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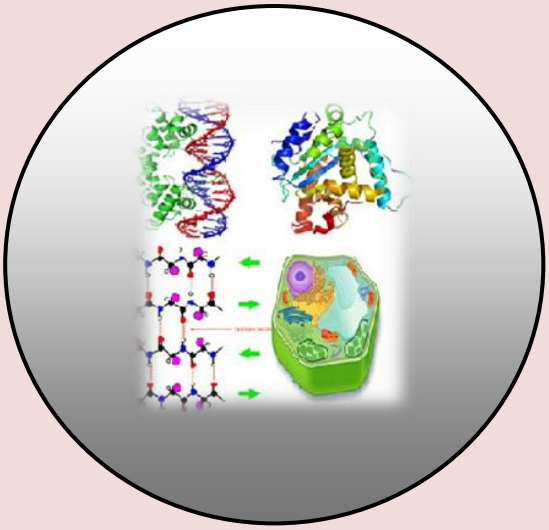

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Nutritional Profile of Soybean: An Overview

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ABSTRACT

The botanical of soybean is (Glycine max). It is a species of legume native to East Asia, widely grown for its edible bean which has numerous uses. The plant is regarded an oilseed rather than a pulse by the UN Food and Agriculture Organization (FAO).

The genus Glycine Wild. is divided into two subgenera, Glycine and Soja. The subgenus Soja (Moench) F.J. Herm. includes the cultivated soybean, Glycine max (L.) Merr., and the Wild soybean, Glycine soja Sieb. & Zucc. Both species are annuals. Glycine soja is the Wild ancestor of Glycine max, and grows wild in China, Japan, Korea, Taiwan and Russia. Many legumes (alfalfa, clover, lupins, peas, beans, lentils, soybeans, peanuts and others) contain symbiotic bacteria called Rhizobia within nodules of their root systems. Protein and soybean oil content account for 56% of dry weight (36% protein and 20% fat). The remainder consists of 30% carbohydrates, 9% water and 5% ash. Soybeans comprise approximately 8% seed coat or hull, 90% cotyledons and 2% hypocotyl axis or germ. Raw soybeans are 20% fat, including saturated fat (3%), monounsaturated fat (4%) and polyunsaturated fat occurring mainly as linoleic acid.

Keywords: Glycine max, Proteins, Health, Nutrition and Linoleic Acid.

INTRODUCTION

The soybean consumption is a matter of much current debate. I have reviewed the research on soybean for food profile focusing for health benefits, when it comes to whole soybean versus isolated soybean derivatives and how fermented soybean foods may provide more benefits than unfermented ones (Ajay and Arvind, 2009, Tucker et al., 2010, Yimit et al., 2011).

Soybean have long been recognized as a plant food that, when compared with other plants having relatively high protein. Recently researchers have taken a very close look at the protein content of soybeans and arrived at fascinating conclusions. Even though soya protein is a plant protein and typically lower in certain amino acids (protein building blocks)

than animal proteins like those found in chicken eggs or cow's milk, once adjustments have been made for digestibility and other metabolic factors, soybeans turn out to receive a protein quality rating that is equal to the ratings for egg or cow's milk. Soyabean has very small and unique proteins referred as "peptides." Examples of unique peptides in soybeans include defensins, glycinins, conglycinins and lunasin, all are now known to provide us with health benefits, including improved blood pressure regulation, control of blood sugar level and maintained immune function (Noroozi et al., 2011, Whent et al., 2011).

Researches have provided some mixed results about the impact of soy consumption on our cardiovascular system. Soya protein and risk of coronary heart disease (CHD). What they found was an overall decreased risk of CHD when approximately 30 grams of soy protein was consumed on a daily basis. Decreased LDL cholesterol was found to be an important part of this lowered risk. While we think it makes the most sense to consume soybeans in their whole food form (versus soy protein alone), and that daily protein intake should come from a variety of different foods, the findings in this study lend support to the conclusion that soy can play a beneficial role in support of cardiovascular health (Ajay and Arvind, 2009).

Figure 1. Soybean cultivation in 2013.

WH Foods Recommendation

When including soybeans, try to stick with the whole food forms, and also consider giving preference to fermented versions like tempeh, fermented tofu, and soy miso. Unfortunately, in the United States, we seldom consume soybeans in their whole natural form (either fresh or dried). Instead, we process soybeans by using hexane or other solvents to remove the oil (which can be sold as cooking oil or oil to be added to other processed foods), and then we take what's left over (defatted soy flour) and either (Ajay and Arvind, 2009) combine it with other proteins to make animal feed or (Amadou et al., 2009) wash it with water to create soy protein concentrate. Soy protein concentrate becomes the source for two forms of soy that are even more processed: TVP, or textured soy protein that can be produced through a process called extrusion and SPI (soy protein isolate), which can be produced by making the soy protein concentrate more solubilized. SPI is used in many low-fat soy milks (Anderson and Bush, 2011).

All of the above processing steps create a soy product that is very different from the soybeans' whole food form. Full-fat soy milk, for example, can be made by simply cooking whole soybeans in water and using a cloth to strain the soymilk (liquid) from the fibrous part of the cooked beans. Tofu can be made from full-fat soy milk by using salts or acids to coagulate the milk into curds that can be pressed into "cakes." (Tofu can be further preserved through fermentation) Natto is another good example of a whole food form of soybean (Ollberding et al., 2011). Natto can be made by taking whole soybeans, adding bacteria called *Bacillus subtilis*, and giving the bacteria time to ferment the beans. Natto, tofu, and full-fat soymilk are whole food forms of soybean that stand in sharp contrast to processed forms like TVP and SPI (Nanri et al., 2010).

Since genetically modified (GM) soybeans have reached 90% market penetration in the United States select organically grown soy products to avoid GMO (Bahlai et al., 2010).

Public Health Recommendations

Many public health organizations—including the American Diabetes Association, the American Heart Association, and the American Cancer Society—recommend legumes (the category in which soybeans are classified) as a key food group for preventing disease and optimizing health. The 2005 Dietary Guidelines for Americans developed by the U.S. Department of Health and Human Services (USDHHS) and the U.S. Department of Agriculture (USDA) recommends 3 cups of legumes per week (based on a daily intake of approximately 2,000 calories). Because 1 serving of legumes was defined as 1/2 cup cooked, the Dietary Guidelines for Americans come very close to this as they recommend of 1/2 cup of cooked legumes on a daily basis. Based on our own research review, we believe that 3 cups of legumes per week is a very reasonable goal for support of good health. However, we also believe that optimal health benefits from legumes may require consumption of legumes in greater amounts. This recommendation for greater amounts is based upon studies in which legumes have been consumed at least 4 days per week and in amounts falling into a 1-2 cup range per day. These studies suggest a higher optimal health benefit level than the 2005 Dietary Guidelines: instead of 3 cups of weekly legumes, 4-8 cups would become the goal range. Remember that any amount of legumes is going to make a helpful addition to your diet (Lanou, 2011). And whatever weekly level of legumes you decide to target, we recommend inclusion of soybeans among your legume choices. This chart graphically details the % DV that a serving of Soybeans provides for each of the nutrients of which it is a good, very good, or excellent source according to our Food Rating System. Additional information about the amount of these nutrients provided by Soybeans can be found in the Food Rating System Chart. A link that takes you to the In-Depth Nutritional Profile for Soybeans, featuring information over 80 nutrients, can be found under the Food Rating System Chart.

Total soy consumption is different when comparing East to West The amount of total soybean consumption in Eastern versus Western countries is also very different. In studies from China and Japan, it's not surprising to see intake of soybeans occurring at the level of 100-200 grams per day. Yet in the U.S., we average less than one-tenth of that amount (Barnes, 2010).

Metabolic differences

Longstanding culinary traditions involving soy also seem to have contributed in various ways to important metabolic differences in Asian versus non-Asian populations.

For example, about 50-60 % of adults in Japan, China and Korea digest soybeans in such a way as to convert daidzein (one of soy's key isoflavone phytonutrients) into equol (a closely-related phytonutrient called an isoflavan). By contrast, when U.S. adults eat soybeans, only 25-30 % metabolizes daidzein in this way. The role of bacteria in the digestive tract seems critical in the equol production process, and there may be other aspects of metabolism that also play pivotal roles (Klein et al., 2010).

When combined, these metabolic and whole-versus-processed food differences make research on soy difficult to interpret. A soy-related dietary practice that works for adults in China may not work for adults in the U.S., or vice-versa. In addition, until soybeans are enjoyed on a more regular basis in their whole food form in the U.S., research studies on U.S. adults may continue to show mixed results in terms of health benefits. Even with all of the "east versus west" circumstances that complicate research on soybeans and health, we believe several areas of health benefit still shine through in studies of this much-loved legume. In the paragraphs below, you will learn more about these specific health areas (Butler et al., 2010).

Overall Nutrient Benefits

According to a recent research analysis, U.S. adults would increase their intake of folate, vitamin K, calcium, magnesium, iron and fiber if they replaced their meat and dairy intake with soy. Since legumes like soybeans are often overshadowed by vegetables and fruits in terms of nutrient richness, we sometimes forget just how beneficial legumes like soybeans can be (Kim et al., 2006).

In addition to all of their nutrient richness described above, soybeans also offer many unique nutrients less familiar to most people. In some cases, the health benefits of these nutrients are only beginning to be understood by researchers. Below is a list of some key nutrients currently under investigation in soybeans (Chai et al., 2011).

Study of Cardiovascular Benefits

As discussed earlier, research on soybeans has provided mixed results in the area of cardiovascular benefits, with some studies showing no benefits and other studies showing significant ones. We believe that two aspects of the "east versus west" phenomenon described earlier may have contributed to these mixed findings. First is the difference between studies involving whole soybeans versus studies involving processed soybean components (like soy protein isolates). In repeated research findings, whole food soybeans have been shown to provide us with better cardiovascular support than dietary supplements containing soy components. "Better" in this case means not only more consistent but also more in-depth cardiovascular support (Keiko et al., 2008). However, even in the case of whole food soybeans, we would not describe this cardiovascular support as being "strong." A better word would be "moderate." The most consistent effect of soybean intake on blood fats has been a moderate lowering of LDL cholesterol. Some studies show other positive impacts on blood fats, such as the lowering of triglycerides and total cholesterol or the raising of HDL cholesterol (the "good" cholesterol). However, these additional blood fat results have not been confirmed in all studies (Crist et al., 2009).

Cancer Prevention Benefits

The area of cancer prevention is perhaps the most controversial area of health research on soybeans. Many studies provide us with evidence that supports the role of whole soy foods in a cancer-preventing diet.

Genistein (an isoflavone phytonutrient in soy) is often a key focus in these cancer-prevention studies. This soy isoflavone can increase activity of a tumor suppressor protein called p53 (Jenkins et al., 2011). When p53 becomes more active, it can help trigger programmed cell death (apoptosis) in cancer cells, and it also help trigger cell cycle arrest (helping stop ongoing cancer cell activity). Genistein has also been shown to block the activity of protein kinases in a way that can help slow tumor formation, especially in the case of breast and prostate cancer. It's also worth noting here that genistein becomes more concentrated in soy foods when those foods are fermented (Evans et al., 2007).

Table 1. The more background information.

Nutrient	Amount	DRI/DV (%)	Nutrient Density	World's Healthiest Foods Rating
Molybdenum	129.00 mcg	287	17.3	Excellent
Copper	0.70 mg	78	4.7	Excellent
Manganese	1.42 mg	71	4.3	Very good
Phosphorus	421.40 mg	60	3.6	Very good
Protein	28.62 g	57	3.5	Very good
Iron	8.84 mg	49	3.0	Good
Omega-3 fats	1.03 g	43	2.6	Good
Fiber	10.32 g	41	2.5	Good
Vitamin B2	0.49 mg	38	2.3	Good
Magnesium	147.92 mg	37	2.2	Good
Vitamin K	33.02 mcg	37	2.2	Good
Potassium	885.80 mg	25	1.5	Good

World's Healthiest Foods Rating	Rule
Excellent	DRI/DV>=75% OR Density>=7.6 AND DRI/DV>=10%
Very good	DRI/DV>=50% OR Density>=3.4 AND DRI/DV>=5%
Good	DRI/DV>=25% OR Density>=1.5 AND DRI/DV>=2.5%

In-Depth Nutritional Profile for Soybeans

Soy and Hot Flashes

Hot flashes are very common symptoms of menopause and peri-menopause in U.S. women (often called "night sweats" when they occur at night) can cause great suffering and can easily affect mood throughout the day and impair concentration.

Approximately 70-80 % of U.S. women of menopausal and peri-menopausal age experience hot flashes, in comparison with approximately 10-20 % of Asian women (Hara et al., 2012). By comparison, the average level of the soy isoflavone genistein in the bloodstream of Asian women is approximately 25 nanograms per milliliter, but in U.S. women, only 2 nanograms. This sharp contrast between frequency of hot flash symptoms and soy genistein levels has led many researchers to wonder about the hot flash-preventing potential of soybeans. Unfortunately, most studies to date fail to establish a reliable connection between dietary soy intake and occurrence of hot flashes (Japakaset et al., 2009). It's possible that future research studies will tell a different story, but at present, we aren't aware of any findings that show clear benefits for hot flash relief from increased intake of soy (Fumi et al., 2009).

Study of Nutritional Profile

Soybeans are perhaps best known for their fantastic blend of protein and fiber. But soybeans are also an excellent source of molybdenum and copper. They are a very good source of manganese, phosphorus, and protein as well as a good source of iron, omega-3 fatty acids, dietary fiber, vitamin B2, magnesium, vitamin K, and potassium. There are also a wide range of unique proteins, peptides, and phytonutrients contained in soy. These nutrients include flavonoids and isoflavonoids (daidzein, genistein, malonylgenistin, and malonyldaidzin); phenolic acids (caffeic, coumaric, ferulic, gallic and sinapic acids); phytoalexins (glyceollin I, glyceollin II, and glyceollin III); phytosterols (beta-sitosterol, beta-stigmasterol, campestrol); unique proteins and peptides (defensins, glycinin, conglycinin, and lunacin) and saponins (soyasaponins from group A and group B, and soyasapogenols) (Gundermann et al., 2011).

Introduction to Food Rating System Chart

In order to better help you identify foods that feature a high concentration of nutrients for the calories they contain, we created a Food Rating System. This system allows us to highlight the foods that are especially rich in particular nutrients. The following chart shows the nutrients for which this food is either an excellent, very good, or good source (below the chart you will find a table that explains these qualifications). If a nutrient is not listed in the chart, it does not necessarily mean that the food doesn't contain it. It simply means that the nutrient is not provided in a sufficient amount or concentration to meet our rating criteria. (To view this food's in-depth nutritional profile that includes values for dozens of nutrients - not just the ones rated as excellent, very good, or good - please use the link below the chart.) To read this chart accurately, you'll need to glance up in the top left corner where you will find the name of the food and the serving size we used to calculate the food's nutrient composition. This serving size will tell you how much of the food you need to eat to obtain the amount of nutrients found in the chart. Now, returning to the chart itself, you can look next to the nutrient name in order to find the nutrient amount it offers, the percent Daily Value (DV%) that this amount represents, the nutrient density that we calculated for this food and nutrient, and the rating we established in our rating system. For most of our nutrient ratings, we adopted the government standards for food labeling that are found in the U.S. Food and Drug Administration's "Reference Values for Nutrition Labeling."

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