Getting at the Roots of Health-Enhancing **Sprouts**

Some Chronic Diseases Potentially Preventable by Dietary Modification





Sprouts for Prevention of Cardiovascular Disease

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Collection of diseases affecting heart and blood vessels – the cardiovascular system

Atherosclerosis: plaque deposits constrict blood vessels

Plaque contains cholesterol (also Calcium, clotting proteins) Leads to blocked arteries in heart: heart attack in brain: stroke

CVD> 30% deaths worldwide



Risk Factors: Smoking high blood cholesterol (high triglycerides) high blood pressure lack of physical activity obesity type II diabetes (insulin resistance) chronic inflammation





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Affected by diet

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HOW CAN SPROUTS DECREASE RISK ?

Cholesterol Control in the Blood



Cholesterol Control in the Blood



SPROUTS TO STOP CHOLESTEROL ABSORPTION

Alfalfa saponins (soaps) may bind dietary cholesterol



An *in vitro* interaction of alfalfa saponins suggests that saponins bind cholesterol, making micelles that are not absorbed from the gut.

	mg bound cholesterol/ mg saponin	%
Digitonin	0.191	89.1%
Alfalfa plant	0.71	14.4%
Alfalfa sprout	0.44	11.5%
is a		

(Digitonin is a positive control)

Story et al, AJCN 1984

Feeding alfalfa or alfalfa sprouts to rats had no impact on serum cholesterol.

Note: Rats metabolize cholesterol differently to man: serum cholesterol is not controlled.

Alfalfa also contains **coumestan**, a phytoestrogen which might inhibit cholesterol synthesis in liver.

	Ch diet	Ch + alfalfa	Ch + alfalfa sprout	Ch + alfalfa sprout NO SAPONINS
Cholesterol				
Serum (mg/dL)	87.5+/- 10.3	64.8+/-6.4	63.9+/-4.1	92.6+/-11.5
Liver (mg/g)	5.3+/-0.8	3.5+/-0.4	4.2+/-0.7	2.6+/-0.3

Story et al, AJCN 1984

Alfalfa Saponin Extract (0.6 g/kg diet) decreased LDL-Cholesterol in monkeys at 6 weeks

DIET	HDL-Chol	Total/ HDL
Control (n=8)	113 +/- 17	4.6 +/- 0.9
Saponin (n=8)	115 +/- 13	2.7 +/- 0.4

Fecal steroids and bile acids were significantly increased (doubled)

Malinow et al, 2001

Alfalfa seeds lower LDL-cholesterol in people

Measurement	PRE- treatment	Alfalfa 4 wks	Alfalfa 8 wks	POST- treatment
Total Chol (mmol/L)	9.58	8.21*	8.00*	9.22
LDL Chol (mmol/L)	7.69	6.18	6.33*	7.20
HDL Chol mmol/L)	1.08	1.07	1.12	1.05
Total triglycerides (mmol/L)	1.02	1.48	1.11	1.66

15 hypercholesterolemic patients were given autoclaved roasted alfalfa seeds 40 g 3 times daily at meal times

Molgaard et al, Atherosclerosis 65:173-179 (1987)

But alfalfa seeds and plants contain **concanavalin**, a protease inhibitor that causes toxicity at these doses.





Lessons learned from Alfalfa studies:

- 1. In vitro studies suggest mechanism, but there may be other mechanisms not studied
- 2. Animal studies are not all equal: rat is a poor model for cholesterol studies; monkey (or hamster) is a better model
- 3. The only data that really count are those in people
- 4. Above all, do no harm: if 40 g roasted seed is not acceptable, how about fresh sprouts ??? What is the concanavalin content of sprouts ?

Sprouts as Antioxidants: phenolics

Mono and poly phenolics, commonly found in fruits and vegetables, can act as antioxidants.



Flavonoid / polyphenolic

Phenol / monophenolic



www.nal.usda.gov/fnic/foodcomp/Data/Flav/flav.html



PHENOLIC ACIDS

Benzoic acid Caffeic acid Cinnamic acid Courmaric acid Ferulic acid Gallic acid Gentistic acid Hydroxybenzoic acid Protocatechuic acid Sinapic acid Salicylic acid Syrigic acid Syrinaldehyde Vanillic acid Vanillin Veratic acid

Buckwheat antioxidant flavonoids increase with sprouting days, to day 8 - 10





Kim et al, Fd Res Int 2004

Total, HDL and LDL cholesterol in hamsters fed buckwheat seeds or sprouts

	Control	Chol	+seed2.5%	25%	+ sprout 2.	5%25%
ТС	121±16**	217±20	181±11*	179±10**	170±8**	161±8**
HDL-C	92±14*	108±19	119±9.5	109±11	116±11	110±14
LDL-C	64±4**	95±6	75±10**	75±9**	62±5**	61±5**

J. Agric. Food Chem., **2008**, *56* (4), pp 1216–1223



Epidemiological Study: COMPARISON BETWEEN BUCKWHEAT SEED-CONSUMING AND NON-CONSUMING MONGOLIAN-CHINESE POPULATIONS IN INNER MONGOLIA, CHINA

Persons with hypertension:

in Kulun, consumed buckwheat seed as a staple food was 18.22% (95% confidence interval (CI): 16.95%, 19.49%),

in Kezhuohou, consumed corn as a staple food, was 23.31% (95% CI: 21.92%, 24.70%).

Zhang et al, Clinical and Experimental Pharmacology and Physiology (2007) 34, 838–844

Epidemiological Studies

- Questionnaires about diet and health: using quartiles of intake, correlate health outcomes.
- Not very reproducible, not suitable information for planning a clinical study
- Full of assumptions, so a trial based on these studies may not give the expected answer: 1) beta carotene; 2) WHEL study.

An Optimal Scientific Approach to the Study of Foods with

Health Benefits



*Because foods help maintain health in a normal population, phase II clinical trials in **patient populations**, are not appropriate.

Food and Drug Administration has approved health claims for fruits and vegetables and risk of heart disease:

Based on Fiber or sterol/stanol esters or whole grain (must be 51 % of food; must include 5.6% fiber)

National Nutrient Database shows alfalfa sprouts as 1.9% fiber



What types of research are performed to show health effects ?

- Epidemiological studies
- Cell culture for efficacy/ mechanism
- Animal studies for bioavailability/ efficacy/ safety
- Small clinical studies/ larger clinical trials to confirm bioavailability/ efficacy/ safety: health claim
- Analysis of food composition: content claim

Nutrient Density

Typically, sprouts create nutrients as they grow the first few days:

Vitamin C, not present before sprouting

Flavonoids synthesized in first 10 days

Not true for everything: glucosinolates in brassica are richest in seed



Changing the growing period canoptimize content of bioactives like flavonoids, also the light/dark conditions



Changing the growing conditions can improve growth: 10 mM NaCl, with no impact on germination



Yuan et al, Food Chem 121:1014-19 (2010)

Sprouting increases total flavonoid content

Phenolic content (mg CAE per seed) 0 1 2 2 4 2 9 2 А 0.25 Per SEED 0.20 dormant seed imbibed seed 0.15 7 d sprout 3 0.10 2 0.05 B Sunflower Soybean Mungbean Femigreek Lentil wheat Muslard Radish Broccoli 4.9% 4040 Allalla onion DB) в 6000 Per Dry Wt Phenolic content (mg CAE 100g¹ 5000 4000 3000 F E 2000 1000 GH 0 Muropean Fenugleet Sunflower Radish Mustard Soybean Broccoll Locul tale 4040 onion С Per wet wt Mungbean Sunflower Ferugleek Soybean Radish Muslard Broccoli Lenul 4310 4340 Mool onion

Cervallos-Cadals and Cisneros-Zevallos Fd Chem 119:1485-1490 (2010)



Changing the growing conditions can improve bioactivity: 50 mM folate or 500 mM vitamin C greatly enhanced inhibition of Angiotensinconverting enzyme-I (ACE-I)

ACE-I synthesizes angiotensin, which constricts blood vessels causing increased blood

pressure.



FIG. 4. EFFECT OF PRIMING PEA SEEDS WITH FOLIC ACID AND VITAMIN C ON ANGIOTENSIN-CONVERTING ENZYME I (ACE I) INHIBITION Marked data are significantly different than control at P < 0.01 (*) and P < 0.05 (+).</p>

Burguieres et al, J Fd Biochem 32: 3-14 (2008)

SPROUT	ACTIVE COMPONENT(S)	EFFECTS
Buckwheat	phenolics, quercetin	lower LDL-chol,
	vitamin C	raise HDL-chol
Soybean	isoflavones/phytoestrogens	estrogenic/may enhance liver uptake of cholesterol
Clover, alfalfa	coumestans/phytoestrogens	same
Alfalfa	saponins	bind gut cholesterol
Milkthistle	silymarin	lower Chol
		strong antioxidant

