SOY & HEART HEALTH

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Impact of Coronary Heart Disease

In the United States, 13 million people suffer from coronary heart disease (CHD). Among those at least 20 years of age, over 100 million have cholesterol levels above the recommended target goal of 200 mg/dl. In fact, nearly 38 million Americans have cholesterol levels above 240 mg/dl, which officially puts them at high risk of developing heart disease. Approximately one-half of men and one-third of women over the age of 40 will develop CHD in their lifetime. According to the American Heart Association, in 2005 the estimated direct and indirect cost of CHD is $142 billion.

Total Cholesterol	
Optimal	< 200
Borderline High	200-239
High	≥ 240
LDL Cholesterol	
Optimal	< 100
Near Optimal	100-129
Borderline High	130-159
High	160-189
Very High	≥ 190
HDL	
Optimal	≥ 60
Borderline High	< 40

While the statistics are grim, evidence indicates that dietary and lifestyle changes can have a significant impact on lowering the risk and incidence of heart disease. Soyfoods in particular have received widespread attention for their cholesterol-lowering effects and possible role in reducing risk of CHD. The purpose of this fact sheet is to provide perspective on the potential public health impact of the cholesterol-lowering effects of soy protein and to discuss the overall role of soyfoods in reducing CHD risk.

The Soy Protein Health Claim

The first rodent studies[1, 2] showing soy protein lowered cholesterol were published more than 60 years ago and the first clinical trial demonstrating a reduction were published in 1967.[3] However, health professionals did not start to become aware of this relationship until 1995, when a meta-analysis summarizing the human studies on the hypocholesterolemic effects of soy protein was published.[4] Formal recognition came four years later when the U.S. Food and Drug Administration (FDA) approved a health claim for soy protein and CHD stating that ***25 grams of soy protein a day, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease***.[5] In 2002, a similar claim was approved in the United Kingdom and claims in several other countries are now being considered.[7]

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Effects on Serum Lipids: Low density lipoprotein cholesterol (LDLC)
Several meta-analyses have estimated the extent to which soy protein lowers serum cholesterol. For example, in 2005, Zhan and Ho reported that soy protein lowered low-density lipoprotein cholesterol (LDLC) by 5.25 percent.[6] This analysis involved 33 comparisons (only post-1995 trials were considered) and 1,749 subjects. A meta-analysis conducted by Tufts University that involved 52 trials found the reduction to be slightly less – approximately 3 percent. These reported decreases are similar to the 1995-meta-analysis referred to in the previous section.[4] In that analysis, the overall reduction in response to 47 g/d soy protein was 12.9 percent but the estimated decrease in response to 25 g/d (the amount established by the FDA as the threshold intake for cholesterol reduction) was approximately 5 percent. Of course, the reduction experienced by any given individual may vary as research has shown there is a considerable inter-individual response to cholesterol-lowering diets in general.

Factors thought to specifically impact the hypocholesterolemic effects of soy protein include initial cholesterol level, gender, the total amount of soy protein consumed and the isoflavone content of soy protein. The mechanism by which soy protein reduces cholesterol has not been established, although the reduction does not result from the low-saturated fat content of soyfoods. In most trials the fatty acid content of the control and soy-diets were similar. One hypothesis is that peptides formed from the digestion of soy protein upregulate LDLC receptors in the liver.[8-10]

Effects on HDLC and Triglycerides
There is widespread agreement that soy protein, in addition to lowering LDLC, lowers triglyceride levels and raises high-density lipoprotein cholesterol (HDLC). All three meta-analyses cited above concur on this point. In the meta-analysis by Zhan and Ho for example, triglyceride levels were decreased by 7 percent and HDLC levels were increased by 3 percent. Although modest, the latter effect is particularly noteworthy as it is relatively difficult to substantially raise HDLC levels through dietary modification.

Soy & Lipid Levels: Summary
The effect of soy on lipid levels is similar to that of soluble fiber, and when combined with other dietary approaches may allow highly motivated individuals to avoid the use of cholesterol-lowering medications. Importantly, even the effects of soy protein alone have public health relevance since:

- Each 1 percent reduction in LDLC results in a 2-4 percent reduced risk for heart disease
- The favorable effects on triglycerides and HDLC further reduce risk
- Each 1 percent increase in HDLC reduces CHD risk by 2-3 percent

Elevated triglycerides are also thought to be an independent risk factor for CHD although there is debate on this point.

Effects on non-lipid risk factors
Differences in the traditional risk factors – elevated cholesterol, blood pressure and smoking – explain a large part of the variation in CHD risk among individuals, but it is

increasingly recognized that other factors are also important. Recent research suggests that soy protein, likely in part because of its isoflavone content, may favorably affect several of these. Indirect support for this suggestion comes from a prospective epidemiologic study involving nearly 65,000 women from Shanghai.[11] Even after controlling for a wide variety of risk factors, this study found that soy protein intake was associated with a marked reduction (relative risk = 0.14 for the highest vs. the lowest quartile of intake; P for trend = 0.001) in the risk of non-fatal myocardial infarction, a protective effect far beyond that which could be expected from a modest reduction in cholesterol. One risk factor that soy may favorably affect is endothelial function.

Endothelial dysfunction is thought to be a global indicator of CHD risk.[12] The endothelium is the thin layer of cells that line blood vessels. By secreting several biologically active molecules (such as nitric oxide), the endothelium influences the health of the coronary vessels and, as a result, CHD risk. Endothelial health can be assessed by ultrasonically measuring the ability of the brachial artery to dilate following reactive hyperemia (blood occlusion). Several studies have shown that isoflavone-rich soy protein and isolated isoflavones increase arterial dilation in postmenopausal women – indicating improved endothelial health.[13, 14 15, 16]

In addition to endothelial function, there are also more speculative data suggesting that soy:

- Lowers blood pressure (especially in hypertensives)[17, 18]
- Improves systemic arterial compliance (increasing arterial flexibility)[19]
- Inhibits LDLC oxidation[20, 21]
- Reduces LDLC particle size (making LDLC less atherogenic).

While the conflicting or limited data in each of these areas prohibits a firm conclusion from being made, the hypotensive effects of soy protein are particularly intriguing.

Soy Protein and Blood Pressure

Although there is only limited evidence in support of soy protein lowering blood pressure in comparison to other proteins, a recently conducted large 12-week trial involving ~300 prehypertensive and stage 1 hypertensive patients found that in comparison to a carbohydrate control, 40 g/d soy protein significantly lowered blood pressure.[17] In the hypertensive subjects, the effect of soy protein (~8 mm Hg ↓) on systolic blood pressure was equivalent in potency to currently used blood pressure medications. Even modest reductions in blood pressure can result in significant benefits; for example, reducing systolic blood pressure by just 2-5 mm Hg reduces risk of CHD and stroke from 4 to 9 percent and 6 to 14 percent, respectively.[22]

Soy Oil – A Source of Both Essential Fatty Acids

Approximately 56 percent of the fat content of the soybean is comprised of linoleic acid, making soybeans and full-fat soyfoods excellent sources of this essential polyunsaturated fatty acid. Linoleic acid lowers serum cholesterol when added to the diet and when substituted for saturated fat.[23] The soybean is also one of the few good plant sources of the essential omega-3 fatty acid, alpha-linolenic acid (ALA). Importantly, a recent meta-

analysis found that those subjects who consumed the most ALA were approximately 20 percent less likely to die from CHD as compared to those whose consumption was low.[24] The ALA intake difference between the high and low consumers was only 1.2 g/d; three cups of full-fat soymilk provide approximately this amount.

The means by which ALA reduces CHD risk have not been established, but omega-3 fatty acids in general are thought to reduce risk of cardiac arrhythmia.[25] Interestingly, one recent study found that soy oil was almost as effective as fish oil in increasing heart rate variability, which decreases risk of arrhythmia.[26]

Conclusions

Substantially reducing CHD risk through lifestyle modification requires making comprehensive changes. No single food or nutrient is sufficiently potent to produce meaningful reductions in risk. It is clear however that the established coronary benefits of soy protein (reductions in triglycerides and LDLC, and increased HDLC) in combination with the possible benefits (such as reduction in blood pressure and improved endothelial health) justify recommendations to include soyfoods in a heart-healthy diet. For cholesterol reduction, an intake of 25 g/d soy protein is recommended (see Protein Content of Soyfoods table).

Protein Content of Soyfoods

Food	Serving size	Kcal	Protein (g)
Tofu, silken, lite firm	1 slice	32	5.3
Tofu, raw, firm	½ cup	183	19.9
Soy burger	1 patty	125	12.5
Soynuts	¼ cup	203	15.2
Edamame	½ cup	127	11.1
Soymilk	1 cup	127	5.5

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The United Soybean Board is a farmer-lead organization comprised of 64 farmer-directors. USB oversees the investments of the soybean checkoff on behalf of all U.S. soybean farmers.

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