

The POWER of  **THE LONG-LASTING ANTIOXIDANT**



=

20oz.  
broccoli



=

1oz.  
**BROCCO SPROUTS**<sup>®</sup>



560mg.  
broccoli seed extract

For distribution to  
Medical Professionals only.

# The Emerging Science of



# Glucoraphanin

The Long-Lasting Antioxidant



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In 1992, scientists at Johns Hopkins University School of Medicine identified sulforaphane (SF) as a naturally occurring compound in broccoli that produces long-lasting antioxidant and detoxification activity and appeared to be responsible for the epidemiological findings that diets rich in broccoli and cruciferous vegetables were correlated with lower levels of cancer. These scientists subsequently determined that the compound present in the broccoli plant was the glucosinolate precursor of sulforaphane—known as glucoraphanin (GR) and available as .

In 1997, this research group demonstrated that glucoraphanin content of mature broccoli was highly variable. Further, there is no way for consumers to detect this variability and know whether they are getting high-concentration broccoli or not. However, GR was present at much higher concentrations in the 3-day-old sprouts of broccoli. BroccoSprouts® broccoli sprouts were developed to provide consumers with selected broccoli sprouts containing verified consistent and meaningful levels of GR.

Since 1992, glucoraphanin and sulforaphane have been extensively studied at Johns Hopkins and other prestigious medical institutions around the globe. More than 800 studies have been published which support the possible health benefits of GR and SF.

GR works as a potent catalyst to boost Phase 2 enzymes in the body. These detoxification enzymes trigger ongoing antioxidant action for at least 72 hours. As a result, the indirect antioxidant activity of GR lasts significantly longer than that of direct antioxidants such as vitamins C, E and beta carotene. Furthermore, 3-day-old sprouts have a much higher concentration of GR than the average mature broccoli (73 mg v. 11 mg per serving, respectively), which means that one ounce of broccoli sprouts contains as much GR as over 1-1/4 pounds (20 ounces) of market-stage broccoli.

The body of scientific knowledge concerning GR and broccoli sprouts continues to grow at a rapid rate; key studies with respect to GR are summarized below. Although research suggests a promising role for GR in promoting health, the research results do not permit definitive scientific conclusions on specific health benefits. At this time, the U.S. FDA has not reached any such conclusions or authorized any claims specifically for GR or broccoli sprouts.

Summaries of some key studies follow:

# Cancer

## **Carcinogen Detoxification**

*Potential to detoxify carcinogens.* An elevated level of hepatitis virus and environmental toxins results in a very high prevalence of liver cancer in a rural area of China. Scientists from Johns Hopkins University and Qidong Liver Cancer Institute performed a clinical test to assess whether broccoli sprouts influenced the body's abilities to detoxify carcinogens. In a single-blinded placebo-controlled trial, 100 test and 100 control subjects drank a water extract of 3-day-old broccoli sprouts or a placebo daily over a period of two weeks. The broccoli sprouts group showed a significant decrease in aflatoxin-DNA adduct (a biomarker of DNA damage) levels with increasing levels of broccoli sprout consumption. The change in these biomarkers signals an enhanced detoxification (neutralization) of carcinogens from the human body leading to a reduction in cancer risk.

—*Cancer Epidemiology, Biomarkers Prevention, 2005; 14(11).*

## **Tumor Progression and Activity**

*The inhibition of lung cancer tumors.* Scientists at Georgetown University Medical Center reported that sulforaphane and another isothiocyanate (PEITC) could prevent initial benign tumors in the lungs of mice produced by a cigarette carcinogen from developing into malignant cancer tumors. Using a model in which the animals were exposed to the carcinogens, scientists demonstrated that sulforaphane inhibits the progression of the disease by causing the programmed death of the damaged cells. Findings suggest that chemoprotective agents might be useful among people exposed to tobacco carcinogens, including current smokers, ex-smokers or those exposed to second-hand smoke.

—*Cancer Research, 2006, 65 (18):8538-8547.*

## **Stomach Cancer**

*Suppression of H. pylori infection.* Infection with the bacterium *H. pylori* can cause stomach ulcers and markedly increases the risk of developing stomach cancer. *In vitro* and animal experiments by a Johns Hopkins research team, led by Dr. Jed Fahey, showed potent and selective antibacterial properties of sulforaphane and sulforaphane's ability to selectively target the *H. pylori* bacteria, which are often difficult to eradicate. Also, sulforaphane was effective against *H. pylori* strains that had developed

resistance to the typical antibiotic treatment. In a Japanese study involving patients infected with *H. pylori* bacteria, patients eating 100 grams (approximately 3-1/2 ounces) of broccoli sprouts daily for 2 months experienced substantially reduced measures of *H. pylori* infection when compared with control subjects fed alfalfa sprouts containing no glucoraphanin. These results suggest that GR from broccoli sprouts may be responsible for the reduction of the bacteria and that a diet rich in GR may be useful in reduction of *H. pylori* infection and chemoprevention against gastric cancer.

—*Proc. Natl. Acad. Sci. USA, 2002, 99(11):7610-7615.*

—*Cancer Epidemiology, Biomarkers & Prevention, 2005, 14(11.2): 2754s.*

### **Skin Tumors**

*Skin tumor formation after exposure to UV radiation.* Mice were exposed to damaging levels of UV light for 20 weeks in a study conducted at Johns Hopkins Medical School. Following the exposure, application of sulforaphane resulted in a 50 percent reduction in the number of mice with tumors. The number of tumors per mouse and the mass of tumors were also reduced. A significant aspect of the study is that administration of the chemoprotective agent was after carcinogen exposure, suggesting an ability to prevent the progression of cancer after cells are already damaged.

—*Cancer Epidemiology, Biomarkers & Prevention, 2005, 14(11).*

—*Cancer Letters, 2006, 240:243-252.*

—*Cancer Research, 2006, 66: 8293-8296.*

### **Breast Cancer**

Work from Dr. Paul Talalay's lab at Johns Hopkins, published in 1994, demonstrated chemoprotective effects of sulforaphane, showing its ability to reduce mammary tumor formation in rats. Scientists at Shanghai Cancer Center in China conducted a retrospective (epidemiological) study of 350 pairs of women. One of each pair had breast cancer. The other was cancer-free. The study results revealed that women who had eaten higher levels of Brassica vegetables—broccoli, cabbage, cauliflower and kale (all of which contain GR and related compounds)—were 50 percent less likely to be diagnosed with breast cancer. Cornblatt and colleagues (2007) have now shown that sulforaphane actually reaches breast tissue in humans within an hour or so of consumption.

—*Cancer Research, 2003, 63:3980-3986.*

—*Carcinogenesis, 2004, 25: 219-227.*

—*Carcinogenesis, 2007, 28(7):1485-1490.*

### **Prostate Cancer**

*Prostate cancer cell inhibition.* Human prostate cancer cells responded to treatment with sulforaphane in the form of broccoli sprout extracts, showing dramatic increases in their Phase 2 protective enzymes. Dr. James D. Brooks, Urology Department, Stanford University, suggests broccoli sprouts, a rich natural producer of sulforaphane, might be appropriate for use in intervention trials in humans.

—*Cancer Epidemiology, Biomarkers & Prevention, 2001, 10:949-954.*

—*Carcinogenesis, 2004, 25:83-90.*

—*BMC Cancer, 2006, 6: 62.*

### **Colon Cancer**

*Colon cancer cell inhibition.* American Health Foundation researchers showed that sulforaphane significantly inhibited the formation of colon cancer in rats. Much work has demonstrated the ability of sulforaphane and broccoli sprouts extracts to inhibit cancer in human colon cancer cells.

—*Proceedings of the American Association for Cancer Research, 2000, 41:660.*

—*J. Nutrition, 2005, 135:1865-1872.*

—*Cancer Chemother. Pharm., 2006, 57:317-327.*

### **Bladder Cancer**

*Prevention and control of bladder cancer.* Epidemiological evidence strongly suggested a role for cruciferous vegetables in prevention of bladder cancer. Indeed, although an analysis of 47,909 men in the Health Professionals Follow-Up Study showed virtually no correlation between lower level of cancer and high consumption of fruits and vegetables overall, or yellow or green leafy vegetables specifically, however, it did show a statistically significant reduction among those men who consumed large amounts of cruciferous vegetables.

Several studies have suggested that the bladder is one of the most responsive organs to induction of detoxification enzymes by extracts, and have demonstrated that this was evident in human bladder cancer cells *in vitro* and using broccoli sprouts rich in sulforaphane potential in animal models *in vivo*. In addition, studies have also shown that sulforaphane and broccoli sprout extract can induce apoptosis and cell cycle arrest in human bladder cancer cells *in vitro*, while showing that activity levels from pure sulforaphane and broccoli sprout extracts were

virtually equivalent, confirming that this effect is due exclusively to the sulforaphane potential in the sprouts, not other components.

—*Journal of the National Cancer Institute*, 1999, 91(7):605-613.

—*Journal of Nutrition*, 2004, 134:2004-2010.

—*Mol. Cancer Ther.*, 2006, 5(4):935-944.

### **Impact on Developing or Developed Cancers**

*Cancer cell apoptosis and cell cycle arrest.* French researchers showed that sulforaphane might do more than just activate antioxidants. Their research describes the ability of sulforaphane to cause cancer cells to undergo self-destruction, known as *apoptosis* or programmed cell death. The multidimensional ability of sulforaphane both to eliminate or detoxify carcinogens and to kill cells with potential cancer-causing mutations suggests that GR may have broader effects on developed cancer at various stages as well as prevention.

—*Cancer Research*, 2001, 61(16):6120-6130.

—*Current Cancer Drug Targets*, 2006, 6:135-145.

*Antimetastatic activity.* Scientists at the Amala Cancer Research Centre in India reported that sulforaphane may inhibit the spread of B16F-10 melanoma cells *in vitro*. Mice were treated with sulforaphane either prior to, simultaneously, or following exposure to the carcinogens. Results indicated the simultaneous treatment of sulforaphane was most effective with a 95% reduction of lung tumor formation and a 94% increase in the life span of the animals. The findings suggest that sulforaphane may have the ability to prevent metastasis of established cancers, rather than simply preventing development of cancers.

—*Life Science*, 2006; 78(26):3043-3050.

## Other health conditions:

### **Cholesterol Levels**

In a pilot study, researchers at Tokyo University of Agriculture and The Japan Institute for the Control of Aging found that individuals who ate 3-1/2 ounces of broccoli sprouts a day for just one week showed decreased overall levels of cholesterol, while increasing HDL or good cholesterol. The GR in broccoli sprouts also appear to reduce the amount of oxidative stress or cell destruction caused by free radicals.

—*Biofactors*, 2004, 22:271-275.

### **High Blood Pressure**

In laboratory studies with animals that are bred to have high blood pressure and are therefore at high risk for stroke, Dr. Bernhard Juurlink at the University of Saskatchewan in Saskatoon, Canada, found that sulforaphane-induced Phase 2 enzymes from broccoli sprouts improved cardiovascular health by decreasing inflammation and improving heart, artery and kidney function.

—*Proc. Natl. Acad. Sci. USA*, 2004, 101(18): 7094-7099.

### **Macular Degeneration**

Johns Hopkins University scientists studied the ability of sulforaphane to protect retinal pigment epithelial cells from damage by chemical carcinogens and by UV light. These processes are the similar to the kind of damage that can lead to macular degeneration in the eye. Macular degeneration is the leading cause of blindness among the elderly.

—*Proc. Natl. Acad. Sci. USA*, 2001, 98(26):15221-15226.

—*Proc. Natl. Acad. Sci. USA*, 2004, 101(28):10446-10451.

—*Invest. Ophthalmol. Vis. Sci.*, 2005, 46: 979-987.



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