Cardiovascular Health, Hypertension, Atherosclerosis, Anti-Aging (oxidative stress)

Broccoli Sprouts

"Dietary Approach to Attenuate Oxidative Stress, Hypertension, and Inflammation in the Cardiovascular System",

Proceedings of the National Academy of Sciences of the United States of America, PNAS, May 4, 2004, vol. 101, no. 18, 7094-7099, Medical Sciences, Lingyun Wu , M. Hossein Noyan Ashraf*, Marina Facci, Rui Wang, Phyllis G. Paterson , Alison Ferrie and Bernhard H. J. Juurlink.

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Imbalance between production and scavenging of superoxide anion results in hypertension by the inactivation of nitric oxide, and the increased oxidative stress from the resultant peroxynitrite that is produced promotes inflammatory processes such as atherosclerosis. Induction of phase 2 proteins promotes oxidant scavenging. We hypothesized that intake of dietary phase 2 protein inducers would ameliorate both hypertension and atherosclerotic changes in the spontaneously hypertensive stroke-prone rat. For 5 days/week for 14 weeks, we fed rats 200 mg/day of dried **broccoli sprouts** that contained glucoraphanin, which is metabolized into the phase 2 protein-inducer sulforaphane (Group A), sprouts in which most of the glucoraphanin was destroyed (Group B), or no sprouts (Group C). After 14 weeks of treatment, no significant differences were seen between rats in Groups B and C. **Rats in Group A had significantly decreased oxidative stress in cardiovascular and kidney tissues,** as shown by increased glutathione (GSH) content and decreased oxidized GSH, decreased protein nitrosylation, as well as increased GSH reductase and GSH peroxidase activities. Decreased oxidative stress correlated with better endothelial-dependent relaxation of the aorta and significantly lower (20 mm Hg) blood pressure. Tissues from Groups B and C had considerable numbers of infiltrating activated macrophages, indicative of inflammation, whereas animals in Group A had few detectable infiltrating macrophages. There is interest in dietary phase 2 protein inducers as means of reducing cancer incidence. We conclude that a diet containing phase 2 protein inducers also reduces the risk of developing cardiovascular problems of hypertension and atherosclerosis.

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Broccoli May Bolster Body’s Defenses Against Heart Disease and Stroke

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University of Saskatchawan

May 03, 2004

Compounds in broccoli may supercharge the body's ability to mop up free radicals and so protect against high blood pressure, stroke and heart disease, according to research led by University of Saskatchewan health scientist Bernhard Juurlink and recently published in the Proceedings of the National Academy of Sciences (PNAS) in the U.S.

"Nearly all the studies to date have focused on the protective effects of these substances against cancer," said Juurlink, head of the U of S department of anatomy and cell biology. "This study is the first to show that broccoli sprouts rich in these compounds, through raising the antioxidant and thereby the anti-inflammatory capacities of cells, can correct major dysfunctions such as hypertension and stroke."

The research team is exploring oxidative stress which occurs when free radical production outstrips the body's ability to neutralize it. Free radicals are unstable chemical byproducts of the body's normal metabolism which damage essential cell molecules in a manner similar to the rusting of iron. This damage leads to cardiovascular disease and other ailments.

Tissues have a variety of defenses to prevent this "rusting" - systems that Juurlink and his team found can be bolstered by eating foods rich in chemicals called phase 2 protein inducers. One such inducer, glucoraphanin (Grn), is found in high levels in broccoli sprouts (baby broccoli plants with a pleasant, tangy flavor).

"Phase 2 inducers promote the production of phase 2 proteins," Juurlink says. "These proteins either promote scavenging of oxidants or decrease the chance of these oxidants being formed in the first place. The result is a huge multiplier effect. One phase 2 protein inducer likely has the same effect as thousands of typical anti-oxidant molecules."

The researchers fed broccoli sprouts to two groups of rats that were prone to high blood pressure and stroke. One group received sprouts high in Grn, while the other group received a Grn-poor variety. At the end of 14 weeks, the rats on the high-Grn diet displayed more vigorous antioxidant defense mechanisms. They also had lower blood pressure and decreased inflammation of the heart and kidney.

The study suggests a modest change in diet could have profound health benefits. Juurlink says if humans respond the same way as the test animals, one or two grams of fresh broccoli sprouts per day per kilo of body weight would do the trick. This works out to 70 to 140 grams (roughly **two to four ounces**) for a 70-kilogram person, or a smallish serving with supper every day. The team hopes to repeat the study in human subjects to confirm the beneficial effects.

Anti-cancer effects of the sprouts, documented in a study published in 2002 by a team at Johns Hopkins University School of Medicine in Maryland, appear to be due to the same enhanced antioxidant effect. The 2002 study also showed a powerful antibacterial effect against Helicobacter pylori, an organism known to cause stomach ulcers.

Why sprouts? **They have much higher concentrations of Grn than mature broccoli**. Juurlink **estimates you would need to eat 20 to 50 times as much of the mature plant to get the same benefits.**

If broccoli sprouts are hard to come by in your supermarket, you can also get phase 2 protein inducers into your system with other foods. Some examples are flax seed, soy products, kale - and for dessert, raspberries, blackberries, strawberries, blueberries and cranberries.

Funding for the study was provided by the Saskatchewan Agricultural Development Fund. Other researchers on the team included Lily Wu (pharmacology), Hossein Noyan Ashraf (post-doctoral fellow in anatomy and cell biology), Marina Facci (graduate student), Rui Wang (physiology), Phylis Paterson (pharmacy and nutrition), and Alison Ferrie (National Research Council's Plant Biotechnology Institute).

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Inhibition of Urinary Bladder Carcinogenesis by Broccoli Sprouts.

Cancer Res. 2008 Feb 29 Munday R, Mhawech-Fauceglia P, Munday CM, Paonessa JD, Tang L, Munday JS, Lister C, Wilson P, Fahey JW, Davis W, Zhang Y.

AgResearch Limited, Ruakura Agricultural Research Center, Hamilton, New Zealand; Departments of Pathology and Cancer Prevention and Control, Roswell Park Cancer Institute, Buffalo, New York; Institute of Veterinary, Animal and Biomedical Sciences, Massey University, Palmerston North, New Zealand; The New Zealand Institute for Crop and Food Research Limited, Lincoln, New Zealand; and Departments of Pharmacology and Molecular Sciences and International Health, the Johns Hopkins University, Baltimore, Maryland.

Isothiocyanates are a well-known class of cancer chemopreventive agents, and broccoli sprouts are a rich source of several isothiocyanates. We report herein that dietary administration to rats of a freeze-dried aqueous extract of **broccoli sprouts significantly and dose-dependently inhibited bladder cancer** development induced by N-butyl-N-(4-hydroxybutyl) nitrosamine. T**he incidence, multiplicity, size, and progression of bladder cancer were all inhibited by the extract**, while the extract itself caused no histologic changes in the bladder. Moreover, inhibition of bladder carcinogenesis by the extract was associated with significant induction of glutathione S-transferase and NAD(P)H:quinone oxidoreductase 1 in the bladder, enzymes that are important protectants against oxidants and carcinogens. Isothiocyanates are metabolized to dithiocarbamates in vivo, but dithiocarbamates readily dissociate to isothiocyanates. We found that >70% of the isothiocyanates present in the extract were excreted in the urine as isothiocyanate equivalents (isothiocyanates + dithiocarbamates) in 12 h after a single p.o. dose, indicating high bioavailability and rapid urinary excretion. In addition, the concentrations of isothiocyanate equivalents in the urine of extract-treated rats were 2 to 3 orders of magnitude higher than those in plasma, indicating that the bladder epithelium, the major site of bladder cancer development, is most exposed to p.o. dosed isothiocyanate. Indeed, tissue levels of isothiocyanate equivalents in the bladder were significantly higher than in the liver. In conclusion, **broccoli sprout extract is a highly promising substance for bladder cancer prevention** and the isothiocyanates in the extract are selectively delivered to the bladder epithelium through urinary excretion. [Cancer Res 2008;68(5):1593-600].

Broccoli Sprouts Eaten During Pregnancy May Provide Children with Life-long Protection Against Heart Disease – University of Saskatchewan Study

Tuesday, January 31, 2006
2006-01-14-ME

Eating broccoli sprouts during pregnancy may provide your kids with life-long protection against cardiovascular disease, according to a research team led by Bernhard Juurlink at the University of Saskatchewan.

Using pregnant rats, the researchers found that not only did the broccoli sprouts improve the mothers' health; they also seem to improve the health of their offspring into adulthood - even if the babies never tasted a sprout.

"We looked at the offspring up to six months later and even on a normal diet, they were in better health than their mothers," says Juurlink, a professor in the U of S anatomy and cell biology department.

The findings are published in the journal of the Federation of American Societies for Experimental Biology (FASEB).The work is a follow-up to the team's 2004 study that found broccoli sprouts fed to hypertensive rats lowered their blood pressure.

Juurlink's lab studies the impact of oxidative stress which occurs when the body produces free radicals, a byproduct of normal metabolism, faster than it can remove them. These highly reactive molecules can cause a host of problems such as tissue inflammation, hypertension and stroke. The research team is trying to find ways to reduce oxidative stress using diet.

So where do the broccoli sprouts fit in? The sprouts are high in a phase 2 protein inducer called glucoraphanin. In fact, they have 20 to 50 times more glucoraphanin than mature broccoli.

"Phase 2 inducers promote the production of phase 2 proteins which either promote scavenging of oxidants or decrease the chance of these oxidants being formed in the first place," Juurlink said.

In effect, broccoli sprouts boost the body's natural defenses against the oxidative stress that causes high blood pressure and inflammation. Surprisingly, this dietary change not only improves the health of the expectant mothers, but also has a lasting effect on the offspring.

"It appears we've instituted a permanent change in the offspring, the question now is how," Juurlink says.

Human trials are planned in the near future. Juurlink says if humans react the same way as rats, 200 grams or less of sprouts every other day may be enough to reduce oxidative stress. If he's right, a simple dietary change may prevent or delay onset of cardiovascular diseases such as hypertension, or possibly even neurodegenerative diseases such as Alzheimer's.

It's important to eat the right variety of sprouts. The Calabrese variety used in the study produced beneficial effects, but even better, some commercially available varieties of broccoli sprouts have seven times as much glucoraphanin. Broccoli sprouts are typically eaten raw in salads or wraps, or cooked in a variety of dishes.

Funding for this study was provided by the Canadian Institutes of Health Research. Other research team members were Hossein Noyan-Ashraf (anatomy and cell biology) and Lily Wu (pharmacology).

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Dietary approaches to positively influence fetal determinants of adult health.

FASEB J (The journal of the *Federation of American Societies for Experimental Biology*

2006 Feb;20(2):371-3..
Noyan-Ashraf MH, Wu L, Wang R, Juurlink BH.
Department of Anatomy and Cell Biology, College of Medicine, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

An imbalance between production and scavenging of oxidants is a commonality found in factors that result in fetal determinants that negatively affect adult health. We reasoned that a dietary intervention that promotes oxidant scavenging through phase 2 protein induction would have **positive effects on fetal programming of adult health**. Previously, we demonstrated that a diet containing **broccoli sprouts** high in glucoraphanin (Grn), precursor of the phase 2 protein inducer sulforaphane, decreased oxidative stress and associated problems in male spontaneously hypertensive stroke-prone rats (SHRsp). We hypothesized that placing females on a Grn-containing (Grn(+)) diet would have similar positive effects and that the adult offspring of such females would have lower blood pressures and less tissue inflammation than offspring from mothers on control diet. We demonstrate that female SHRsp on a Grn(+) diet had decreased oxidative stress and associated problems such as hypertension than females on control diet. The offspring of females on Grn(+) diet also had lower blood pressures and less tissue inflammation in adulthood regardless of diet, with offspring placed on a Grn(+) diet having the best health outcomes. **We conclude that reducing oxidative stress in pregnant females has profound outcomes in the health of their adult offspring.**

Bone Density, Breast, Colon, & Prostate Cancers. Cardiovascular Health

Health effects of phytoestrogens.
Forum Nutr. 2005;(57):100-11.
Branca F, Lorenzetti S.
National Institute for Research on Food and Nutrition, Rome, Italy.

Phytoestrogens are naturally occurring plant-derived phytochemicals, whose common biological roles are to protect plants from stress or to act as part of a plant's defense mechanism. Although composed of a wide group of nonsteroidal compounds of diverse structure, phytoestrogens have been shown to bind estrogen receptors and to behave as weak agonist/antagonist in both animals and humans. Phytoestrogens include mainly **isoflavones** (IF), coumestans, and lignans. These compounds are known to be present in fruits, vegetables, and whole grains commonly consumed by humans. IF **are found in legumes--mainly soybeans--whereas flaxseed is a major source of lignans, and coumestans are significantly present in clover, alfalfa and soybean sprouts.** 8-Prenyl flavonoids are common in vegetables. Bioavailability of IF requires an initial hydrolysis of the sugar moiety by intestinal beta-glucosidases to allow the following uptake by enterocytes and the flow through the peripheral circulation. Following absorption, IF are then reconjugated mainly to glucuronic acid and to a lesser degree to sulphuric acid. Gut metabolism seems key to the determination of the potency of action. Several epidemiological studies correlated high dose consumptions of soy IF with multiple beneficial effects on **breast and prostate cancers, menopausal symptoms, osteoporosis, atherosclerosis and stroke, and neurodegeneration**. **For the relief of menopausal symptoms a consumption of 60 mg aglycones/day has been suggested; for cancer prevention a consumption between 50 and 110 mg aglycones/day is considered beneficial to reduce risks of breast, colon and prostate cancer; to decrease cardiovascular risk a minimum intake of 40-60 mg aglycones/day**, together with about 25 g of soy protein has been suggested. For improvement in **bone mineral density, 60-100 mg aglycones/day for a period of at least 6-12 months could be beneficial.**

Daikon, A Promising Anti-Cancer Vegetable

RIRDC Project No DAQ-342A, June 2007, Dr Tim O'Hare Queensland Department of Primary Industries and Fisheries, Queensland Horticulture Institute, Gatton Research Station

Objectives

Identify daikon and radish varieties with highest anti-cancer activity, following on from DAQ-307A which identified daikon and radish sprouts as having extremely high anti-cancer potential. Provide labeling advice in relation to the strongest possible claims that can be made.

Progress (June 2007)

Daikon and radish were analyzed at the seed and sprouted-seed stage to identify cultivars high in the anti-cancer glucosinolate, glucoraphenin. Of the cultivars tested, 'Cherry Belle' and 'Black Spanish' maintained highest levels of glucoraphenin. Levels were highest in seed, and decreased with increasing sprout age. Decline in concentration was largely due to dilution associated with cell expansion, and partly due to other mechanisms. Differences in the latter appear to have impact on anti-cancer potential.

Analysis of mature daikon and radish tissue (roots and shoots) indicated that the principal glucosinolate in roots of all cultivars was glucodehydroerucin, which is estimated to have one tenth the potency of glucoraphenin, the principal glucosinolate found in seeds and young sprouts. By contrast, the principal glucosinolates present in mature shoots were glucoraphanin and glucoraphenin, both potent anti-cancer agents. Shoots were estimated to have approximately 20 times the anti-cancer potential of roots.

Glucosinolate Compostition and Anti-Cancer Potential of Daikon and Radish Sprouts

ISHS Acta Horticulturae 765: XXVII International Horticultural Congress - IHC2006: International Symposium on Plants as Food and Medicine: The Utilization and Development of Horticultural Plants for Human Health. T.J. O'Hare, L.S. Wong, L.E. Force, C.B. Gurung, D.E. Irving, D.J. Williams

Abstract: Daikon and radish sprouts contain high levels of glucoraphenin, a glucosinolate which hydrolyses to form sulphoraphene. Sulphoraphene, like sulphoraphane from broccoli, is a potent inducer of phase 2 detoxification enzymes and consequently has potential anti-cancer action. Unlike broccoli however, **daikon and radish** do not possess epithiospecifier protein, a protein that inhibits conversion of glucosinolates to isothiocyanates, and consequently they **may represent more suitable sources of phytochemicals with anti-cancer potential**. Concentrations of glucoraphenin were highest in the seed, declining exponentially with sprout development. The rate of decline was observed to vary considerably between varieties of daikon and radish, with some varieties maintaining significantly high levels of glucoraphenin. Varieties maintaining a high level of glucoraphenin included 'Cherry Belle' and 'French Breakfast'.

A scientific paper was presented at the International Horticultural Congress in Seoul (Korea) in August 2006 entitled: **"Glucosinolate Composition and Anti-Cancer Potential of Daikon and Radish sprouts"**. A poster presentation was made at the 6th Annual Health and Medical Research Conference of Queensland. (November, 2006).

Breast, Colon, & Prostate Cancers, Menopause, Bone Density, Atherosclerosis

Health Effects Of Phytoestrogens
Forum Nutr. 2005;(57):100-11.
Branca F, Lorenzetti S.
National Institute for Research on Food and Nutrition, Rome, Italy.

Phytoestrogens are naturally occurring plant-derived phytochemicals, whose common biological roles are to protect plants from stress or to act as part of a plant's defense mechanism. Although composed of a wide group of nonsteroidal compounds of diverse structure, phytoestrogens have been shown to bind estrogen receptors and to behave as weak agonist/antagonist in both animals and humans. Phytoestrogens include mainly **isoflavones** (IF), coumestans, and lignans. These compounds are known to be present in fruits, vegetables, and whole grains commonly consumed by humans. IF **are found in legumes--mainly soybeans--whereas flaxseed is a major source of lignans, and coumestans are significantly present in clover, alfalfa and soybean sprouts.** 8-Prenyl flavonoids are common in vegetables. Bioavailability of IF requires an initial hydrolysis of the sugar moiety by intestinal beta-glucosidases to allow the following uptake by enterocytes and the flow through the peripheral circulation. Following absorption, IF are then reconjugated mainly to glucuronic acid and to a lesser degree to sulphuric acid. Gut metabolism seems key to the determination of the potency of action. Several epidemiological studies correlated high dose consumptions of soy IF with multiple beneficial effects on **breast and prostate cancers, menopausal symptoms, osteoporosis, atherosclerosis and stroke, and neurodegeneration**. **For the relief of menopausal symptoms a consumption of 60 mg aglycones/day has been suggested; for cancer prevention a consumption between 50 and 110 mg aglycones/day is considered beneficial to reduce risks of breast, colon and prostate cancer; to decrease cardiovascular risk a minimum intake of 40-60 mg aglycones/day**, together with about 25 g of soy protein has been suggested. For improvement in **bone mineral density, 60-100 mg aglycones/day for a period of at least 6-12 months could be beneficial.**

Antioxidant and Anti-Cancer. Free Radical Scavenger

Total Phenolics Level, Antioxidant Activities and Cytotoxicity of Young Sprouts of Some Traditional Korean Salad Plants. Plant Foods Hum Nutr. 2008 Nov 19. Chon SU, Heo BG, Park YS, Kim DK, Gorinstein S. EFARINET Co. Ltd., BI Center, Chosun University, Gwangju, 501-759, South Korea.

The aim of this investigation was to study the antioxidant and anticancer activities of young sprouts of some traditional Korean salad plants. Total phenolics, **antioxidant and anticancer activities of the methanol extracts from young sprouts of 11 salad plants were determined**. The highest amount of phenolics was found in methanol extracts of Euonymus alatus (235.7 mg kg(-1)), followed by Hypericum ascyron (197.1 mg kg(-1)), Zanthoxylum piperitum (194.1 mg kg(-1)) and Zanthoxylum schinifolium (142.5 mg kg(-1)). Methanol extracts of E. alatus, H. ascyron, and Z. piperitum at 63 mg kg(-1) exhibited the highest dose-depend DPPH radical scavenging activity by 91.2, 91.2 and 83.9%, respectively. According to the MTT results, the methanol extracts from Stellaria aquatica, Eleutherococcus sessilifolrus and Z. schinifolium showed the highest anticancer activities against Calu-6 (IC50 < 25.0 microgml(-1)) and from S. aquatica-the highest anticancer activities against SNU-601 (153.3 microgml(-1)), following by E. sessilifolrus (196.7 microg ml(-1)) and Amaranthus mangostanus (303.1 microgml(-1)). Total phenolics were highly correlated with the DPPH, suggesting that they contribute to the antioxidant properties of the studied plants.

In conclusion: young sprouts of Korean salad possess antioxidant and anticancer properties and could be used as a supplement to proper drugs.

Broccoli sprouts as inducers of carcinogen-detoxifying enzyme systems: clinical, dietary, and policy implications.

Proc Natl Acad Sci U S A 1997 Oct 14;94(21):11149-51 Nestle M. Department of Nutrition and Food Studies, New York University, 35 West 4th Street, 10th Floor, New York, NY 10012-1172, USA.

Cancer is the second leading cause of death in the United States; it accounts for nearly one-fourth of annual deaths (1). Although the rates of some cancers have been declining, rates of others have increased. Thus, despite advances in early detection and treatment, overall death rates from cancer have remained largely unchanged since the early 1970s, suggesting the need for a stronger research focus on prevention (2). Approaches to prevention necessarily include smoking cessation and dietary changes, because each is believed to contribute to about one-third of annual cancer deaths (3). For two decades, dietary advice to prevent cancer has emphasized fruit and vegetable consumption (4), and recent recommendations, such as those listed in Table 1, give highest priority to consuming plant-based diets (5, 6). Such advice is entirely consistent with recommendations for prevention of heart disease and other diet-related chronic diseases (4). It is supported by substantial, increasing, and extensively reviewed evidence linking intake of plant foods to impressive reductions in cancer risk at several major sites (6-11). On the basis of this evidence, researchers recently have estimated that plant-based diets prevent 20% (6) to 50% (11) of all cases of cancer.

Table 1. American Cancer Society guidelines for diet and cancer prevention (5)

- Choose most of the foods you eat from plant sources.
- Eat five or more servings of fruits and vegetables each day.
- Eat other foods from plant sources, such as breads, cereals, grain products, rice, pasta, or beans several times each day.
- Limit your intake of high-fat foods, particularly from animal sources.
- Choose foods low in fat.
- Limit consumption of meats, especially high-fat meats.
- Be physically active: achieve and maintain a healthy weight.
- Be at least moderately active for 30 minutes or more on most days of the week.
- Stay within your healthy weight range.
- Limit consumption of alcoholic beverages, if you drink at all.

Epidemiologic and animal studies have associated certain food plants with pronounced reductions in cancer risk. Among such plants are cruciferous (mustard family) vegetables of the genus *Brassica*: broccoli, cabbage, cauliflower, and Brussels sprouts, among others. National committees have recommended consumption of these vegetables for cancer prevention since the early 1980s (12). What characteristics of these vegetables might protect against carcinogenesis? Fahey *et al.* (13) directly address this important question. *Brassica* vegetables contain little fat, are low in energy, and are sources of vitamins, minerals, and fiber —all aspects linked to cancer protection. They also contain a large number of phytochemicals, some of which protect against carcinogenesis in various *in vitro* and animal testing systems (11). Table 2 summarizes the principal attributes and components of cruciferous vegetables that singly or together might protect against carcinogenesis.

Table 2. Potentially anticarcinogenic attributes and components of broccoli and other cruciferous vegetables (9, 11)

- **Energy and macronutrients**
- Low fat
- Low energy
- **Micronutrients**
- Vitamin A
- Vitamin C
- Vitamin E
- Folic acid
- Selenium
- **Fiber**
- **Phytochemicals**

- Carotenoids
- Coumarins*
- Dithiolthiones*
- Flavonoids*
- Glucosinolates*
- Indoles#
- Isothiocyanates*
- Phenols*
- Terpenes

*Includes at least one compound identified as carcinogenic in test systems (17, 27, 28).
Not present in sprouts (13).

The research of Fahey *et al.* (13) aims to identify specific phytochemicals in *Brassica* vegetables that may confer protection and the mechanisms by which they do so. The hypothesis underlying this work is that certain phytochemicals might raise the activity of enzyme systems that detoxify carcinogens. Several enzyme systems oxidize, reduce, or hydrolyze (phase 1) and then conjugate or otherwise affect (phase 2) drugs, metabolites, carcinogens, and other toxic chemicals, thereby increasing their polarity and excretability. Phase 1 enzymes activate or deactivate carcinogens, depending on the experimental conditions. Phase 2 enzymes are more likely to detoxify. For 20 years, consumption of cruciferous vegetables has been known to induce enzyme detoxification in experimental systems (12).

Such observations have led Paul Talalay and his colleagues (14-16) to conduct an elegant series of studies on the effects of cruciferous vegetable extracts on phase 2 enzyme induction and animal tumorigenesis. They have developed an *in vitro* assay to distinguish bifunctional phytochemicals that induce both phase 1 and phase 2 enzyme systems from monofunctional phytochemicals that induce only phase 2 enzymes. They then used this assay to demonstrate that *Brassica* vegetables are particularly rich sources of monofunctional phase 2 inducers (14) and to identify the isothiocyanate sulforaphane as the principal phase 2 inducer in broccoli extracts (15). They also have demonstrated that sulforaphane is a dose-related inhibitor of carcinogen-induced mammary tumorigenesis in rats (16).

These impressive accomplishments now have been extended to identify phase 2 inducer activity in sprouts of broccoli and in mature plants. Most of this activity derived from the glucosinolate precursor of sulforaphane, glucora-phanin. Because no net synthesis of phase 2 inducers occurs after sprouting, their concentration decreases as the plant grows. Extracts of broccoli sprouts contain 10-100 times the phase 2 inducer activity of mature broccoli plants and are more efficient inhibitors of rat tumorigenesis. In contrast, mature broccoli also contains significant amounts of indole compounds that induce phase 1 as well as phase 2 enzymes. Thus, sprouts would appear to offer at least two anticarcinogenic advantages over mature broccoli: they contain higher concentrations of inducers, and the inducers mainly affect phase 2 enzyme systems. On this basis, Fahey *et al.* (13) conclude that small amounts of cruciferous vegetable sprouts may be just as protective against cancer as larger amounts of mature plants of the same variety.

These studies leave no doubt that sulforaphane does indeed induce phase 2 enzymes and inhibit carcinogenesis under these conditions. At issue, however, is the clinical significance of induction of such enzyme systems by single phytochemicals. Both phase 1 and phase 2 systems are highly multifunctional and inducible by a wide variety of dietary compounds. Food plants have evolved to contain thousands of chemicals that act as protective pesticides against infection or predation (17), and humans may consume as many as 10,000 of these compounds and their metabolic products when eating vegetables. The Ames group (17) has identified 49 such compounds in cabbage, among them several that have been tested and found mutagenic or carcinogenic in animal test systems. Table 2 identifies the classes of phytochemicals in cruciferous vegetables that contain at least one compound that has proved mutagenic or carcinogenic in such tests. Thus, cruciferous and other vegetables contain some phytochemicals that are carcinogenic and others that are anticarcinogenic in test systems.

This confusing situation is complicated further by the ability of both phase 1 and phase 2 enzyme systems to inactivate some carcinogens, but activate others, depending on circumstances (18). Chemicals that induce activating enzymes also will induce activation of any other compounds present that are metabolized by the same system; the same is true of

substances that induce inactivation. This dual nature of the enzyme systems, the vast number of compounds that can induce them, the presence in broccoli of chemicals that induce both activation and inhibition of carcinogenesis, and the complexity of the interactions among food phytochemicals and enzyme systems, constitute the basis of ongoing debates as to whether sulforaphane or any other single phytochemical or nutrient can explain the cancer-protective effects of cruciferous vegetables (19-21).

Fortunately, the dietary implications of this work are less complicated. The precise role in carcinogenesis of specific vitamins, minerals, fiber, and phytochemicals may be uncertain, but the overall anticarcinogenic properties of vegetables clearly outweigh any effects of their constituent carcinogens or carcinogen-inducers. The value of eating more vegetables in general, and *Brassica* vegetables in particular, is well supported by current evidence if for no other reason than this food group is a principal source of antioxidant vitamins; vegetables provide more than 80% of the carotene, 50% of the vitamin C, and 25% of the folate in the American food supply (22).

Dietary recommendations for prevention of cancer and other chronic diseases always have emphasized the value of consuming a variety of plant foods (4). Each vegetable contributes nutrients, fiber, and phytochemicals, but in varying amounts and proportions. Fahey *et al.* (13) found an 8-fold variation in phase 2 inducer activity among different samples of fresh broccoli, a variation that was independent of appearance or growing conditions. Broccoli may be especially rich in sulforaphane, but tomatoes are especially rich in lycopenes, peppers in carotenoids, and onions and garlic in allium compounds —all demonstrably protective against carcinogenesis (11).

President George Bush did not like broccoli (23); the mass appeal of broccoli sprouts is even less certain. My local health food store sells cruciferous sprouts of cabbage, radish, and mustard, but not yet broccoli; broccoli sprouts taste like milder versions of the mature vegetable and are slightly pungent or peppery. The store does offer dessicated broccoli in the form of 500-mg supplements labeled as containing 200 µg sulforaphane; 50 such tablets cost $14.70.

Price considerations aside, supplements confer little advantage. Fresh vegetables provide a higher content of vitamin C, folic acid, and fiber, and a balance of phytochemicals that favor overall protection against carcinogenesis. The full range of nutrients contained in foods must be present to detoxify carcinogens; iron, niacin, and riboflavin, for example, are essential cofactors in phase 1 and phase 2 enzyme systems. Just as single-nutrient approaches to cancer prevention have yielded disappointing results, single phytochemical approaches are likely to prove equally disappointing and are not recommended (5, 6).

The policy implications of this research also seem quite straightforward. Policies are needed to promote consumption of vegetables among a greater proportion of the population. Recent data suggest that the average American consumes slightly more than two standard half-cup servings of vegetables (other than white potatoes) daily; at least 10% of the population reports consuming less than one daily serving of any vegetable whatsoever (24). Although broccoli and cabbage rank among the top 10 vegetables purchased in supermarkets (25), and U.S. annual production (though not necessarily consumption) of fresh broccoli rose from 0.8 to 4.1 pounds per capita from 1973 to 1997 (26), this quantity translates to just 5 g per day per capita. Thus, the current situation leaves considerable room for improvement. From the standpoint of public health policy, existing data are more than sufficient to promote greater consumption of broccoli and its sprouts along with other vegetables. Educational campaigns to encourage fruit and vegetable consumption have achieved some success, but a greater range of policies and programs targeted to food producers as well as to consumers might prove more effective in raising consumption levels (4).

From the standpoint of cancer research policy, information about the role of each nutrient and phytochemical is of vital interest; such information may well explain why diet-related cancer risks vary across different sites and among individuals and populations. The effects of single anticarcinogenic phytochemicals, however, no matter how well characterized, cannot be understood in isolation, just as the anticarcinogenic effects of single nutrients cannot be understood except as part of an overall dietary pattern. Dietary patterns, of course, are difficult to study. If research to date has focused on the effects of isolated nutrients and phytochemicals, it is because such systems are far more amenable to investigation. Debates about the significance of the effects of sulforaphane on cancer risk are best interpreted as evidence of the need for

high-quality research on the health effects of dietary patterns and their determinants —behavioral, environmental, economic, and cultural —as well as on the scientific basis of these relationships.

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AntiOxidant, Anti-Aging

Wheat sprout extract induces changes on 20S proteasomes functionality.

Amici M, Bonfili L, Spina M, Cecarini V, Calzuola I, Marsili V, Angeletti M, Fioretti E, Tacconi R, Gianfranceschi GL, Eleuteri AM.

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Wheat sprouts contain a very high level of organic phosphates and a powerful cocktail of different molecules such as enzymes, reducing glycosides and polyphenols. The antioxidant properties of wheat sprouts have been widely

documented and it has been shown that they **are able to protect DNA against free-radicals mediated oxidative damage**. Furthermore, we have recently reported on the effects of several polyphenols on 20S proteasomes, underlying the dual role of epigallocatechin-3-gallate as **an antioxidant and a proteasome effector in cancer cells**. The aim of this study was to investigate the effects of wheat sprout extracts on 20S proteasome functionality. Wheat sprout extracts have been analysed and characterized for their polyphenolic content using the Folin-Ciocalteau reagent and RP-HPLC technique. Comparing our data with a polyphenol standard mixture we identified five different polyphenols: gallic acid, epigallocatechin-3-gallate, epigallocatechin, epicatechin and catechin. The treatment of isolated 20S proteasomes with the extract induced a gradual inhibition of all the tested components, ChT-L, T-L, PGPH and BrAAP, in both the complexes. At low extract concentration a slight activation of the enzyme was evident only for the BrAAP component of the constitutive enzyme and the ChT-L activity of the immunoproteasome. Beta-casein degradation rate decreased, particularly with the immunoproteasome. **Human Colon adenocarcinoma (Caco) cells, stimulated with 12-O-tetradecanoylphorbol-13-acetate, showed activation of the 20S proteasome activities at short incubation times and an increase in intracellular oxidative proteins.** Cells treatment with wheat sprout extract led to proteasome inhibition in unstimulated cells and attenuated the effects mediated by TPA. Finally, exposure to the extract affected the expression levels of pro-apoptotic proteins.

Vitamin B9 otherwise known as FOLIC ACID is required for …

- DNA synthesis and cell growth
- Red blood cell formation
- Energy production
- Formation of amino acids
- Creation of heme, the iron containing substance in hemoglobin
- For oxygen transport.
- for healthy cell division and replication
- for RNA and DNA synthesis
- for protein metabolism
- for treating folic acid anemia
- for treating depression and anxiety
- For the nervous system of a developing fetus

Folacin content of alfalfa and mung bean sprouts: The effect of extraction procedures and maturity
Journal of the Science of Food and Agriculture
Volume 36, Issue 11, Date: November 1985, Pages: 1155-1160. Marilyn F. Magaram, Cynthia L. Stotts, Tung-Shan Chen, Christine H. Smith, Arlene J. Kirsch. Division of Food Science and Nutrition Department of Home Economics, California State University, Northridge, California 91330, USA

Abstract
The folacin content of alfalfa (*Medicago sativa*) and mung bean (*Vigna radiata*) sprouts was determined by *Lactobacillus casei*. Several variations of extraction procedures were tested. The optimum conditions for extraction were autoclaving mung bean and alfalfa sprouts in phosphate buffer containing 0.3% and 0.4% ascorbate, respectively, before homogenisation in a blender. The optimum blending time for folacin extraction was 120s for mung bean and 15s for alfalfa sprouts. **Folacin content on dry weight basis increased several times in both types of sprouts during germination. Mature alfalfa and mung bean sprouts were found to contain 186 and 178 μg folacin per 100 g fresh weight, respectively.**

Cholesterol

Aqua-culture improved buckwheat sprouts with more abundant precious nutrients and hypolipidemic activity.
Int J Food Sci Nutr. 2009 Jun 30:1-14. Peng CC, Chen KC, Yang YL, Lin LY, Peng RY. School of Physical Therapy.

Nutritional values of buckwheat reach maximum on day 8 sprouting by solid-phase cultivation (BSSC). The precious nutrients surveyed included linolenic acid, total polyphenolics, rutin, quercetin, l-ascorbic acid and gamma-aminobutyric acid. To investigate whether a change of cultivation method could improve the nutritional status, we performed aquaculture. By performing chemical, biochemical and animal experiments, we found that maximization of nutrient levels in aquacultured **buckwheat sprouts** (BSAQ) occurred 2 days earlier than those from BSSC. **Simultaneously, their bioactivities were much enhanced, being superior to BSSC regarding antioxidative, free radical scavenging (FRS),**

anti-low-density lipoprotein lipoperoxidative capabilities and hypolipidemic bioactivity with respect to serum total cholesterol and triglyceride levels in Syrian hamsters. In addition, serum low-density lipoprotein-cholesterol (LDL-C) and high-density lipoprotein-cholesterol (HDL-C) levels and the ratios LDL-C/HDL-C and total cholesterol/HDL-C were all more efficiently suppressed by BSAQ diets. In conclusion, aquaculture is more efficient than the solid-phase cultivation with regard to acceleration and maximization of precious nutrient levels in buckwheat sprouts.

Alfalfa saponins and alfalfa seeds. Dietary effects in cholesterol-fed rabbits.
Atherosclerosis. 1980 Nov;37(3):433-8. Malinow MR, McLaughlin P, Stafford C, Livingston AL, Kohler GO.

Since alfalfa meal prevents hypercholesterolemia and atherosclerosis in rabbits and alfalfa saponins prevent the expected rise in cholesterolemia induced by dietary cholesterol in monkeys, the experiments being reported here were performed to determine whether alfalfa saponins affect atherogenesis in rabbits. In addition, the effects of alfalfa seeds were studied. Cholesterol-feb rabbits were randomly assigned to 3 groups: (a) control animals (N = 18); (b) animals maintained on a diet containing 1.0 to 1.2% alfalfa saponins (N = 18); and (c) animals maintained on a diet containing 40% alfalfa seeds (N = 17). Results after a 4-month observation period demonstrated that alfalfa saponins and alfalfa seeds reduce hypercholesterolemia, aortic sudanophilia, and the concentration of cholesterol in aortic intima-plus-media and in the liver, but do not induce changes in the hematocrit.

Optimization of Bioactive Compounds in Buckwheat Sprouts and Their Effect on Blood Cholesterol in Hamsters.
J Agric Food Chem. 2008 Jan 24 Lin LY, Peng CC, Yang YL, Peng RY.

Nutrient levels in buckwheats that were maximized in day 8 sprouts (D8SP) included total phenolics, quercetin, and l-ascorbic acid, whereas those of oxalic, malic, tartaric, and citric acids, rutin, and gamma-aminobutyric acid (GABA) were found to reach maximum levels on day 10. Ethanolic extract of D8SP (2.5 mg/mL) revealed potent free-radical scavenging (FRS) and antioxidative (ANO) capabilities. However, its Fe (2+)-chelating capability was only moderate. To further study the hypolipidemic activity of D8SP, 36 Syrian hamsters were grouped into six groups and fed for 28 days, respectively, with (i) control meal, (ii) high fat plus high cholesterol meal, (iii) high fat plus high cholesterol plus 2.5% of buckwheat seeds, (iv) high fat plus high cholesterol plus 25% of buckwheat seeds, (v) high fat plus high cholesterol plus 2.5% of D8SP, and (vi) high fat plus high cholesterol plus 25% of D8SP. High seed meal prominently enhanced body weight gain, whereas high sprout meal exhibited the highest feed efficiency. Ratios of liver/body weight (L/B) were significantly lowered by all BS meals. Although low seed meal reduced serum total cholesterol (TC) levels ($p < 0.05$), its effect was still inferior to the high seed and sprout meals ($p < 0.01$). In contrast, serum triglyceride (TG) levels were lowered only by the high seed and sprout meals ($p < 0.05$). Alternatively, levels of serum low-density lipoprotein cholesterol (LDL-C) were significantly suppressed by all buckwheat meals ($p < 0.01$). Serum high-density lipoprotein cholesterol (HDL-C) levels were increased, however, insignificantly. Nutraceutically more meaningful is that both LDL-C/HDL-C and TC/HDL-C ratios were significantly lowered ($p < 0.01$). Apparently, hepatic TC levels were significantly reduced, whereas hepatic TG levels were totally unaffected. Conclusively, sprouting triggers a variety of nutritional changes in buckwheats. Day 8 sprouts, consisting of high polyphenolic and moderate quercetin contents, are nutraceutically maximized when hypocholesterolemic, hypotriglyceridemic, and antioxidative activities are concerned.

Plasma cholesterol-lowering effect on rats of dietary fiber extracted from immature plants.
Biosci Biotechnol Biochem 2000 Dec;64(12):2543-51 Nishimura N, Taniguchi Y, Kiriyama S.
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Crude dietary fiber samples were prepared from **[sprouts of] beet, cabbage, Japanese radish, onion and mung bean sprouts (BF, CF, RF, OF and MF, respectively).** These samples contained total dietary fiber at the levels of 814, 699, 760, 693 and 666 g/kg, respectively. To examine the effect of these dietary fiber sources on the plasma cholesterol concentration, male Sprague-Dawley rats were fed on a fiber-free (FF) diet or on an FF diet supplemented with 5% or 10% dietary fiber. Dietary fiber extracted from vegetables, wood cellulose (CL), pectin (PE) and guar gum (GG) were used as the fiber sources. Compared with the rats fed on the FF diet, a significant reduction in the plasma cholesterol concentration was observed in the rats fed on BF, CF, RF, MF, **PE** or GG after a 21-d feeding period. Cecal acetate, n-butyrate and total short-chain fatty acids were significantly higher in the rats fed on these dietary fibers, except for CF, than in those fed on the FF diet. A negative correlation was apparent between the total dietary fiber content, hemicellulose content and pectin content of each dietary fiber source and the plasma cholesterol concentration. These results suggest that some vegetable fibers exert a plasma cholesterol-lowering effect through cecal fermentation of these fibers.

Toxicological and nutraceutical assessments of peanut sprouts as daily supplements to feed Sprague-Dawley rats for 18 weeks

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BACKGROUND: Peanut sprouts are occasionally consumed by peanut farmers. To investigate the possibility of introducing peanut sprouts as a functional vegetable to the public, an *in vivo* experiment involving toxicological and nutraceutical assessments was conducted.

RESULTS: Sixty female Sprague-Dawley rats (8 weeks old) were **fed with peanut sprouts as a dietary supplement for 18 weeks**. The rats were divided into five groups and fed with different daily supplements, namely 0 g (control), 16.5, 10 or 6 g of sprouts or 2.4 g of kernels. Aflatoxin contents of the sprouts (n = 24) were less than 1 μg kg^{-1}. Body weights of all rats increased with feeding time, and final body weights differed insignificantly among test groups (P > 0.05). Weights of liver, kidney and spleen and organ/body weight ratios varied insignificantly among test groups (P > 0.05). All serum and blood cell determinations differed insignificantly (P > 0.05) among test groups, apart from the observation of a **significant lowering of serum triacylglycerol (TG)** level in the 10 g sprout group (P < 0.05).

CONCLUSION: In general, no obvious growth hazard or health toxicity was detected. For nutraceutical development, **the lowering of serum TG level achieved by appropriate intake of peanut sprouts is noteworthy.**

Diabetes

Antidiabetic activity of Mung bean extracts in diabetic KK-Ay mice.

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The anti-diabetic effects of Mung bean sprout (MBS) extracts and Mung bean seed coat (MBSC) extracts were investigated in type 2 diabetic mice. Male KK-A (y) mice and C57BL/6 mice were used in this study. In KK-A (y) mice, the blood glucose, plasma C-peptide, glucagon, total cholesterol, triglyceride, and blood urea nitrogen (BUN) levels were significantly higher than those in the C57BL/6 mice ($P < 0.001$, $P < 0.001$, $P < 0.01$, $P < 0.001$, $P < 0.01$, and $P < 0.01$). In addition, KK-A (y) mice **showed an obvious decrease in insulin immunoreactivity in pancreas as well.** MBS and MBSC were orally administrated to KK-A (y) mice for 5 weeks. It was found that MBS (2 g/kg) and MBSC (3 g/kg) **lowered blood glucose, plasma C-peptide, glucagon, total cholesterol, triglyceride, and BUN levels and at the same time markedly improved glucose tolerance and increased insulin immunoreactive levels. These results suggest that MBS and MBSC exert an antidiabetic effect in type 2 diabetic mice.**

Soaked and germinated Glycine max (soybean seeds) is highly effective blood sugar regulator
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Patents (PCT) WO2004/096250, 904/Del/2002 and 663/Del/2003.
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Abstract

Glycine max seeds when soaked and germinated, become highly effective blood sugar regulator. This was observed in 35 volunteer type–II diabetes patients. **All patients except one were taking oral hypoglycemic drugs (OHG)** to control their elevated blood sugar level before they started taking soaked and germinated soybean seeds as a medicine to control their blood sugar. These patients stopped taking OHG during the period of investigation and took only soaked and germinated soybean seeds as a medicine to control their high blood sugar level. **It was observed that soaked and germinated soybean seeds are more effective than the OHG.** Out of these 35 patients the blood sugar of 22 patients were observed for three months. Out of these 22 patients 4 patients got revived. The high efficacy of such seeds could be because of the following reasons: (1) synthesis of phosphatidylinositol 3 kinase (PI3K) in Glycine max seeds during germination, (2) synthesis of D-chiro inositol during germination and (3) action in synergy of many phytochemicals synthesized/enhanced during germination, which might be making Glycine max seeds, a potent antioxidant.

Introduction

Diabetes is a multidimensional, complex and varied symptom physiological disorder. It is a disease where the sugar level of the blood increases. This research is about an invention of a highly effective blood sugar regulating product from soybean seeds. The aim of this research is to develop a natural product more effective than OHG and free from harmful side effects on the health of diabetes patients.

Subjects, materials and methods:

35 volunteer type-II diabetes patients were investigated in two separate groups to see the effect of soaked and germinated soybean seeds on the blood sugar level. 17 patients were included in group-1 and 18 patients were included in group-2. Their random blood sugar were recorded after six hours of food (lunch) when they were taking OHG. All the patients were taking OHG except one patient before the investigation started. During the investigations these patients of both the groups did not take OHG or any other medicine to control their blood sugar except soaked and germinated soybean seeds. These diabetes patients agreed to stop OHG because their blood sugar level was better controlled by this new medicine. Group-1 patients took two doses (each dose of 250 ml) of soybean milk one in the morning before food and one in the evening before dinner as a medicine (table-1& table-1a). Soybean seeds were soaked for 8 to 12 hours, soaked seeds were ground in fine paste, a milk was prepared from this paste by adding water into it, finally this milk was heated up till boiling. This boiled milk after getting cooled was filtered. This filtered milk was the final form of medicine for group-1 patients. Group-2 patients took two doses (each dose of 15gms) of dry soaked and germinated soybean powder after mixing it in half glass of lukewarm water: one in morning one hour before lunch and one in evening one hour before dinner. Soybean seeds were soaked for 8 to 12 hours, left for 24 hours for germination at room temperature, germinated soybean seeds are dried. These dried seeds were ground in powder and stored as the medicine sample for group-2 patients. In both the groups blood sugar was recorded initially after two hours, followed by other blood sugar measurements after eight hours and twelve hours respectively; then blood sugar was measured once a day; and gradually the frequency of

blood sugar measurement was decreased to once a week. Blood sugar was measured for three months in 4 patients of group-1 and in all 18 patients of group-2.

Results:

It was observed that soaking and germination produces high antidiabetes property in simple Glycine max (soy) seeds. The production of effective blood sugar regulating property appears to be primarily taking place because of induction of phosphatidylinositol 3 kinase (PI3K) in nodule organogenesis of Glycine max seeds. This natural therapy overcomes the harmful health effects associated with OHG besides being cost effective.

Discussion:

It was observed that their blood sugar was much better controlled than OHG in both the groups of diabetes patients. The results show that this new medicine (soaked and germinated Glycine max seeds) are regulating blood sugar better than OHG. Greater the blood sugar level greater is the fall due to this new medicine. I can think of the following possibilities, which are responsible for the development of the antidiabetes property in soybean seeds during soaking and germination:

1. Synthesis of Phosphatidylinositol 3 Kinase (PI3K) in soybean seed during germination. Phosphatidylinositol 3-kinase (PI3K) is an important component of various receptor tyrosine kinase complexes in mammalian cells. PI3K plays a central role in insulin's metabolic effect. PI3Kcatalyzes the generation of phosphatidyl inositol (3,4,5)triphosphate (PIP(3)). Inhibition of PI3K activity results in blockade of insulin signaling including glucose uptake and glycogen synthesis. This, PIP(3) is a critical mediator of insulin action. Either this soybean PI3K is catalyzing the reactions to facilitate the proper reactions to achieve insulin's physiologic expression or it is helping in synthesis of appropriate phosphatidyl inositol derivative, which might be mediating insulin's physiologic expression. I am evaluating both the possibilities. (ref. 1- 5)
2. Synthesis of D-chiro inositol in soybean seeds during embryo development could be producing antidiabetes property in soaked and germinated soybean seeds. (ref. –6,7)
3. Enhancement of vitamins during soaking and germination of soybean seed, particularly vitamins of B group (niacin and riboflavin) could be playing important roles. (a) The vitamins enriched soaked and germinated soybean seeds could be acting as good superoxide scavengers. Recent studies report that overproduction of superoxide by the mitochondrial electron transport chain seems to be the first and key event in the activation of all other pathways involved in the pathogenesis of diabetic complications (ref-8). (b) Intracellular concentration of NAD (nicotinamide adenine dinucleotide) is depleted in diabetes (ref-8) which slows the rate of glycolysis. Niacin, increased during embryo development of soybean seeds, could be increasing the intracellular level of NAD and hence increasing the rate of glycolysis. Vitamins are organic nutrients that are required in small quantities for a variety of biochemical functions, and which generally, cannot be synthesized by the body and must therefore be supplied by the diet.

Apart from the above possible factors on the basis of published research papers, I also think on my own that during diabetes human body might be going to lower energy state and when a diabetes patient takes soaked and germinated soybean powder the energy state of the body goes up. I think this low energy state of the human body is the vital factor for many physiological complications including reduced activation of many enzymes in the body.

Looking at the results it can be concluded that soaking and early germination converts simple Glycine max seeds into an effective blood sugar regulator. This natural therapy overcomes the harmful health effects associated with OHG besides being cost effective.

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Table – 1
Effect of 250ml Soaked Soybean solution (SSS) on the blood sugar after two hours of its intake
(On group-1 patients)

Patient	Age at detection of diabetes	Present Age	Random Blood sugar (after six hours of the lunch) in mg/dl when they were on OHG	Blood Sugar in mg/dl after two hours of intake of SSS	Reduction in blood sugar in mg/dl due to SSS
1	45	50	134	123	11
2	63	70	294	109	185
3	36	58	141	110	31
4	68	70	477	409	68
5	46	46	355	290	65
6	45	52	249	172	77
7	43	48	170	140	30
8	37	40	196	106	90
9	38	44	121	104	17
10	36	45	166	123	43
11	40	45	96	75	21
12	43	43	152	115	37
13	40	49	232	214	18
14	38	42	135	84	51
15	40	43	89	63	26
16	43	45	86	116	-30
17	30	37	76	84	-8

OHG = Oral Hypoglycemic Drug
Random Blood Sugar = Blood sugar taken after six hours of food.

Table –1 (a)
The effect of Soaked Soybean Solution (SSS) on blood sugar for four months on patients taking SSS twice a day (250ml per dose) after stopping OHG.
(On group-1 patients)

Patients of Table 1	Previous random blood Sugar in mg/dl when the patient was taking OHG medicine for controlling blood sugar	Blood Sugar in mg/dl after the start of SSS as a medicine and after stopping other OHG for controlling blood sugar			
		Aug 2002 Fasting	Sept 2002 Fasting	Oct 2002 Fasting	Nov 2002 Fasting

5	Detected Diabetic for the first time in Aug 2002. 355	After 10 Days 121	103	109	106
13	232	134	100	117	126
11	96	89	108	118	106
12	152	118	115	92	108

OHG = Oral Hypoglycemic Drug
Random Blood Sugar = Blood sugar taken after six hours of food

Table - 2
Effect of Soaked Soybean Powder (SSP) on blood sugar after two hours of its intake after mixing it in a half glass of lukewarm water
(On group-2 patients)

Patient	Sex	Age at detection of diabetes	Present Age	Random Blood sugar** (after six hours of lunch) in mg/dl when they were on OHG*	Dosage of SSP in gms	Blood Sugar in mg/dl after two hours of intake of SSP	Reduction in blood sugar in mg/dl due to SSP
1	M	40	46	264	15	165	99
2	M	44	47	315	15	197	118
3	F	44	45	145	7.5	128	17
4	M	45	52	230	15	155	75
5	M	42	42	168	15	98	70
6	M	57	59	235	15	82	153
7	M	45	47	149	15	109	40
8	M	42	47	294	7.5	159	135
9	M	37	51	173	15	106	67
10	M	52	58	237	15	156	81
11	F	37	51	321	15	149	172
12	F	56	58	212	15	147	65
13	M	44	46	316	15	305	11
14	M	51	59	253	15	173	80
15	F	46	51	384	15	294	90
16	M	40	45	191	15	120	71
17	F	43	47	145	7.5	128	17
18	F	48	50	262	15	167	95

OHG = Oral Hypoglycemic Drug
Random Blood Sugar = Blood sugar taken after six hours of food

Table – 2 (a)
The effect of Soaked Soybean Powder (SSP) on blood sugar for three months on patients taking SSP twice a day (15 gms per dose) after stopping OHG. (On group-2 patients)

Patients of Table-2	Age	Previous blood sugar in mg/dl when patients were taking OHG drugs	Blood sugar in mg/dl after patients started SSP only as a blood sugar controlling medicine			
			After 15 Days	After 1 Month	After 2 months	After 3 months

	ADD	ATM	PA	F	PP	F	PP	F	PP	F	PP	F	PP
1	40	40	46	140	264	130	243	112	153	95	210	96	140
2	44	44	47	148	361	135	254	140	232	130	220	122	212
3	44	44	45	150	210	118	145	108	122	85	130	80	120
4	45	45	52	190	235	150	191	134	150	121	146	116	144
5	42	42	42	120	168	110	168	97	151	88	134	73	106
6	57	57	59	188	210	96	150	92	143	84	132	85	124
7	45	45	47	119	149	110	132	87	122	93	144	102	108
8	42	42	47	198	294	179	271	164	258	139	237	152	240
9	37	37	51	106	173	96	173	87	118	106	127	84	120
10	52	52	58	155	237	156	237	157	189	158	190	131	189
11	37	37	51	152	321	148	165	140	188	139	155	126	150
12	56	56	58	174	325	194	310	168	201	175	295	164	210
13	44	44	46	277	316	262	298	251	284	236	273	186	239
14	51	51	59	168	293	174	281	158	264	163	273	157	261
15	46	46	51	221	384	190	35	185	321	156	271	-	-
16	40	40	45	150	191	161	210	134	150	121	146	124	160
17	43	44	47	130	173	107	112	108	122	85	130	80	120
18	48	48	50	156	262	145	232	133	195	121	155	107	164

ADD = Age at Diabetes Detected ATM = Age at Medicine (OHG) Taken for control of the blood sugar
PA = Present Age

Diabetes and Parkinson's Disease

Improved health-relevant functionality in dark germinated Mucuna pruriens (Fava Bean) sprouts by elicitation with peptide and phytochemical elicitors.

Bioresour Technol. 2009 Oct;100(19):4507-14. Epub 2009 May 19 Randhir R, Kwon YI, Shetty K.
Department of Food Science, Chenoweth Laboratory, University of Massachusetts, Amherst, MA 01003, USA.

The health-relevant functionality of Mucuna pruriens (Fava Bean) was improved by priming the seeds with elicitors of the pentose phosphate pathway (PPP) such as fish protein hydrolysates (FPHs), lactoferrin (LF) and oregano extract (OE) followed by dark germination. FPH elicited the highest phenolic content of 19 mg/g FW on day 1, which was 38% higher than control sprouts. OE enhanced Parkinson's disease-relevant L-DOPA content by 33% on day 1 compared to control sprouts. Anti-diabetes-relevant alpha-amylase inhibition percent (AIP) and alpha-glucosidase inhibition percent (GIP) were high in the cotyledons and decreased following elicitation and sprouting. **For potential anti-diabetic applications**, low AIP and high GIP with moderate L-DOPA content on **day 4 of dark germination could be optimal**. Improved L-DOPA concentrations in a soluble phenolic and antioxidant-rich M. pruriens background on **day 1 sprouts have potential for Parkinson's disease management.**

L-DOPA and Total Phenolic Stimulation in Dark Germinated Fava Bean in Response to Peptide and Phytochemical Elicitors

Process Biochemistry Volume 37, Issue 11 , June 2002, Pages 1247-1256 Reena Randhir, Preethi Shetty and Kalidas Shetty Department of Food Science, Chenoweth Laboratory, University of Massachusetts, Amherst, MA 01003, USA

Fava bean sprouts are a rich source of levo dihydroxy phenylalanine ($_L$-DOPA) the precursor of dopamine and is **used in the treatment of Parkinson's disease**. Its phytopharmaceutical value was improved by priming the seeds with natural elicitors like fish protein hydrolysates (FPH), lactoferrin (LF) and oregano extract (OE). The elicitors in general stimulated the phenylpropanoid pathway through the pentose phosphate and shikimate pathway and enhanced the production of phenolics. Among the different FPH elicitor concentrations, 2 ml/l elicited the highest phenolic content of

3.4 mg/gFW on day 2, which is three times higher than that of control. LF proved to be a better elicitor at a low concentration of 50 ppm producing 5.2 mg of phenolics/gFW on day 3. The response of fava bean treated with 5 ml/l of OE showed the highest phenolic stimulation of 2.9 mg/gFW on day 3. Control, FPH and OE elicitors **showed a higher antioxidant activity in germinating fava bean sprout on day 1 and 2 which correlated with higher phenolic content**. In fava bean primed with FPH, the glucose-6-phosphate dehydrogenase (G6PDH) and guaiacol peroxidase (GPX) activity peaked on day 5 followed by a concurrent increase in phenolics on day 6 demonstrating the mobilization of carbohydrates from the cotyledons towards the phenylpropanoid pathway in response to the elicitors. In the case of both LF and OE the peak activity of G6PDH and GPX was seen just prior to the boost in phenolics on day 3 and drops to a minimal on day 4 suggesting that the products may allosterically regulate the enzyme. For all elicitors and control the $_{L}$ -DOPA content was high on day 1 and steadily declined with germination. The $_{L}$-DOPA content in fava bean elicited by LF showed a 40% increase, where as FPH and OE showed a 20% increase compared to that of the control. **The maximal stimulation of $_{L}$-DOPA content was seen on day 2 for fava bean treated with 2 ml/l of FPH, which was 100% higher than that of control.**

Arthritis

Inhibition of synovial hyperplasia, rheumatoid T cell activation, and experimental arthritis in mice by sulforaphane, a naturally occurring isothiocyanate.

Arthritis Rheum. 2009 Dec 28;62(1):159-170. Kong JS, Yoo SA, Kim HS, Kim HA, Yea K, Ryu SH, Chung YJ, Cho CS, Kim WU. Catholic University of Korea, Seoul, South Korea.

OBJECTIVE: To investigate whether sulforaphane (SFN), an isothiocyanate derived from cruciferous vegetables such as broccoli, regulates synoviocyte hyperplasia and T cell activation in rheumatoid arthritis (RA).

METHODS: Synoviocyte survival was assessed by MTT assay. The levels of Bcl-2, Bax, p53, and pAkt were determined by Western blot analysis. Cytokine concentrations in culture supernatants from mononuclear cells were analyzed by enzyme-linked immunosorbent assay. The in vivo effects of SFN were examined in mice with experimentally induced arthritis.

RESULTS: SFN induced synoviocyte apoptosis by modulating the expression of Bcl-2/Bax, p53, and pAkt. In addition, nonapoptotic doses of SFN inhibited T cell proliferation and the production of interleukin-17 (IL-17) and tumor necrosis factor alpha (TNFalpha) by RA CD4+ T cells stimulated with anti-CD3 antibody. Anti-CD3 antibody-induced increases in the expression of retinoic acid-related orphan receptor gammat and T-bet were also repressed by SFN. Moreover, the intraperitoneal administration of SFN to mice suppressed the clinical severity of arthritis induced by injection of type II collagen (CII), the anti-CII antibody levels, and the T cell responses to CII. The production of IL-17, TNFalpha, IL-6, and interferon-gamma by lymph node cells and spleen cells from these mice was markedly reduced by treatment with SFN. Anti-CII antibody-induced arthritis in mice was also alleviated by SFN injection.

CONCLUSION: SFN was found to inhibit synovial hyperplasia, activated T cell proliferation, and the production of IL-17 and TNFalpha by rheumatoid T cells in vitro. The antiarthritic and immune regulatory effects of SFN, which were confirmed in vivo, suggest that **Sulforaphane may offer a possible treatment option for rheumatoid arthritis**.