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Health benefits of soybean and soybean based food products: A study

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Abstract

With the recent upsurge in many lifestyle diseases, combined with the added risk of a pandemic wreaking havoc across the globe, the focus on good health has increased by many folds. Proteins which are body building and protective macronutrients have gained a significant importance due to this. Apart from animal sources of proteins, people are turning towards new plant based alternatives due to popularity of veganism and also animal cruelty involved in production of animal meat proteins. Soyfoods have long been recognized as sources of high-quality protein and healthful fat, but over the past 25 years these foods have been rigorously investigated for their role in chronic disease prevention and treatment. There is evidence, for example, that they reduce risk of coronary heart disease and breast and prostate cancer. In addition, soy alleviates hot flashes and may favorably affect renal function, alleviate depressive symptoms and improve skin health. Hence Soybean which has a significantly high protein content as well as superior quality of proteins compared to other plant proteins has gained significance due to these factors. This review covers health benefits of Soybean and different processed products that can be prepared by utilizing soybean.

Keywords: Soybean, tofu, soymilk, tempeh, miso, Shoyu, Natto

Introduction

Soybean (*Glycine max* L.) is the most cultivated plant in the world and contains a high amount of protein. Among modern agricultural commodities, soybean has a prominent place as the world "s most important seed legume, which contributes 25 per cent to the global vegetable oil production. Currently the crop is grown in 103 million ha globally with an annual production of 261 million tons and average productivity of 2 533 kg per ha (FAOSTAT, 2020) [1].

The commercial cultivation of soybean in India commenced in late sixties; thereafter it has made an unprecedented phenomenal growth, having no parallel in the crop history world over. Starting from an area of just 30, 000 ha in 1970, soybean has reached to 11.7 million ha in 2018. The production and productivity levels of 14 000 tons and 0.43 t per ha in 1970 have increased to 14.14 million tons and 1.2 t per ha in 2018, respectively (DAC, 2019) [2].

Although, the contribution of India in the world soybean area is 10 per cent, it is only 4 per cent in total world "s production indicating its relatively lower productivity as compared to World average. At present the area under soybean is mainly spread in latitudinal belt of about 15 to 25° N comprising the states of Madhya Pradesh, Maharashtra, Rajasthan, Chhattisgarh, Andhra Pradesh and Karnataka. Besides improving the socio-economic conditions of small and marginal farmers of the country, the crop contributes 25 per cent of the total edible oil produced in the country and earns substantial amount of foreign exchange (INR 70 000 million) by exporting defatted oil cake (DOC). As soybean is the cheapest source of high quality protein, the crop has potential to alleviate large scale protein malnutrition in the country (Bhatia *et al.*, 2008) [3].

Nutritional composition and health benefits of soybean

Soybeans are very rich nutritive food. Besides the very high protein content soybean also contains a lot of fibre and are rich in calcium, magnesium. The soy protein has a high biological value and contain all essential amino acids. Soybeans are rich in unsaturated fatty acids and low in saturated fatty acids, which need to be avoided (Anderson *et al.*, 1995) [4].

It was found that 100gm of soybean contains 8.5g of water, 36.5g of proteins which is very high compared to other plant based protein sources, 19.9g of total fat, 30.2g of carbohydrates and 9.3g of fibre. It also contained 1797 mg of potassium, 704 mg phosphorus, 277mg of calcium, 200mg of isoflavones, 15.7 mg of iron (Kulkarni, 2007) [5].

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Like most legume seeds, it contains several proteins, most of which contribute to nutrition and good health. In addition to proteins, they are notably rich in isoflavones, anthocyanins, saponins, lipids, and oligosaccharides (Barnes, 2010)^[6].

Consumption of soybean and soybean-derived fermented products has been linked to many health benefits, including the reduction of cardiovascular disease incidence, reduced risk of ischemic stroke, and lower cholesterol levels that in turn reduce the incidence of atherosclerosis (Olivia *et al.*, 2015)^[7].

The efficacy of soybean phytochemicals against several types of cancer such as breast, prostate, colorectal, ovarian, and also endometrial cancers has also been demonstrated (Fisk *et al.*, 2011)^[8].

Soybean has also long been known to reduce menopausal symptoms in women and to reduce the risk of diabetes type 2 (Messina *et al.*, 2003)^[9].

Soybean is long been known to possess antioxidant activity. Among soybean phytochemicals, isoflavones have shown a wide range of health benefits. (Lee, 2005)^[10].

Different processed products of Soybean

1. Soymilk

Soymilk is traditionally made by soaking soybeans in water (1:10) overnight, then grinding the beans in a mill with additional water being added during the grinding step. The resulting slurry is boiled and stirred for 15 to 30 min. This heating step improves the nutritional value of the milk, by inactivating trypsin inhibitors, and improves the flavor, by inactivating lipoxygenase and volatilizing some of the off-flavor compounds that appear during grinding. Heating also increases the shelf life of the milk by reducing its microbial load (critical control point). The heated slurry is then filtered through a cloth or nylon bag to separate the undispersible fiber residue, *okara*, from the soymilk. (Wilson, L.A., *et al.*, 1992)^[11].

Soy milk is rich in omega-3 fatty acids, which are “healthy” fats that your body cannot form on its own. Omega-3 fatty acids are linked to a reduced risk of dementia and Alzheimer’s disease. Soy milk is still being studied for its effect on these diseases, but soy in general is one of the best non-animal sources of omega-3 fatty acids (Angela, *et al.*, 2013)^[12].

2. Tofu

Tofu, also called bean curd, soft, relatively flavourless food product made from soybean. Tofu is an important source of protein in the cuisines of China, Japan Korea, etc. Tofu is made from dried soybeans that are soaked in water, crushed, and boiled. The mixture is separated into solid pulp (*okara*) and soy “milk.” Salt coagulants, such as calcium and magnesium chlorides and sulfates, are added to the soy milk to separate the curds from the whey. In some cases, acid coagulants, such as citric acid or glucono delta-lactone, may be used. The soy milk is poured into molds to allow the carbohydrate-laden whey to drain off. The resultant soft cakes are cut into squares and stored under water until sold, in bulk or in individual water-filled tubs. Tofu can be made extra soft, soft (silken), firm, or extra firm, depending on the method of production. Dried tofu, which does not require refrigeration, is also sold (Wilson, L.A., *et al.*, 1992)^[11].

Tofu is a good source of protein and contains all nine essential amino acids. It is also a valuable plant source of

iron and calcium and the minerals manganese and phosphorous. Soya protein (from which tofu is derived) is believed to help lower levels of bad cholesterol (LDL). Tofu contains phytoestrogens called isoflavones – a group of chemicals found in plant foods. They have a similar structure to the female hormone oestrogen and therefore mimic the action of oestrogen produced by the body. They naturally bind to oestrogen receptor sites in human cells including breast cells – potentially reducing the risk of breast cancer (Eze *et al.*, 2018)^[13].

3. Tempeh

Tempeh is a fermented whole soybean product that originated in Indonesia but is now equally popular in Malaysia. Tempeh is made by soaking soybeans overnight, then boiling them with the hulls (Malaysian) or without the hulls (Indonesian) for 30 min. The excess water is drained off, and the beans are placed on a tray for inoculation with a piece of tempeh or *Rhizopus oligosporus*. The beans are then allowed to ferment at room temperature for 1 to 2 d or at 30 to 32°C (86 to 90°F) for 20 hours. During fermentation, white mold mycelium covers the beans and binds them together into a solid sheet. The tempeh sheet is then cut into smaller pieces and, since it is a perishable product, sold that day. If it is to be stored for future use, it is usually blanched, sun-dried, or frozen. Tempeh is usually cooked before it is eaten. Preparation usually involves frying, deep-fat frying, or baking the product. It is also added to soups and fast foods and is used as a meat replacement in main dishes (Wilson, L.A., *et al.*, 1992)^[11].

Tempeh seems to be rich in prebiotics — types of fiber that promote the growth of beneficial bacteria in your digestive system. Studies have found that prebiotics increase the formation of short-chain fatty acids in the colon. These include butyrate which is the primary source of energy for the cells that line your colon. Evidence suggests prebiotic supplements cause beneficial changes in the gut microbiota — the bacteria that reside in your digestive system. Although studies have provided mixed results, some have linked prebiotic intake with increased stool frequency, reduced inflammation and improved memory (Subandi *et al.*, 2018)^[14].

4. Miso

Miso is made by mixing cooked soybeans with *koji* (starter culture, often fermented rice), and salt water. This material is then fermented for several months. There are several miso products, which differ in the type of *koji* used for the fermentation. Rice *koji* is used to make rice miso, barley *koji* to make barley miso, and soybean *koji* to make soybean miso. A high ratio of rice or barley to soybeans results in a more lightly colored and sweeter miso. The fermentation period for high-wheat or -barley miso is usually shorter than for miso with greater soybean content. "Soybean miso" has the longest fermentation period, taking from 1 to 2 year to produce an acceptable flavor. The salt content of miso is usually about 10% or more by weight. Recent research has succeeded in depressing the salt content by adding alcohol or extra yeast to suppress undesirable "wild" fermentations (Wilson, L.A., *et al.*, 1992)^[11].

Soybean miso is made exclusively from soybeans. Cooked soybeans are ground, molded into balls, then covered with powdered *koji* starter and incubated in a *koji* room to promote the growth of *Aspergillus oryzae*. After four days, soybean

koji germination is complete. The mash is then mixed with water and salt, and ripened in casks. This miso is aged for one year. The interrelationships between the various ingredients that produce the unique sensory properties of miso (color, texture, flavor, taste, aroma) are complex. A key factor in the quality of the final product is the enzymatic action of the microorganisms and how they influence the composition of the substrate (rice, barley, soybeans, rice and barley, rice and soybeans, barley and soybeans) (Abiose *et al.*, 1982)^[15].

Miso is rich in essential minerals and a good source of various B vitamins, vitamins E, K and folic acid. As a fermented food, miso provides the gut with beneficial bacteria that help us to stay healthy, vibrant and happy; good gut health is known to be linked to our overall mental and physical wellness (Ito 2020)^[16].

5. Natto

Natto is a cooked whole soybean product fermented with *Bacillus natto*. There are similar products in the Indonesian and Thai markets, but not in China. Originally natto was developed using *B. natto* grown in rice straw. Modern production is relatively straightforward. Soybeans are soaked in water overnight, then cooked to soften them. The cooled mash is inoculated with a commercial

B. natto culture (a liquid suspension or starchlike powder), then mixed in a rotary cask. Fresh packets are then prepared by wrapping 50 to 100 g of mash with a thin piece of perforated polyethylene film or by placing the mixture in shallow polystyrene or wood trays. These are stacked in the fermentation room at 30 to 40°C (86 to 104°F) for 24 hr or until the soybeans are fully covered by a white, sticky glutamic acid polymer. The product is then transferred to a cold room for storage or transported to market (Pradhananga 2018)^[17].

Our gut contains trillions of microorganisms — more than 10 times the total number of cells found in your body. Having the right type of bacteria in your gut creates a healthy gut flora, which is linked to numerous health benefits like improved digestion. The probiotics in natto can act as your gut's first line of defense against toxins and harmful bacteria. Researchers report that probiotics can help reduce gas, constipation, antibiotic-associated diarrhea and bloating, in addition to symptoms of inflammatory bowel disease (IBD) etc. Most probiotic-rich foods and supplements contain 5–10 billion colony-forming units (CFUs) per serving. Comparatively, natto can contain between one million and one billion colony-forming bacteria (CFUs) per gram. Thus, each gram of natto contains almost the same amount of probiotics you'd get from a whole serving of most other probiotic-rich foods or supplements. Interestingly, natto fermentation helps reduce the levels of antinutrients that are naturally found in soybeans, facilitating their digestion. (Nagai 2015)^[18].

Future of Soybean products

The acceptance of soybean proteins is increasing, due to increase in consciousness towards health among people. A lot of soy products such as Tempeh, Soymilk, Miso, Tofu etc are getting attention from vegetarian population of India as well as from the new phenomenon of vegan diet. Due to superior quality and high quantity of proteins and low presence of fat, soy products are recommended by doctors. Soy products like Tofu are gaining attention from people who are working out in the gym to gain muscles as the amount of fat is very less in

soybean. When compared to milk products the market price of soy products is less without compromising on the quality of products and due to adulteration in milk products, soy products have gained importance. Soy food industry is growing annually by 20% hence it has a great market potential.

Conclusion

Soybean is a very important legume type which has been consumed for ages in many countries. It is known as “miracle plant” in many regions because of its high nutritional value especially in terms of protein content. It is also an important source of linoleic and linolenic acids. It is also very good alternative for vegan people. For this reason, there are many utilization methods of soybean in the world.

The potentially beneficial effects of soy consumption clearly indicate both the need and the justification for more clinical and experimental studies. Further studies are required to examine the effects of soy beans and soy bean products on cardiovascular risk factors, cancer, osteoporosis and the relief of menopausal symptoms. Although multiple factors are driving research on soy, the single most important factor is arguably that soy beans are a concentrated source of isoflavones. Definite data about the relationship between soyfoods and isoflavones and the risk of chronic disease may be many years away. However, the foundation has now been laid for research to determine not only the effects of soy and isoflavones on serum lipids, but also on the incidence of heart disease; not only on bone mineral density, but also on fracture risk, and not only on biomarkers of cancer risk, but also on cancer rates.

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