

Soybean Nutritional Composition and its Health Benefits: A Review

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Abstract

Soybean (*Glycine max*) has been consumed as a staple food for a long time in many countries due to its low cost and high nutritional value. In present scenario, soybean has received commercial attention due to its high protein, fiber, vitamin, mineral and phytochemical content. Many human clinical and animal based trials have demonstrated the health benefits of soybean in preventing many diseases, which has increased the soybean consumption in many western countries. The present review aims to summarize and highlight the current knowledge regarding the nutritional composition and health benefits of soybean such as (i) coronary heart disease (CHD) (ii) various types of cancers (iii) diabetes mellitus (iv) menopausal symptoms (v) bone health (vi) obesity (vii) cognitive function (viii) skin health. Current review also highlights the different food products (fermented and non-fermented) developed by utilizing soybeans. It is imperative to illuminate the nutritional value and health benefits of soybean as it will promote the utilization of soybean as a functional food in the food industry and will provide the additional evidence for its optimized use for health promotion.

Keywords: Soybean; Health Benefits; Nutritional Value; Phytochemical

Abbreviations

CHD: Coronary Heart Disease; FDA: Food and Drug Administration; HDL: High Density Lipoproteins; LDL: Low Density Lipoproteins; TLC: Therapeutic Lifestyle Changes

Introduction

Now days, as a result of growing understanding regarding health and food sciences, consumers perspective of selecting foods has changed [1]. Nutrition has become the influential factor shaping their preferences and ingredients and their utilization in product development manipulate their food choices. Legumes owing to their superior nutritional profile, functional properties and health benefits, have gained tremendous attention in the public [2]. One such valuable legume is soybean. Soybean is a significant commodity in the world's food supply chain. Its consumption as a legume has a long history in Eastern Asian countries [3]. According to FAO, worldwide soybean production is 253.1 million metric tons whereas South America produces approximately 79% of this total [4]. It can be observed that soybean contains substantial amount of protein, unsaturated fat, vitamins, minerals and also exhibit antioxidant properties due to the presence of isoflavones and other phytosterols [5]. The health effects of soybean consumption have been studied extensively through the animal experimental studies and human clinical trial [6]. It has been found to play an active role in preventing of many chronic diseases [7]. Therefore, enlightening the science-based information on the nutritional composition and health-promoting properties of soybean would be of great importance and can further promote the utilization of soybeans around the world [3].

Soybean nutrients and bioactive compounds

Soybean (*Glycine max*) belongs to the legume family. Soybean has been considered as a miracle bean. Its nutritive virtues were realized over 4000 years ago [8]. Soybean was considered among the five sacred grains including rice, barley, millet and wheat. Soybean has been

regarded as an excellent source of protein. The crude protein in soybean ranges from (35 - 40%) which is highly digestible (92% - 100%), soybean protein is comparable to the animal protein and contains all essential amino acids i.e. leucine, isoleucine, phenylalanine, histidine, tyrosine, tryptophan, threonine, lysine and valine except methionine that are crucial for the functioning of human body [9]. Rizzo and Baroni [7] reported soybean proteins are reliable sources of dietary proteins because of their high- quality essential amino acid balance and high bioavailability. Messina [10] revealed that soybean contains 35 percent carbohydrates, which comprises of oligosaccharides (stachyrose, verbisose and raffinose), which have been found to act as prebiotics. It could be observed that soybean has been found to possess high content of unsaturated fatty acids. From the acquired results it has been revealed major fatty acids present in soybean were oleic acid C18:1, linoleic acid C18:2 and linolenic acid C18:3 which are essential for the human growth and development [11].

Etiosa., *et al.* [12] revealed that soybean is rich in B vitamins i.e. niacin, folic acid, riboflavin, pantothenic acid but it lacks vitamin B12. Soybean is also regarded as a chief source of vitamin A, vitamin D, vitamin C and tocopherols [7]. It has also been found to contain substantial quantities of minerals i.e. calcium, iron, sodium, potassium, phosphate and magnesium [12]. Although soybean contains anti-nutritional factors (phytate and oxalate) which inhibit the mineral absorption but calcium and iron absorption from soybean is quite superior [10].

Samruan and Onsilvai [13] reported that soybean comprises of significant concentration of isoflavones (0.05 - 0.5%) which are genistein and daidzein. Physiological experiments have suggested isoflavones are highly accountable for numerous benefits of soy foods as they exhibit antioxidant and anti-inflammatory properties [10]. Although isoflavones have been considered as key component which impart health benefits, soybean has also been found to possess considerable concentrations of other bioactive components such as protease, phytosterols, saponins and lecithin, which are known as phytochemicals. Due to the presence of these active components, soybean has been regarded as powerhouse of phytochemicals [14].

Potential health benefits of Soybean

Many studies have highlighted the relationship of soybean intake with desirable health outcomes [15]. Soybean and its active constituents have been found to play an active role in the reduction of metabolic disorders (cardiovascular diseases, diabetes and obesity) as well as other diseases i.e. cancer and osteoporosis [16].

Coronary heart diseases protection.

Coronary heart disease (CHD) accounts for 20% of deaths over the worldwide, thus increasing the mortality rates in different countries. Consumption of soybean has been correlated with modest reduction in LDL (low density lipoprotein) cholesterol, triglycerides and subsequent increase in HDL (high density lipoprotein) cholesterol [17]. Soybean protein has been found to decrease the production of lipoprotein A, which is potentially detrimental in anti-atherogenic therapy [18]. Various studies have reported soybean not only lessen the risk of cardiovascular diseases by decreasing the susceptibility of low density lipoproteins to oxidation but also increases the vascular functioning [19]. Lou., *et al.* [20] conducted an analysis of eight studies (three case controls and five cohort) and examined the link between soybean and CHD and suggested a significant relationship between the increased soy foods intake and reduced risk of CHD. In 1999, Food and Drug Administration (FDA) approved the health claim for food labels, which stated that 25g/day intake of soybean reduces the risk of cardiovascular diseases.

Anti-cancer properties

Numerous researches have been conducted to investigate the anti-carcinogenic properties of soybean and suggested that the regular consumption of soybean has been associated with the lessened risk of cancer [17]. An analysis of eight studies (seven case controls and one cohort) conducted on Asians consuming high soy based foods showed a significant relationship between the increased intake of soy foods and reduced risk of cancer [21]. A review was conducted on 26 animal studies in order to determine the effect of soybean on various types of cancers, 17 out of the 26 studies revealed the preventive action of soybean on hormone and non-hormone dependent cancers [22]. Several lines of evidence suggested that soybean isoflavones (genistein and daidzein) possess anti-oxidant properties and have been

found reduce the risk of breast, stomach, lung, colon and prostate cancer [23]. Apart from isoflavones, some other phytochemicals such as phytates, phytosterols and saponins present in soybean have also been found to exhibit anti- carcinogenic activity [17].

Type 2 diabetes prevention

Soybean has been found to possess low glycemic index and improves the blood glucose tolerance [24]. Soybean plays an important role in diabetes due to the presence of glycine and arginine, which tend to regulate blood insulin levels. Soluble fiber present in soybean also exerts insulin moderating effect and improves the plasma glucose concentrations in diabetic patients [25,26]. Epidemiological studies revealed that soybean protein reduces the rate of renal hyper filtration, thereby reduces the risk of renal disease in diabetic patients [27]. Bhatena and Velasquez [28] conducted a study on postmenopausal women and found significant correlation between the soybean consumption and low fasting insulin levels, suggesting the protective role of soybean in maintaining the normal blood glucose concentrations.

Menopausal symptoms

Epidemiological data have pointed out the relationship between soy food intake and menopause [29,30]. Studies support the evidence on reduced severity and frequency of hot flashes in menopausal women by soy foods [31,32]. In a study, sixty healthy postmenopausal women were randomized in a crossover design to a therapeutic lifestyle changes (TLC) diet alone and a TLC diet of similar energy, fat, and protein content in which one-half cup soy nuts divided into three or four portions spaced throughout the day, after 8-week diet period, subjects filled out the menopausal symptom quality of life questionnaire and revealed that consumption of soy nuts throughout the day was associated with the decrease in hot flashes and improvement in menopausal symptoms [33]. The utilization of soybean phytoestrogen supplements as a substitute to hormone therapy among women has also recently gained attention [34].

Bone health

Considerable evidence revealed isoflavones present in soybean have been found to inhibit the rate of bone loss in women which is related with the onset of menopause [35,36] and many studies have supported the evidence that soy intake is positively correlated with the subsequent increase in the bone mineral density [37]. A meta-analysis was conducted on the randomized control trials and it was revealed that utilization of soy isoflavones among the menopausal women notably alleviated the resorption turnover through bone markers and also improved the bone mineral density [38]. Soybean also possesses high quality protein which play a critical role in the maintenance of the bone health [39,40].

Obesity

Obesity has been found to be a major public health problem and contributes to premature mortality in adults [41]. Bhatena and Velasquez [28] reported that increased intake of soybean is positively interrelated with low body mass index. Several lines of evidence suggested that usual consumption of soybean results in reduced fat mass and body weight as it regulates the process of adipogenesis, thus decreasing the activity of lipoprotein lipase [6]. Allison, *et al.* [42] studied the safety and efficiency of low-calorie diet based on soybean for the treatment of obese individuals and revealed that soybean based diet stimulated a higher weight loss than the animal protein based diet. Another research work was carried out to evaluate the benefits of soybean on the human health; results demonstrated that soybean consumption had a favorable effect on reduction of the appetite when compared to the egg protein [43].

Cognitive function

Several researches have supported the association between cognitive function and soybean isoflavones [44]. Tang [26] revealed that soybean plays beneficial role in the prevention of Alzheimer's disease and leads to improved cognitive functioning in all age groups. Preliminary findings from a previous study enrolling cognitive healthy older adults found that treatment with soy isoflavones was associated with improved performance across several cognitive domains, including nonverbal memory, construction, verbal fluency, and speeded dexterity compared to treatment with placebo [45]. An analysis of ten randomized control trials which included 1024 participants revealed that consumption of soy isoflavones favorably improved the visual memory and cognitive functioning in postmenopausal women [32]. Farzana and Mohajan [46] revealed soybean also increases memory power, physical abilities and level of hemoglobin in children.

Skin health

Preliminary data exists on the impact of soybean intake on skin health. Soybean oil is rich source of linoleic acid, a polyunsaturated fatty acid, which has been found to offer antioxidant properties, that are useful in maintain healthy skin. Soybean has also positive research support for its antioxidant properties which increase its potential to reduce photoaging which occurs as the result of chronic sun exposure [47]. Considerable evidence suggested that soy isoflavones reduces the wrinkles and improves the skin quality. A comparative study was conducted on twenty postmenopausal women and results indicated that inclusion of soy isoflavones in usual diet for three months significantly improved the discoloration, facial-wrinkling and overall appearance of the skin [10].

Soybean utilization in food industry

For many years, extensive varieties of food products have been processed from soybean [17]. Several published articles indicated soybean has been used as whole, grounded into paste, milled into flour, powder and oil is produced from the beans. Soy oil makes the large proportion of edible vegetable oil [48] and soy powder has been utilized in many nutritional beverages [22]. Guzeler and Yildirim [48] revealed that traditional soy foods are divided into two categories i.e. fermented and non fermented soy products. Fermented soy products include tempeh, soy sauce, miso and natto that involves the utilization of fermented soy beans. Tempeh serves as a substitute for meat in vegetarian diet whereas miso is used as flavoring agent and base for the soups [49]. Non-fermented soy products include dry soybeans, soy sprouts, soy nuts, soy milk and tofu [7]. Jooyandeh [49] reported tofu also known as soybean curd has been regarded as a significant source of proteins, isoflavones and calcium (128 mg/100g).

Now a days, soy based dairy products i.e. (soy milk, tofu soy frozen desserts and soy cream cheese) have gained public attention due to their noticeable attributes as they are free from milk protein and lactose and are considerable sources of protein, B-vitamins, minerals, dietary fiber and bioactive components i.e. isoflavones. In western countries, the consumption of soy milk has replaced the cow's milk due to the increased lactose intolerance. Soy formulas have been suggested for the infants suffering from lactose intolerance, cow's milk allergy and galactosemia [17]. Soybean has also been utilized in many baked goods i.e. breads, cookies, muffins, biscuits. In bakery products, incorporation of soy can be a useful strategy to promote the consumption of protein, fiber, micronutrients and antioxidants in the diet. New formulations could therefore be tested with an aim to develop food supplemented with higher proportion of soybean flour as a functional ingredient [50].

Conclusion

Soybean has evolved as a promising food because of its rich content of essential amino acids, fiber and bioactive metabolites and low carbohydrate content. Decades of investigation and research work have discovered the health promoting aspects of soybean including prevention of metabolic syndrome, cardiovascular diseases, several kinds of cancers, osteoporosis and other diseases. Important components of soybean which play a potential role in promoting the health benefits of soybean are soy phytochemicals. It is essential to study the mechanism of action by which these phytochemicals work in order to fully utilize their health benefits. Existing literature have suggested that soybean would be a valuable candidate for utilization in food industry. Its protein content is comparable to animal sources, due to which it can replace many animal based foods in the diet. Therefore, it can be concluded that, promoting the consumption of soybean and its by-products can play an imperative role in fighting and preventing many diseases and malnutrition problem emerging in developing countries and would be a significant step to be taken towards healthy society.

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