

# Health Benefits of Cruciferous Vegetables

## Cruciferous Vegetables



The cruciferae are the family of plants that include the various familiar members of the species *Brassica oleracea*. Examples include: broccoli, cabbage, cauliflower, kale, and Brussels sprouts. Other examples of widely consumed cruciferous vegetables include: oriental cabbage, arugula, watercress, radish, daikon, wassabi, and various mustards.



A striking and characteristic chemical property of cruciferous plants is their high concentration of glucosinolates. Glucosinolates and their isothiocyanate hydrolysis (breakdown) products are well-known protectors against the development of cancer, suggesting that greater intakes of these vegetables may lower the risk of several types of cancer.

## The Phytochemistry of Crucifers



Glucosinolates are the precursors of isothiocyanates (mustard oils). Glucosinolates play protective and evolutionary important roles in plants, including:

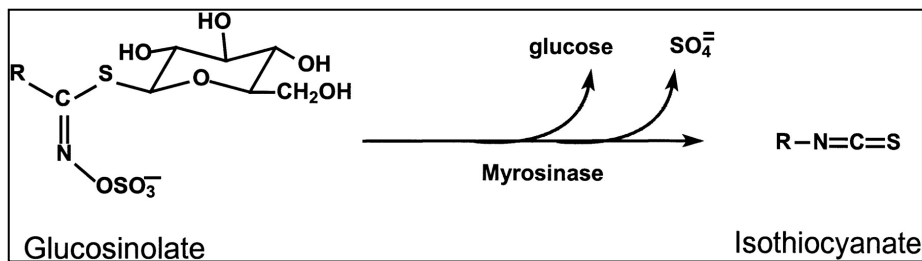
- ◆ Allelopathy  
Suppression of growth of neighboring plants
- ◆ Specific positive and negative feeding cues  
For some insects
- ◆ Broad antibiotic properties  
Including nematocidal, antimicrobial, antifungal, antiprotozoal, and insecticidal activities

## Activation in humans

When food is prepared or chewed, or in response to plant injury by predators, the enzyme myrosinase, which accompanies the glucosinolates is released. This enzyme is responsible for hydrolyzing glucosinolates to isothiocyanates. In the absence of myrosinase (when food is cooked and myrosinase is heat inactivated), humans have the ability to efficiently convert glucosinolates to isothiocyanates through the action of microflora in the GI tract.



Cabbage Worm



Conversion of Glucosinolates to Isothiocyanates by Plant Myrosinase.

## Chemoprotective effects of isothiocyanates and glucosinolates



Since the early 1960's, both natural and synthetic isothiocyanates have attracted considerable and growing attention as important and effective protectors against chemical carcinogenesis in a number of animals. Some glucosinolates have been examined and appear to be very effective in inhibiting carcinogenesis.

## History

Cigarette smoke releases several carcinogenic compounds in the lungs during smoking. Lung tissue activates these compounds to carcinogenic compounds that bind to DNA and cause carcinogenic changes. Isothiocyanates isolated from vegetables were effective inhibitors of this activation in animals and humans. They inhibit enzymes that are responsible for this conversion in the cells. Isothiocyanates also increase the excretion of metabolic byproducts of the carcinogens by more than fourfold.





## Evidence

Evidence of the inverse association between crucifer consumption and cancer exists among several types of cancer, including:

### Bladder cancer

Almost 50,000 men in the Health Professionals Follow-up Study were studied during a 10 year period for the relationship between variables such as fruit and vegetable intake and bladder cancer. There were no significant associations found between bladder cancer and the consumption of:

- ◆ Total fruits and vegetables
- ◆ Fruits only
- ◆ Vegetables only
- ◆ Yellow vegetables
- ◆ Or green leafy vegetables

However, there was a 51 percent risk reduction for bladder cancer in those consuming more than 5 servings of cruciferous vegetables a week versus those consuming less than one a week.

In the Health Professionals Follow-up Study, smoking was significantly related to increased risk of bladder cancer. Men with a history of heavy smoking had substantially higher risk of bladder cancer than nonsmokers. Risk increased with age and numbers of cigarettes smoked.



- ◆ Bladder cancer
- ◆ Prostate cancer
- ◆ Breast cancer
- ◆ Non-Hodgkin's lymphoma

### Prostate cancer

More than 1000 men were studied for the relationship between fruit and vegetable consumption and prostate cancer incidence. Findings show that:

- ◆ Men consuming 28 or more servings of vegetables a week had 33 percent decreased risk of prostate cancer.
- ◆ Those consuming 3 or more servings of **cruciferous vegetables had a 41 percent reduced risk of prostate cancer** compared to those that consumed only one or less a week.

The National Cancer Institute, National Institutes of Health and the new Dietary Guidelines for Americans 2005 recommend 9 fruits and vegetables for adults on a 2000 calorie diet. This would amount to about 35 servings of vegetables and 28 servings of fruits a week.



### Breast cancer

A case-controlled study in China found that intake of cruciferous vegetables, measured by urinary secretion of isothiocyanates, was inversely related to the risk of breast cancer.

- ◆ The quartile with the highest intake of cruciferous vegetables had only 50% of the risk of the lowest intake group for breast cancer.

### Non-Hodgkin's lymphoma

In the Nurses' Health Study, a high intake of cruciferous vegetables (5 or more servings/week compared to less than two servings/week) was associated with a 33% lower risk of non-Hodgkin's lymphoma.

### Conclusions...

There is much evidence about cruciferous vegetables and their protective effects against different types of cancer. Much research has been done on the unusual phytochemical known as glucosinolates; in particular on the hydrolysis products, the isothiocyanates. The isothiocyanates modulate the activities of enzymes involved in the metabolism of carcinogens, especially by the induction of phase 2 detoxification enzymes in the liver that detoxify carcinogenic compounds from the body. Cruciferous vegetables:

- \* Detoxify by upregulating detoxification enzymes
- \* Prevent oxidative cell and DNA damage
- \* Are chemoprotective against numerous types of cancer.

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