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Potential Health benefits of Soybean and its value addition: A review

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Abstract
Soybean is one of the most crucial legume crops it is nutritionally rich in protein, carbohydrates, calcium, magnesium, fat and energy. It has prominent health benefits such as it helps in dealing with ailments such as diabetes, obesity, inflammation, oxidative stress, cancerous disease, osteoporosis, cardiovascular diseases etc. Soybean after value added could be utilised from food, feed to fuel industries. It is a magnificent source of protein and its protein extract are also being used. It is gluten free and can be a good alternative to the people with celiac disease. Soy sauce, soy milk, soy flour, meat alternatives, soy oil and biodiesel from soybean are produced in our country. This review focuses on the potential health benefits of soybean and its value addition.

Keywords: soybean, nutrition, value addition, health benefits

Introduction
The soybean (Glycine max) crop is the world's most important source of oil, both nutritionally and commercially (Singh *et al*., 2019) [31]. According to predictions, by 2050, there will be nine billion people on the planet, who would need 333.674 million tonnes of food (Alexandratos & Bruinsma, 2012) [1] In addition to its many industrial applications, soybeans play a vital part in animal feed (Singh & Kumar, 2019) [30]. The demand for its grain will continue to rise in the future (Silva *et al*., 2017) [29]. About 35 countries commercially farm soybean as their primary oilseed crop. Soybean has been referred to as "field meat" since ancient times. Advantages that go beyond the typical nutrients they provide" or Foods having significant amounts of physiologically active soybean primarily contain lipid and protein. In addition to having a low saturated fat content and being a great source of vitamin nutrition, soybean oil is also rich in elements that have additional health benefits (Jooyandeh, 2019) [14] The majority of people want to consume a healthy diet E without substantially altering their dietary habits, the quantity of saturated fat in soybean is approximately 15%. Refusal of the customer to alter dietary practises shows that the levels of poly- and mono-unsaturated fats are 61 and 24%, respectively. Since soy has a significant amount of isoflavonoids and folic acid, it is utilised all over the world as part of a healthy diet. Because soybean and its products contain a significant number of necessary amino acids and have numerous positive effects on human health, they are regarded as significant sources of plant protein (Kamshybayeva *et al.*, 2017) [16]. From a nutraceutical standpoint, soybean's polyunsaturated fatty acid and quality fat content is also crucial. In other words, aside from the fact that there is a large market potential for foods with altered nutritional characteristics that give omega-6 fatty acids, soybeans are among the nutritional attributes, but unmodified sensory few plant foods that supply omega-3 fat á-linolenic acids. features (Jooyandeh, 2011) [14]. Functional meals should be consumed as Soybean protein contains a variety of essential amino acids that are consumed daily. There are times when one or more have a nice balance. The quality of soy proteins allows for the addition of substances that improve health on par with animal protein sources like milk and provide advantages over those provided by conventional meals (beef). The soybean plant (Glycine max) is a suitable supplement because of the high lysine content of soy protein. Soybean is generally valued based on the dry weight of ripe raw seeds. consists of about 35 and 40 percent protein, 20 percent fats, 9 percent dietary fibre, and about 8.5 percent moisture (He &Chen, 2013) [11]. This composition changes depending on where you are. The planting climate and the soybean cultivar both affects the production. Traditional soy foods, those manufactured from absorption, although soy flour can minimise fat absorption in whole soybeans, are often separated into two subbing doughnuts and other deep-fat fried goods, the

non-fermented and fermented food kinds of soy formation and stability of fermented soy products with protein content. traditional soy is unfermented emulsions are very dependent on mixing energy input. Among the foods are soy milk, fresh green soybeans, entire dry beans, soy nuts, soy sprouts, whole-fat soy flour, and the production of food emulsions, particularly very viscous tofu (Gandhi, 2009) [9]. Foods made from soy are a great source of vitamins, minerals, proteins, fibre, and are also low in saturated fat. There are many different types of soy products that have been produced, including tofu, roasted soybeans, boiling soybeans, soymilk, soy mayonnaise, miso, soy cheese, soy yoghurt, tempeh, soy sauce, and tamari (Jatachandran & Xu, 2019) [13].

Table 1: Nutritional composition of soybean

Category	Range	Sources
Moisture (%)	8.07-8.59	Elden, 2009; He&Chen, 2013
Ash (%)	4.9-4.29	Etiosa *et al.*, 2017
Protein (g/100g)	36.5-40	Sindelar, 2014
Fiber (%)	5.44-9.3	Abebaw, G. 2021
Fat (%)	19.9-28.20	Etiosa *et al.*, 2017; Elden, 2009
SFA (Saturated fatty acid)	2.9	Hossein Jooyandeh, 2011; Elden, 2009
USA (Unsaturated fatty acid)	15.7	Hossein Jooyandeh, 2011; Elden, 2009
Carbohydrates (%)	30.2	Elden, 2009
Mg (mg/100g)	258.84-280	Hossein Jooyandeh, 2011; Abebaw, G. 2021
Ca (mg/100g)	277-300.36	He&Chen, 2013
Fe (mg/g)	15.7-16.4	Elden, 2009
Energy (kcal)	416-469.80	Etiosa *et al.*, 2017; Hossein Jooyandeh, 2011

It is important to analyse the nutritional composition of Soybean as it ensures the exact composition of carbohydrates, fats, proteins, vitamins and minerals etc. The adequate nutritional value of food helps in fulfilling the regulatory requirements set by national and international agencies. The moisture % of Soybean varies in between 8.07-8.59%, ash 4.9-4.29%, protein ranges from 36.5-40 g/100g, fiber 5.44-9.3%, saturated fatty acid 2.9% whereas the unsaturated fatty acids are 15.7%, carbohydrates 30.2, the nutrients such as Ca, Mg and Fe are present in significant amounts such as 277-300 mg/100g, 258.84-280 mg/100g, Fe 15.7-16.4 mg/100g. The energy value ranges from 416-469 kcal/100g as depicted in Table 1.

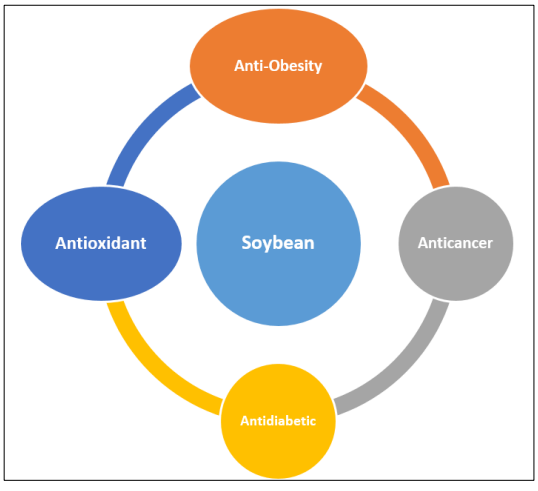

Fig 1: Show the Soybean varies in between

Antioxidant effects

Soy milk is an essential soy product that has been shown through scientific trials to reduce oxidative stress in Type 2 Diabetes Mellitus (T2DM). The results of the investigation demonstrated that fermented soy milk is advantageous for reducing oxidative stress in T2DM and for regulating levels of the total antioxidant, oxidised glutathione, 8-isoprostaglandin F_2, glutathione peroxidase, malondialdehyde, and reduced glutathione (GSH) (Miraghajani *et al.*, 2017) [22] The development of fermented soy meals with high nutritional contents and effective biological activities has also been studied. ABTS [2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid), DPPH, and hydroxyl radicals], as well as changes in the nutritional components (fatty acids, isoflavones, and amino acids) and antioxidant capacity of fermented soybean, were reported by Lee *et al*. Additionally, differences in total phenolic contents, -glucosidase effects, and glucosidase inhibitory activity were also investigated.

Antiobesity effects

Soy meals contain isoflavones, which likely combine with intracellular oestrogen receptors to reduce fat formation and adipose tissue distribution. Numerous research has demonstrated how soy meals and its components have an anti-obesity effect. Because of their structural similarity to 17-estradiol (E2), soy isoflavones and their derivatives have been shown to have estrogenic effects and a high affinity for binding to oestrogen receptors. Adipose tissues, which play a significant role in the control of metabolism and the distribution of lipids or fat, express oestrogen receptors together with other types of cells and organs (Pallottini *et al.*, 2008) [25].

Antidiabetic effects

It has been observed that soy products high in isoflavonoids have an anti-diabetic effect. Soybean extract has also been proven to be effective in preventing the absorption of glucose. into vesicles in the brush boundary membrane (Bhathena & Velasquez, 2002) [4]. There are several phytocompound-derived diets available for the treatment of diabetes. One of these, soybeans and soy products, has demonstrated notable efficacy in the prevention of DM (Jayachandran & Xu, 2019) [13]. Dietary soy has proven to be crucial and has had a major influence on people with chronic renal disease. Most frequently, severe renal disorders and diabetes mellitus are linked. Glomerular Filter Rate (GFR) and proteinuria are decreased when soy proteins are substituted for animal proteins in type 1 diabetes.

Anticancer effects

Soy has also showed potential in lowering the risk of several types of cancer (Banerjee *et al.*, 2008) [3], with breast and prostate cancers being of particular relevance due to their sensitivity to sex steroid hormones. The isoflavones are responsible for soy's ability to prevent cancer. It has been revealed that many modes of action might be in charge. It has been demonstrated that isoflavones have an impact on cell signalling, the cell cycle, apoptosis, differentiation, proliferation, and growth**.** It has been observed that the usage of soy isoflavones reduces the risk markers of cardiovascular disease in men (Sathyapalan *et al.*, 2017) [27], and that they assist improve cardiovascular disease risk markers in women during the early menopause (Sathyapalan *et al.*, 2018) [28].

Value added products from soybean

Value addition refers to the process of enhancing the value or utility of a product or service by incorporating additional features, improvements, or modifications that increase its appeal, usefulness, or desirability to customers. It involves transforming raw materials or basic products into higher-value offerings through various means such as customization, differentiation, improved quality, added functionality, or enhanced packaging. The value added products made from soybean are such as soybean oil, soy milk, tofu, tempeh, natto, soy sauce, soy flour, soynut butter, vodka, biodiesel, okara.

Soy flour

It is made by separating soybean seeds, soaking them in sodium bicarbonate for 12 hours, boiling them for 45 minutes, sun drying them, milling and sifting them, storing and packing them (Odiase *et al.*, 2013) [24]. Soy flour has some advantageous effects on bread dough, including raising the protein content, improving the dough's ability to absorb water, and enhancing crispiness. While baking, soy proteins bonded any free moisture, extending the shelf life of bread. Additionally, they enhanced the bread's interior structure, elasticity, and crust forming characteristics**.** It is utilised in the preparation of pasta, bread spaghetti etc.

Soybean oil

Soybean oil is a highly refined edible oil that can be used to make paints, varnishes, soap, lubricants, sealants, and medicinal oil (Amusat and Ademola, 2013) [2]. Soybean oil is used to make metal coating, ink, anticorrosion compounds, cement components, building supplies, concrete additives, care oils, disinfectants, dust control agents and electrical insulation. Aside from these items, soybean oil is also used to make resin, plastic, paint, varnish, mineral oils, confectionary items, mayonnaise, salad dressings, shortening, imitation chocolate, coffee whiteners, creams, imitation cheese, and frozen desserts (Hammond *et al*., 2005) [12] The average fatty acids content of soybean oil was found to be 11.2360±0.2026% palmitic acid, 3.5585±0.1062% stearic acid, 25.0220±0.8715% oleic acid, 54.4415±0.6809% linoleic acid and 5.7088±0.3192% linolenic acid. The best source of tocopherol, Vitamin E, fatty acids, and nutraceuticals is said to be soybean oil. As an antioxidant and a cholesterol-lowering agent, it is also significant in terms of medicine (Khamar and Jasrai, 2015) [19].

Soy Milk

This milk is made from soybeans that has a high nutritional value. It doesn't contain of caffeine, gluten, and lactose. It contains very little fat but a lot of protein and omega-3 fatty acids. It has a creamy texture and a flavour that is similar to hazelnut. Calcium, phosphorus, and ferrous are among the minerals found in soy milk at levels higher than those found in cow's milk. In various processes, it can be used in place of cow milk. However, some users are negatively impacted by the bean taste and flavour. There are flavoured soy milk varieties available for these customers (Kesenkaş *et al*, 2013; Kesenkaş *et al.*, 2011) [17, 18]

Tofu

Tofu, also known as soybean curd, is a high-protein product that is popular in Asian nations, particularly among vegetarians. It is made by flattening and pressing the curd to remove whey after heated soymilk has been subjected to protein coagulation using food-grade chemicals such calcium chloride, magnesium chloride, magnesium sulphate, calcium sulphate, acetic acid, and citric acid. It is stated that a high yield of tofu is obtained when magnesium sulphate is used for coagulation. Tofu has 23.8% total solids, 15.4% protein, 9% fat, 62 mg of calcium per 100 grammes, and 580 mg of phosphorus per 100 grammes, g. The factors that contributes to the quality of tofu are the water to soybean ratio, the soaking time and temperature of the soybeans, the grinding processing, heat processing and the heating rate, the stirring speed at various points in the process, the coagulation temperature, the type and concentration of the coagulants, method of adding the coagulant to the soymilk, and the weight and time of press of the curds (Jubayer *et al.*, 2013) [15]

Natto

It's a traditional Japanese meal made by fermenting soybeans with Bacillus subtillis natto, a Gramme positive spore-forming bacteria. This stuff smells strongly like strong cheeses. Natto is a fermented substance with functional properties. The extracts that it produces are known to include nattokinase, a fibrinolytic enzyme four times stronger than plasmin. After fermentation, natto contains additional beneficial components such as polyglutamic acid and dipicolinic acid. Dried natto has a nitrogen-free extract of 13.4%, a crude protein content of 41.9%, a moisture content of 5.7%, an ether extract of 21.3%, a crude fibre content of 10.5%, and a gross energy content of 5.631 cal/g (Fujiwara *et al*., 2008a; Fujiwara *et al*., 2008b; He and Chen, 2013) [7, 8, 11]

Soy sauce

It is a light brown to black liquid with a fleshy, salty flavour that is made through two phases of fermentation from soybeans with or without wheat. Soy sauces are referred to as "Meju" in Korea and "Koji" in Japan. Fermented soybeans were used to make soy sauce. Soybeans are cleansed with water before being used to make traditional Meju. They were cooked at air pressure for 2 hours. Soybeans that have been cooked are crushed and fashioned into bricks. They are sun dried for two days before being hung up with rice straw and fermented for 60 days. The acquired menu, sun dried salt, and distilled water are then combined in a 1:2.24:5.6 ratio to produce soy sauce (Park *et al*., 2010) [26]

Vodka

There are various vodka varieties made from potatoes, rice, or wheat. However, there is one well-known vodka brand that creates vodka from soybeans. Consumers believe it is chosen because to its beneficial health impacts (Musonera & Hemley, 2008) [23]. Soybean vodka is made from distilled soy with caffeine, taurine, and guarana added. In contrast to many other spirits, it is stated to have a sweet and smooth taste with fresh and genuine fruit flavours.

Biodiesel

Canola, soybean, and safflower oils are used to make biodiesels for commercial uses. Soybean is used for biodiesel manufacturing, particularly in the United States (Çengelci *et al.*, 2011) [5]. Soybean biodiesel is traditionally produced in two stages: oil extraction and biodiesel conversion. Mechanical presses, solvent extraction, supercritical fluid extraction, and microwave- and ultrasound-assisted solvent

extractions are used to extract oil from soybeans. Transesterification is used to convert the extracted oil to biodiesel once it has been degummed. Transesterification is a chemical reaction in which oil is mixed with alcohol in the presence of a catalyst to generate fatty esters and glycerol (Koç *et al.*, 2011) [20].

Conclusion

Soybean (Glycine max) has emerged as one of the most crucial crops in global agriculture due to its diverse range of applications in various sectors. This paper aims to explore the value addition provided by soybean cultivation, highlighting its significant contributions to the food, feed, and industrial sectors. In the food industry, soybean offers immense nutritional value and versatility. The crop is a rich source of high-quality protein, containing all the essential amino acids necessary for human health. Soybean-derived products such as tofu, tempeh, soy milk, and soy flour are widely consumed, especially in regions with a vegetarian or vegan population. Additionally, soybean oil is a commonly used cooking oil worldwide, valued for its high unsaturated fatty acid content and its potential health benefits.

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