Release 2 (2010)
Blueberries

• Antioxidants
  – “…[ORAC] values indicating antioxidant capacity have no relevance to the effects of…polyphenols on human health”
  – “The data of antioxidant capacity of food generated by in vitro methods cannot be extrapolated to in vivo effects…”

USDA ARS, ORAC of Selected Foods, Release 2 (2010)
Blueberries

- Antioxidants

R. Prior, USDA-ARS
Benefits of Goji Berries

Goji berry marketers have made bold claims about their products' powers: Goji berries can prevent or even cure cancer. They provide more antioxidants than any other fruit. They boost sexual function and keep people looking and feeling young. Of course, not all of these claims are true, and some may be difficult to verify. But there are some things about goji berries that we can determine with certainty.

Goji berries are incredibly nutritious. For their weight -- a daily serving is only 10 to 30 grams -- goji berries have more vitamin C than oranges, more beta carotene than carrots and more iron than steak. Beta carotene is believed to help fight heart disease and also protects the skin from sun damage. Goji berries are also a good source of vitamin A and antioxidants, which protect against harmful free radicals that damage cells in your body. They're also rich in polysaccharides, which aid the immune system, have 18 kinds of amino acids, and are a rich source of potassium. And, as if protecting your heart, skin and immune system weren't enough, beta carotene and antioxidants are thought to help fight cancer.

In fact, the claim that goji berry producers frequently refer to is the fruit's supposed cancer-fighting power. This ability, they say, stems from goji berries' high antioxidant content. Antioxidants are actually a class of vitamins that includes beta carotene and vitamins E and C. Goji berries rate highly in terms of Oxygen Radical Absorbance Capacity (ORAC), a test developed by the U.S. Department of Agriculture. Here are ORAC values (in units per 100 grams) for some foods with high amounts of antioxidants:

- Prunes - 5,770
- Raisins - 2,830
- Blueberries - 2,400
- Kale - 1,770
- Strawberries - 1,540
- Spinach - 1,280
- Brussels sprouts - 960
- Plums - 948
- Oranges - 750

According to several sources, goji berries' ORAC value is more than 25,000! But what does this mean?
Blueberries

- Antioxidants
- Anti-Aging

Joseph et al., 1999; J. Neurosci (19:8114-8121)
Blueberries

- Antioxidants
- Anti-Aging

Krikorian et al., 2010; J. Agric Food Chem [58(7):3996-4000]
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Cabbage Family Boasts Nutrients...
Evidence

• Be especially critical of evidence that agrees with your opinions
Evidence

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• “On the road from the City of Skepticism, I had to pass through the Valley of Ambiguity.”
  – Adam Smith
Evidence?

- Why do we think vegetables are good for you?
  - Long-Term randomized controlled trials are expensive & difficult
Evidence?

• Why do we think vegetables are good for you?
  – Long-Term randomized controlled trials are expensive & difficult
  – Separating vegetable intake from healthy lifestyle choices might be difficult
Confounding Evidence

Risk of Death (compared to abstainers = 1)

Controlled for age, sex, race, BMI, education, marital status, smoking, coronary disease risk

Klatsky et al., 2003, Am. J. Epidemiol.
Lifestyle

- **Wine**
  - Chicken, low-fat cheese, olives, fruit and veggies, oil, low-fat milk

- **Beer**
  - Soda, sausage, margarine & butter, ketchup, chips, cold cuts…

Johansen et al., 2006, BMJ
How do you grow anti-cancer foods?
How do you grow anti-cancer foods?

• Grow fruits and vegetables
Vegetables are superfoods

- “A significant protective effect of fruit and vegetable consumption was found in 126 of 158 dietary studies”

![Relative Risk of Cancer](chart)

- Highest 25% of vegetable consumers
- Lowest 25% of vegetable consumers

Relative Risk of Cancer

- High: 1
- Low: 2

Block, Patterson, and Subar (1992)
Vegetables are superfoods

Protective effects of increased vegetable intake (100 g) on cancers (case-control meta-analysis)

Riboli and Norat (2003)
Vegetables are superfoods?

Protective effects of increased vegetable intake (100 g) on cancers (cohort meta-analysis)

Riboli and Norat (2003)
Vegetables are superfoods
Working Intermission
Working Intermission

- Eating this vegetable will prevent cancer
Working Intermission

- Eating fruits and vegetables will prevent cancer
Working Intermission

• Studies suggest that people who eat more vegetables and fruits may have a lower risk for some types of cancer.
“Three grams of soluble fiber from oatmeal daily, in a diet low in saturated fat and cholesterol, may reduce the risk of heart disease. This oatmeal has 2 grams per serving.”
Phytonutrients

Carrots, squash, sweet corn, yellow peppers *(carotenoids and flavonoids)*

Blueberries, blackberries, purple cabbage, apples *(anthocyanins and phenolics)*

Tomatoes, radishes, red peppers *(lycopene and anthocyanins)*

Onions, garlic, shallots *(allicin)*

Leafy greens, spinach, kale, brassicas *(lutein, indoles, glucosinolates)*
Glucosinolates

Adult female specialists are attracted by ITCs and nitriles upon alighting; they are stimulated to oviposit when tasting glucosinolates

Specialist parasitoids use plant-produced ITCs and nitriles as monomers

Predators and parasitoids attack herbivores, which regurgitate and/or bleed deterrent glucosinolates and repellant ITCs and nitriles

Leaf herbivores induce higher levels of especially indole glucosinolates, which do not give rise to volatile breakdown products

Feeding damage to the plant shoot (or root) affects glucosinolate profile in plant root (or shoot)

Herbivores feeding on the root system induce specific glucosinolates in root tissue, excretion into the root environment, and emissions of ITCs and nitriles

Annu. Rev. Entomol. 54:57–83
Brassicas
Glucosinolates

- sinigrin
- 4-hydroxybutyl
- progoitrin
- glucoraphanin
- glucoalyssin
- glucolesperin
- glucobrassicin
- 4-methoxy glucobrassicin
- neoglucobrassicin
- gluconasturtiin

μmol per 100 grams fresh weight

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Glucosinolates

Glucosinolates

Glucosinolates

- Ingestion
- Absorption
- Metabolism
Glucosinolates

In cooking water

In broccoli

Song and Thornalley, Food Chem. Toxicol., 2007
Glucosinolates

Data adapted from Pellegrini et al., J. Agric. Food Chem., 2010
Aberrant Crypts in Colon

- Precancerous lesions
- Correlates with tumor formation
Glucosinolates

Total Aberrant Crypt Foci per cm²

Groups
Aberrant Crypt Foci
0
2
4
6
8
10
12
Control HPEITC LPEITC HI3C LI3C

a
ab ab
bc
c
p=0.02
p=0.001

Andrea Plate and Dan Gallaher
Glucosinolates

Total Aberrant Crypt Per Cm²

- Control
- Broccoli
- Watercress
- Cabbage

p < 0.008
Glucosinolates

Glucosinolates

Glucobrassicin (ug/g fresh wt.)

Months in Storage (0 C)

Spacing (in)

- Green: 12
- Blue: 18
- Red: 24

'Grand Slam'
[6]-gingerol
[6]-gingerol
[6]-gingerol
[6]-gingerol

angioworld.com

[6]-gingerol

[6]-gingerol

[6]-gingerol

Days After Planting

Mg [6]-gingerol per gram

178  209

Blue  Yellow

Days After Planting

178  209

6"  12"

University of Minnesota
[6]-gingerol
[6]-gingerol
[6]-gingerol
Functional Foods

Eat Smart

Beneforté
Naturally Better Broccoli

Boost your body's antioxidant enzymes
• “The relationship between fruit and vegetable intake and cancer prevention has not been as firmly established and has resulted in conservative recommendations for chemoprevention”

Carkeet et al., 2010. Phytochemicals: health promotion and therapeutic potential
• Does eating vegetables reduce cancer risk?
  – “The overall evidence suggests some lowering of risk for several types of cancer.”
Does eating vegetables reduce cancer risk?
  - “The overall evidence suggests some lowering of risk for several types of cancer.”

“The best advice is to eat at least 2½ cups of a variety of colorful vegetables and fruits each day.”
Questions?
Nutraceutical Development

- Production Consistency
- Sensory Acceptance
- Quantification /Certification
- Real /Perceived Value
Carotenoids

Data adapted from Pellegrini et al., J. Agric. Food Chem., 2010
Carotenoids

Data adapted from Miglio et al., J. Agric. Food Chem., 2008
Glucosinolates

Myrosinase

Glucoraphanin

Sulforaphane (bioactive)
Glucosinolates

Myrosinase

Glucoraphanin

Sulforaphane (bioactive)

DTC (excreted)
Glucosinolates

Myrosinase

Glucoraphanin

Sulforaphane (bioactive)

DTC (excreted)
Glucosinolates

INACTIVE

**Glucoraphanin**

ACTIVE

**Sulforaphane**

**Myrosinase**
Glucosinolates

INACTIVE

Glucoraphanin

Myrosinase

ACTIVE

Sulforaphane

Myrosinase

Glucoraphanin
Vegetables are superfoods

• Americans don’t eat as much vegetables as they probably should

Photo: Jon Green
Vegetables are superfoods

Dong and Lin, 2009
Vegetables are superfoods

Dong and Lin, 2009
[6]-gingerol

![Graph showing the relationship between rhizome yield and [6]-gingerol yield.](image-url)