

Review Article

Processing and Utilization of Soybean for Value Added Products

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Abstract

Soybean is economically most important bean in the world, providing vegetable protein for millions of people and ingredients for hundreds of chemical products. Soy, a versatile bean, is found in foods like soy milk, soy sauce, miso (soybean paste), tempeh (which is kind of like a soy cake), and tofu. Soy is also sometimes added to foods like breads, cereals, and meat products, and used as a meat substitute in vegetarian products such as soy burgers and soy hot dogs. Whole soy beans (edamame) and foods that contain whole soy are a good source of protein. Soy protein is used in the manufacturing of breads, cookies, crackers and other baked goods. Soy protein improves texture; holds moisture; creates cake richness; whitens bread; extends shelf-life; reduces breakage and crumbling; enhances nutrition; improves manufacturing, handling and machine ability; and improves mouth feel and overall quality as perceived by the consumer. Soy products have long recognized as sources of high-quality protein and healthful fat. The processing and utilization of soybean for value added products were reviewed.

Keywords: Soybean; Soy protein; Value added products; Healthful fat.

Introduction

Glycine max, commonly known as soybean in North America, is a species of legume native to East Asia, widely grown for its edible bean which has numerous uses. Soybean has its unique characteristics in that it can be processed into a number or variety of products. Many economically challenged families in Nigeria utilize soybean processing as a means of income generation for household as well as ensure food security. Soybean produces 2-3 times more protein per hectare than any other legume/pulse crop. Soy-protein is superior to other plant proteins and is the most economical source of dietary protein [1]. Soy foods are health promoting. However, soybean also contains some anti-nutritional factors necessitating careful processing to make it fit for human consumption.

Soybeans need to be inoculated with a particular strain of *Rhizobium* fungus before planting. This fungus fixes nitrogen (i. e. takes elemental nitrogen from the air and adds it to the soil in a form that the soybean plant can use). However, if soybeans are planted in a field that contained soybeans as a previous crop, they may not require inoculation because the *Rhizobium*

will still be in the soil. If soybeans are not grown in association with *Rhizobium*, they will grow more slowly, require nitrogen fertilizer, and yield less. *Rhizobium* inoculum must be fresh (viable) and is usually purchased with the seed [2]. If *Rhizobium* inoculum is not available in a particular area, and soybeans are not now being grown, it may be difficult to produce this crop. Soybeans need fertilizer, including both the macronutrients phosphorous and potassium (P and K) and sometimes micronutrients. Nitrogen is not required if soybeans are properly inoculated. Soybeans need rather large amounts of phosphorous, calcium, magnesium, and sulfur. Minor elements are sometimes required. Soybeans cannot be recommended for unfertilized soils.

Production and nutritional value of soybean

The soybean is grown as a commercial crop in over 35 countries as the major oilseed. The fruit of soybean is simple or take the shape of crescent pod, length about 3-7 cm, including 1 or 2 seeds which mass of 1000 seeds take out 115-280 g. On the fodder designed the seeds in mass about 180-200 g. Unripe seeds are green, and mature have from light-yellow by green to brown color. In practice are used seeds of different cultivars, what influence on color and

form of seeds. The soybean seeds of modern cultivars have spherical shape, and the yellow and green color is the most desirable [3]. The soybean products are used in food industry on whole world. The soybean seeds contain high quantity of protein and its amino acid composition is approximate to composition of animal proteins, therefore is often used as replacement component of meat protein. Soybean seeds are used in oil industry. The soybean as a whole contains 40% protein, 20% fat, 23% carbohydrates, 5% minerals, 4% fibre and 8% moisture content [4]. About 90% of soybean seeds make up cotyledons and 8% there are hulls. In the cotyledons are accumulated proteins and fats, the main components of seeds. In the cotyledons also are accumulated carbohydrates and anti-nutritional factors. In result of separation of this components or their extraction were obtained different soybean products used in people and animals feeding.

Soybean products

Soybean sprouts are made by germinating the seeds. Tempeh is fermented soybean mash. Several oriental sauces are made from soybean. High protein flour can be made after defatting, but this is not practical at the low technology scale. There are hundreds of uses for this versatile food.

Soymilk

Soymilk was originated in China. It is a plant based drink and applicable to all sections of people suffering from lactose intolerance. It may consist of pure water, soybean extract, sugar and salt. It has 3-4% protein, 1.5-2% fat and 8-10% carbohydrates [5]. Not only it is higher in protein and iron content, but it is cholesterol free, low fat and low sodium. Figure 1 shows the processing of soymilk.

Benefits of soymilk

Soymilk helps to low cholesterol, it prevents liver damage by oxidative stress, maintains optimal blood pressure in diabetics, it is rich in PUFA, high quality protein and vitamin. Research efforts have been conducted to reduce the beany flavor and obtain a better tasting and acceptable product.

Tofu

Tofu is soymilk that has been coagulated to make gel – soymilk intentionally curdled. It is

available in various types, ranging from soft to extra firm, depending on water content. It is a highly digestible product that is good for people suffering from lactose intolerance [6]. When the tofu is made with calcium, calcium becomes an essential component. The softer one is used for deserts or other foods those require wetter consistency. Figure 2 shows the processing of tofu.

Benefits of tofu

Tofu is a good source of protein and contains all eight essential amino acids. It is also an excellent source of iron and calcium and the minerals manganese, selenium and phosphorous. In addition, tofu is a good source of magnesium, copper, zinc and vitamin B1 [7]. Tofu is an excellent food from a nutritional and health perspective. It is thought to provide the same sort of protection against cancer and heart disease as soya beans. A 100g serve contains 70kcal, 3.5g fat, 1.5g carbohydrate, 8.2g protein and 0.9g fibre. It offers relief for certain symptoms of menopause and helps to lower bad LDL cholesterol.

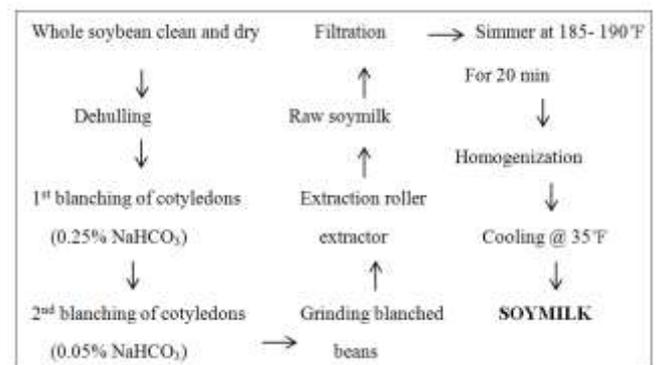


Figure 1. Processing of soymilk

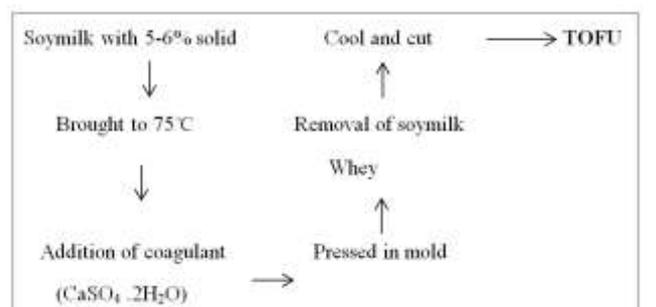


Figure 2. Processing of TOFU

Soy flour

It is made of dehulled beans with oil pressed out. It is used for consumers who cannot consume wheat/flour for gluten content. Soy flours are refatted at levels of 1 to 15% added fat to reduce dustiness and provide fat for a product

formula. Refatting extracted flour allows the use of refined bland oil. Relecithinated soy flours are offered domestically with 3, 6, and 15% added lecithin [8]. Lecithin improves dispersion of the flour and other admixed ingredients in confection and cold beverage products. Generally, oil or lecithin is added to highly toasted flours. The compositions of refatted and relecithinated soy flours are primarily those of the carrier flour, diluted by the amount of oil or lecithin added. Figure 3 represents the processing of soy flour.

Benefits of soy flour

Prevent heart disease, cancer, menopausal problems, osteoporosis, Good for eyes. Soy flour is a great source of high quality soy protein, dietary fiber and important bio-active components, such as isoflavones. This versatile ingredient provides a good source of iron, B vitamins and potassium. Important bio-active components found naturally in soybeans are being studied in relation to relieving menopausal symptoms, such as hot flashes, maintaining healthy bones, and preventing prostate, breast cancers, and colorectal cancer [9]. The content and profile of bio-active components varies from product to product, depending upon how much soy protein is in the food and how the soy protein is processed.

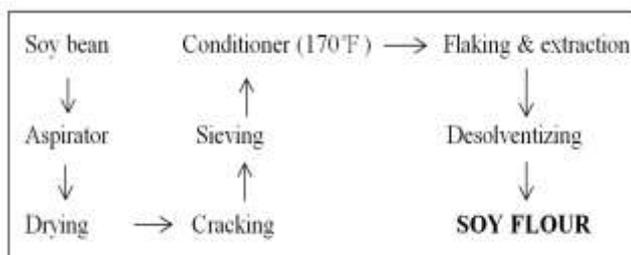


Figure 3. Processing of soy flour

Texturized vegetable protein

Texturized vegetable protein (TVP) may stimulate a ground form of meat or meat flakes; it resembles the texture of meat and is a good source of protein in meatless diets. TVP has prime importance in food industry as well as from the health point of view. TVP is cholesterol free and used worldwide due to quality protein of plant source. Its utilization is also related with religious, cultural and economic issues especially it is popular in vegetarian [10]. Figure 4 shows the processing of textured vegetable protein.

Benefits of texturized vegetable protein

Textured soy protein is at least 50 percent protein. Unflavored textured soy protein is very low in sodium. Textured soy protein is an easy and inexpensive source of dietary fiber, soy protein, and naturally occurring bio-active components, such as isoflavones. Isoflavones are being studied in relationship to relieving menopausal symptoms, such as hot flashes, maintaining healthy bones, and preventing prostate, breast, and colorectal cancers. The content and profile of bio-active components varies from product to product, depending upon how much soy protein is in the food and how the soy protein is processed.

Textured soy protein is a healthy high quality protein source that contains all essential amino acids needed for growth. This high quality protein comes without fat and has no cholesterol and little or no saturated fat. In addition to the quality of soy protein, scientists have found that soy protein may help reduce the risk of heart disease by lowering blood cholesterol and increasing the flexibility of blood vessels [11]. The FDA has approved a health claim stating that “25 grams of soy protein in a daily diet low in saturated fat and cholesterol can help reduce total and LDL cholesterol that is moderately high to high.”

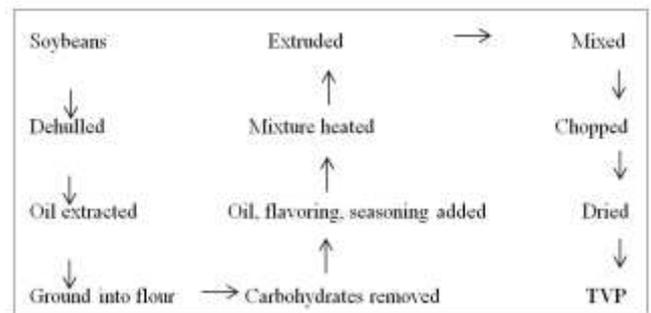


Figure 4. Processing of texturized vegetable protein

Fermented soy products

Tempeh

Tempeh is a soy product originated from Indonesia. It is made from whole soybean seeds which are soaked, dehulled and partly cooked. Spores of *Rhizopus oligosporus*, used as fermenting culture is mixed with seeds. They are spread thinly on tray and allowed to ferment for 24 to 36 hours. They can be cut, soaked in brine or salty sauce and then fried [12].

Soy yoghurt

Yoghurt is a fermented milk product produced from mixed cultures of *Lactobacillus bulgaricus* and *Streptococcus thermophiles*. Soy yoghurt is processed from soybean which is quite cheaper than yoghurt from milk. It is a good source of protein and minerals [13].

Soy sauce:

It is processed by fermenting soybean seeds with two molds of *Aspergillus oryzae* and *Aspergillus sojae* in the presence of salt and water. The fermentation process yields a product called *Maromi* which is pressed to obtain a liquid called soy sauce. Soy sauce prepared from rice or barley is called *Miso* [14, 15].

Industrial products

Soy protein isolates

Soy protein isolates has high protein content of about 90%. It is made of defatted soy meal by removing most of the fats and the carbohydrates [16]. Soy protein isolates are usually combined with other food ingredients such as minerals, vitamins and flavors in preparation of soy protein milk shake powder.

Nutrition highlights of soy protein isolates

Soy isolates are used in coffee whiteners, liquid whipped toppings and pre-whipped toppings. They also are used in sour cream dressings to emulsify fat, control viscosity and provide textural characteristics. Soy protein isolate supplies a high quality of protein that contains all essential amino acids needed for growth. Soy protein isolate is equal in quality to animal products and is almost fat free containing less than 1% fat and unlike animal products contains no cholesterol and little or no saturated fat.

Soybean utilisation

Soybean is used in various forms in different sectors [17]. The utilization of soybeans across various sectors is listed below in figure 5.

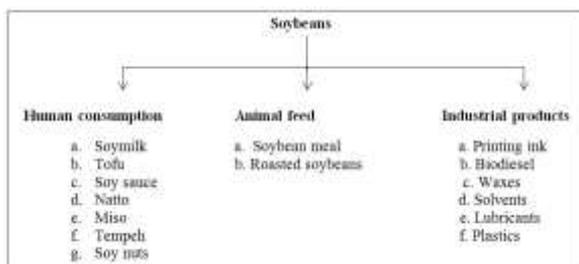


Figure 5. Utilization of soybean

Conclusions

High quality soybeans and soy based foods are preferred. Soybean has proven itself as an excellent nutrient source rich in protein, oil, and other small molecules. The demand for soybean consumption increased as expected in the past decade. Novel technologies to enhance soybean productivity are therefore necessary. The whole soybean genome project was initiated through the DOE JGI Community Sequencing Program and revealed at the end of 2008 (Department of Energy Joint Genome Institute, 2008). In addition to high-yielding varieties selection, this information facilitates many ongoing projects aiming at the genetic manipulation of high yield potential, herbicide resistance, and resistance to pests and diseases. The findings of bioactive compounds within soybean offer fermented soybean products with new applications. Phytoestrogens, especially aglycone isoflavones, can act like the hormone estrogen and have many health-enhancing benefits. Anthocyanin on the seed coat of black soybean is an antioxidant that prevents the blood capillary from the attack of free radicals. These make soybean products very competitive on the functional food market. Apparently, soy foods and soybean products (especially fermented soy foods) exhibit significant contributions to the human welfare. Thus the processing of various soy products was reviewed. Their utilization across various sectors is being discussed.

Conflicts of interest

Authors declare no conflict of interest.

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