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Soy Products as Healthy and Functional Foods

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Abstract: Over the recent decades, researchers have documented the health benefits of soy protein, especially for those who take soy protein daily. Soy products offer a considerable appeal for a growing segment of consumers with certain dietary and health concerns. It is quite evident that soy products do reduce the risks of developing various age-related chronic diseases and epidemiologic data strongly suggest that populations that regularly consume soy products have reduced incidence and prevalence of the aforementioned age-related conditions and diseases than populations that eat very little soy. The subject of what specific components is responsible for the plethora of reported health benefits of soybean remains a strong controversial issue, as the scientific community continues to understand what component(s) in soy is /are responsible for its health benefits. Soy constituents' benefits mostly relate to the reduction of cholesterol levels and menopause symptoms and the reduction of the risk for several chronic diseases such as cancer, heart disease and osteoporosis. A variety of soy products are available on the market with different flavors and textures and a low-fat, nutritionally balanced diet can be developed from them. This article summarized the beneficial health, nutritional and functional properties of the soy ingredients and intends to illustrate the most current knowledge with a consciousness to motivate further research to optimize their favorable effects.

Key words: Soybean · Functional foods · Health benefits · Isoflavones

INTRODUCTION

The concept of functional foods has evolved as the role of food in the maintenance of health and well-being and in the prevention of disease has received increased scientific and commercial interest. Functional foods can be defined as "food products that provide specific health benefits beyond the traditional nutrients they contain" or foods containing significant levels of biologically active components that impart health benefits beyond basic nutrition [1]. Most people would like to eat a healthier diet without fundamentally changing their eating patterns. The refusal of the consumer to change dietary habits suggests that there is a great market potential for foods with altered nutritional characteristics, but unchanged sensory attributes [2]. Functional foods are meant to be eaten as part of the regular diet. In some cases, one or more additional ingredients are added that impart health benefits above and beyond those of regular food [3].

The soybean plant (*Glycine max*) belongs to the legume family. On average, dry soybean contains roughly 40% protein, 20% oil, 35% soluble (sucrose, raffinose, stachyose, etc.) and insoluble (dietary fiber) carbohydrate and 5% ash. Fresh soybean has approximately 14% moisture [4]. Humans can easily digest soy protein products. About 92-100% of soy protein is digestible in humans [5].

Soybean is called meat of the field from ancient time. Lipid and protein are the two major components in soybean. Soybean oil is low in saturated fat, rich in the essential fatty acids and is an excellent source of vitamin E. The amount of saturated fat in soybean is about 15%, while amounts of poly-and mono-unsaturated fats are 61 and 24%, respectively. In other word, besides to providing omega-6 fatty acids, soybeans are among the few plant foods that provide omega-3 fat á-linolenic acids.

The protein content of soybean has rich amino acids with a good balance. The quality of soybean proteins is comparable to that of animal proteins sources like milk and beef. The high lysine content of soy protein makes it a good complement to cereal proteins, which are low in lysine. Recent studies also indicated that the lower

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Table 1: Physiologically functional substances in soybeans [7]

Components in soybeans	Physiological functions
Soybean proteins	Reduction of serum cholesterol, prevention of cardiovascular diseases, reduction of body fat and promotion of serum insulin
Peptide from proteins	Antioxidant activities, inhibition of angiotensin-converting enzymes and promoting action of phagosytosis
Isoflavones	Anti-carcinogenetic activities, prevention of cardiovascular diseases, prevention of osteoporosis, antioxidant activities and alleviation of menopausal symptoms
Saponins	Anticarcinogenic activities, hypocholesterolemic effects, inhibition of platelet aggregation, HIV preventing effects and antioxidant activities
Phytosterol	Anti-carcinogenic activities
Phytic acid	Anti-carcinogenic activities
Lectin (Hemagglutinin)	Activation of lymphocytes (T cell) and aggregating action of tumor cells
Nicotianamine	Inhibitor of angiotensin-converting enzyme
Protease inhibitors	Anti-carcinogenic activities

amount of methionine in soybean proteins compared with casein may contribute to the selective retardation of tumors (rat was used) [6]. Soy protein mainly consists of β-conglycinin (7S globulin) and glycinin (11S globulin). The amino acid profile and structure of these two main proteins concern much with the physicochemical functions, including emulsification, foaming, gelation and water and fat binding abilities. The physiological functions of major soybean proteins and minor components are shown in table 1.

With the economic development of economy in the world, chronic diseases, such as osteoporosis, cardiovascular diseases are becoming more and more popular to us. Food custom involves much with this kind of disease. Soy protein represents a safe, viable and practical non-pharmacological approach to lowering cholesterol. The most interesting thing about the physiological function of soybean is that many minor components that were considered as anti-nutrient factor, now are thought to have preventing effect on cancer. These components include isoflavones, saponins, trypsin inhibitors, phytic acid, etc. Among these, isoflavones (mainly genistein and daidzein) are becoming one of the hotspots of functional food research because soybean is the only significant dietary source of these compounds.

Soy Isoflavones: Soy protein products contain bioactive molecules called phytoestrogens or isoflavones. The 3 major isoflavones found in soybeans are genistein, daidzein and glycitein. Their abundance in soy protein preparations and their related products varies widely and depends on the processing techniques used during production [8, 9]. Dehulling, flaking and defatting soybeans produces a relatively pure preparation of protein that is low in isoflavones [10], whereas methods used to produce textured soy protein result in a preparation that retains the isoflavones [8]. Isoflavone concentrations range from 2 mg/g protein in textured soy protein, soy flour and soy granules to 0.6 to 1.0 mg/g protein in isolated soy protein [11]. Soy protein concentrate, depending on how a product is processed, may or may not contain significant amounts of isoflavones. Alcohol-extracted soy protein and soy products contain less isoflavone content compared to water-washed concentrates. Typically, soy sauce and soy oil do not contain isoflavones, but soy flour has very high concentrations followed by soy milk, tofu, tempeh and miso [12].

Isoflavones may reduce the risk of a number of cancers, including those of the breast, lung, colon, rectum, stomach and prostate. While it appears that daidzein is more bioavailable than genistein, most of the research interest in the anticancer effects of soybean isoflavones has centered on genistein [5, 13]. Genistein is thought to act against cancer in several ways: by interfering with cancer promoting enzymes, by blocking the activity of hormones in the body and even by interfering with the process by which tumors receive nutrients and oxygen [13].

Health Benefits of Soy Consumption: Although soy foods have been consumed for more than 1000 years, only in the past two decades have they made an in road into Western cultures and diets [14]. Today, the most notable attributes of soybeans is their health benefits linked to the prevention and treatment of many chronic diseases owing to their protein and isoflavone activities [15]. Regular consumption of soy products reduces one’s risk for chronic diseases such as cancer, heart disease and stroke. Soy foods can provide the body with beneficial agents including vitamins, minerals, fiber and flavonoids. Numerous clinical trials have investigated the potential of soy to protect against risk of chronic disease.

Heart Disease: Isoflavones may play a greater role in improving vascular functions than in reducing cholesterol [16]. Isoflavones resemble estradiol structurally but bind preferentially to estrogen receptors (ERs) that is present in the vasculature and may resemble the behavior of selective ERs modulators [17]. Summarily, consumption of soy protein has been associated with reducing arterial stiffness, decreasing the susceptibility of LDL cholesterol to oxidation, lowering total and LDL cholesterol and increasing HDL cholesterol, possibly reducing the risk of coronary artery disease [18].

Cancer: Numerous studies have investigated the anti-carcinogenic properties of soy. It has been suggested that the isoflavones genistein and daidzein may decrease the amount and size of cancer tumors [18]. Regular consumption of soy protein by healthy adult populations has been associated with a reduction in risk of both breast and prostate cancer. Clinical studies suggested that soy phytoestrogens stimulate epithelial cell proliferation in breasts of premenopausal women, a potential precursor of cancer [19-21]. Furthermore, soy isoflavones have estrogenic, antiandrogenic and other activities that could prevent prostate cancer or slow its progression.

Osteoporosis: Osteoporosis causes bones to become overly porous and brittle from the loss of calcium and other minerals. It progresses without any symptoms, that is, until irreversible pain, loss of height and bone fractures occur. Soy foods may help prevent and treat osteoporosis. Due to the similarity in the structures of the isoflavones and estrogen, several studies are investigating the ability of isoflavones to reduce the rapid rate of bone loss that is associated with the onset of menopause [5, 11, 19, 21]. The isoflavones daidzein and genistein, found in significant amounts only in soybean and soy foods, may directly inhibit bone resorption [22, 23]. Epidemiological evidence has shown that Asian women who consume the highest levels of soy protein have elevated bone mineral density [24].

With the calcium, soy is easily absorbed by the body. Soy foods may play other roles in protecting bone health [25]. A study conducted by Erdman and Potter [26] found that, after 6 months, consuming 40 of isolated soy protein per day significantly increased both mineral content and density in the lumbar spine. Fortified soy milk made with calcium salt is a good source of calcium.

Diabetes: Legumes, especially soybeans, have a very low glycemic index and are valuable foods to include in a diabetic diet. Regular consumption of soy protein may help to reduce symptoms associated with Type 2 Diabetes. Soy has been shown to decrease postprandial hyperglycemia, improve glucose tolerance and decrease amounts of glycosylated hemoglobin [27].

Obesity: Obesity is a disorder of energy balance and is associated with hyperinsulinemia, insulin resistance and abnormalities in lipid metabolism and it is one of the most important risk factors in the development of Type II diabetes, cardiovascular disease, atherosclerosis and certain cancers. Adipocytes play a central role in lipid homeostasis. These cells store energy in the form of triglycerides during periods of nutritional abundance and release it as free fatty acids in times of nutritional deprivation. Excess fat consumption can stimulate enlargement of existing adipocytes and induce differentiation of dormant preadipocytes in the adipose tissue into mature adipocytes to accommodate the demand for extra storage [28]. Several transcription factors have been identified as important regulators of the differentiation pattern of gene expression and the lipid content of fat cells. Hormones, including estrogen, growth hormone, thyroid hormone, catecholamines, glucagons, insulin and insulin-like growth factor are regulators of adipogenesis [29]. 17β-estradiol, the most ubiquitous estrogen, is a major regulator of adipocyte development and adipocyte number in females and males [30]. As a result of isoflavones structural similarities to endogenous estrogens, isoflavones elicit weak estrogenic effects by competing with 17β-estradiol for binding to the intranuclear ERs and exert estrogenic or antiestrogenic effects in various tissues [31]. Bhathena and Velasquez [27] in a study on postmenopausal women found a favorable association between usual consumption of soy protein and a lower body mass index, higher HDL cholesterol concentration and lower fasting insulin levels.

Cognitive Functions: Recent studies suggest that soy isoflavones can activate estrogen receptor β [32, 33] prevalent in both the hippocampus and frontal cortex of the brain [34-37] and alter metabolism in these areas [38]. Isoflavones can also increase choline acetyltransferase and mRNA levels of neurotrophins in the hippocampus and frontal cortex [39]. In humans, the hippocampus and surrounding cortex play vital roles in explicit encoding and consolidation of verbal and visual-spatial memories [40, 41]. The frontal cortex is important for working memory [42], inhibiting irrelevant information [43] and other cognitive executive functions [44].

Table 2: Functional Properties of Soy Protein Products in Food [45]

Funtional property	Mode of action	Food system used	Product[b]
Solubility	Protein solvation, pH dependent	Beverages	F,C,I,H
Water absorption and binding	Hydrogen-bonding of water, entrapment water (no drip)	Meats, sausages, breads, cakes	F,C
Viscosity	Thickening, water binding	Soups, gravies	F,C,I
Gelation	Protein matrix formation and setting	Meats, curds, cheeses	C,I
Cohesion-adhesion	Protein acts as an adhesive	Meats, sausages, baked goods, pasta products	F.C.I
Elasticity	Disulfide links in deformable gels	Meats, bakery items	I
Emulsification	Formation and stabilization of fat emulsions	Sausages, bologna, soups, cakes	F,C.I
Fat absorption	Binding of free fat	Meats, sausages, doughnuts	F,C,I
Flavor-binding	Adsoprtion, entrapment,	Simulated meats, bakery items	C,I,H
Foaming	Forms film to entrap gas	Whipped toppings, chiffon desserts, angel cakes	I,W,H
Color control	Bleaching (lipoxygenase)	Breads	F

[b]Abbreviations: F,C,I,H and W denote soy flour, concentrate, isolate, hydrolyzate and soy whey, respectively.

Functionality of Soy Protein Ingredients: Increased acceptance of soy proteins is due to supreme qualities like good functional properties in food applications, high nutritional quality, abundance, availability and low cost. Various processing treatments can alter the characteristics of soy protein products. These treatments can involve the use of enzymes, solvents, heat, fractionation and pH adjustment, or a combination of these treatments. It is essential to know the fundamental properties of proteins in order to understand the basis of their functionality and to understand how proteins can be modified to acquire needed functions for potential applications. Soybeans are an abundant source of proteins that have been recognized for excellent functional properties in food (Table 2).

The ability of protein to aid the formation and stabilization of emulsion is critical for many applications in chopped, comminuted meats, cake batters, coffee whiteners, milks, mayonnaise, salad dressings and frozen desserts [46]. The physical properties of meat, poultry, seafood, eggs and dairy products are also closely related to their protein composition. Successful incorporation of soy proteins into these traditional food products usually requires that the protein ingredient exhibit properties in the food product similar to those of the protein being supplemented or replaced. Flours, concentrates and isolates bind 1 to 6 grams of water per gram of protein. Normally, isolates and concentrates are desired for fat absorption, although soy flour can reduce fat absorption in doughnuts and other deep-fat fried products [47].

Formation and stability of protein-based food emulsions depend very much on mixing energy input. In general, both the process and the equipment used in making food emulsions, particularly very viscous emulsions, exert major influences on the emulsion's properties. Functional properties are not only important in determining the quality of the final product, but also in facilitating processing; for example, improved machinability of cookie dough or processed meat slicing [48].

Texturised Soy Protein: It is made wholly from either defatted soy meal flakes or soy protein concentrates. Base on desired protein requirements and other attributes of the final product, an isolate or concentrate may be selected. Textured protein products are produced in a variety of shapes, sizes and colors. These products can also be flavored to resemble the meat or poultry product which they may replace [48]. Their structure and texture can be modified by varying the extrusion mix. They absorb water and some fat and therefore have a physical function in addition to providing meat-like textural properties. It is widely used as ingredient in ground meat for patties, sausages and meal loaf and in vegetarian foods and stews.

Traditional Soy Food Products: The use of soybean products in the feed and food industry has increased steadily. The world soybean production is currently 219.8 million metric tons [49]. Soybeans are high in good quality protein, isoflavones, fiber, poly-unsaturated fat and low in calories, fat and cholesterol free.

Traditional soy foods, those foods prepared from whole soybeans, are typically divided into two sub-categories of soy food types: non-fermented and fermented soy products. Traditional non-fermented soy foods include soy milk, fresh green soybeans, whole dry soybeans, soy nuts, soy sprouts, whole-fat soy flour and tofu [14]. Soy nuts are typically dry roasted and characteristically eaten as a snack food. Soy sprouts, prepared by soaking, washing and sprouting of soybeans, are consumed as a vegetable throughout the year in many Asian countries and in the US are typically seen in soups, salads and side dishes. Soymilk and tofu begin with the soaking of the whole soybeans, rinsing, grinding and filtering. The insoluble residue is called okara and can be used in dishes or a fermentation step can be added to yield a product called tempeh. Further processing of the filtered soybean liquid produces soymilk. Tofu is made from processing the soymilk, then adding a coagulant to precipitate the protein from the soymilk. The precipitate is pressed into a solid, then dried, frozen or fried [50].

Soy is the most frequent substrate for Asian fermented foods. Traditional fermented soy foods such as tempeh, natto and soy sauce are richer in aglycone isoflavones and total isoflavones than unfermented soy [51]. These products will be discussed briefly in the following section.

Functionality of Soy in Various Food Products

Fermented Products: The main objections to soybean products by some consumers are the associated intrinsic flavor which has been described as beany/grassy or astringent and phenomenon of flatulence. Indeed, the first benefit of soy fermentation is the reduction of its beany flavor and chalkiness. Furthermore, soybeans are high in phytate (phytic acid) and oxalate (oxalic acid), substances that can block the uptake of essential minerals-calcium, magnesium, iron, copper and zinc-in the intestinal tract. Fermentation can reduce antinutritional factors, objectionable flavor and flatulent sugars; namely stachyose and raffinose. This can be achieved by using microbial cultures in the form of mono-and multi-cultures; particularly using lactic acid bacteria. However, it has been reported that acceptability of soy bean products may be enhanced by modification or processing methods. For instance, in soymilk preparation, application of heat, soaking of soybean in ethanol or alkali and acid grinding are some of modifications in cold-water soy extraction [14].

Soy is considered a good substrate for functional foods, since fermentation by probiotics has the potential to (1) reduce the levels of some carbohydrates possibly responsible for gas production in the intestinal system, (2) increase free isoflavone levels and (3) favor desirable changes in bacterial populations in the gastrointestinal tract [52]. During fermentation and microbial growth, the functional properties of soy products like other foods are formed as follows: protein is hydrolyzed to amino acids and peptides by proteolytic enzymes, oligosaccharides are hydrolyzed to monosaccharides, phytic acid degraded to inorganic phosphates. These properties are fundamental physicochemical characteristics, which affect the behaviour of proteins in food systems during processing, manufacturing, storage and preparation [53]. The most well-known soy fermented products are miso, tempeh, soy sauces (shoyu), Natto and fermented tofu.

Miso, meaning fermented bean paste, is used as a base for soups or as a flavoring. Varieties of miso are rice miso, barley miso and soybean miso. The production of miso starts with rice, barley, or soybeans that have been soaked, cooked, cooled and inoculated with a mixure of strains of *Aspergillus orzae* and *Aspergillus soyae*. The product is fermented and ripened prior to blending and mashing to form the final product [50].

Tempeh is a product produced from the fermentation of dehulled, boiled soybeans by *Rhizopus oligosporus*. This fermentation yields a cake-like product with a clean yeasty odor, covered completely by mycelium. Tempeh is usually a main dish or a meat substitute in a vegetarian or Asian diet. When it is sliced and deepfried, it has a pleasant aroma, crunchy texture and nutty flavor [50].

Soy sauce is one of the most widely consumed products in Asia. In Japan, per capita consumption is more than 10 liters per person per year, or more than 30 g per day [54].There are different types of soy sauces, each having their own particular characteristics and specific manufacturing procedures. The manufacture of traditional soy sauce or shoyu starts with preparation of raw material (whole beans, soy meals or soy flakes) and addition of koji (source of enzymes, containing bacteria, mold and yeast). After addition of salt brine, mashing is done. Fermentation, pressing and refining, pasteurization and packaging are the next steps.

There are two types of Fermented tofu: Pickled and stinky tofu. Pickled tofu consists of cubes of dried tofu soaked in salt water, Chinese wine, vinegar and minced chiles, or a unique mixture of whole rice, bean paste and soybeans. Stinky tofu is a soft tofu that does not have fixed formula for starter bacteria. The traditional method for producing stinky tofu is to prepare brine made from fermented milk, vegetables and meat; the brine can also include dried shrimp, amaranth greens, mustard greens, bamboo shoots and Chinese herbs. This kind of tofu has strong pungent odor which described by many as rotten and fecal.

Dairy Type Products: The demand for alternatives to dairy products is growing due to problems with intolerance and allergy, desire for vegetarian alternatives and so on and hence the interest in soy-based foods has developed [55]. Soybeans provide an alternative source of protein for people who are allergic to milk protein. Soy protein is highly digestible (92% to 100%) and contains all essential amino acids [56]. Although relatively low in methionine, it is a good source of lysine. Soy dairy free products are lactose free and are a good source of essential fatty acids. They contain no cholesterol and little or no saturated fat. These alternatives can be good sources of high quality protein, B vitamins, potassium, iron, dietary fiber and bio-active components, including isoflavones. Nowadays, dairy soy products free of lactose and milk protein, including soy milk, cheese alternatives, yoghurt (sogurt), soy sour cream, soy cream cheese and frozen soymilk desserts are available in market.

Amongst the many soy products, soymilk is one of the popular traditional products in China and other Asian countries consumed as a nutritious and economical protein food. Consumers in western countries also consume soymilk mainly as an important replacer of cow milk due to lactose intolerance or allergic reaction to cow's milk and as a low cost source of good quality protein and energy. Many soymilks are fortified with calcium, vitamins A and D, riboflavin, zinc and vitamin B12.

Soy cheese alternatives may be made from tofu or soymilk or a combination of soymilk with tofu and soy protein isolates. Soy cheese alternatives are now available in a number of traditional cheese varieties such as mozzarella, cheddar, pepper jack, jalapeño, which can be found pre-sliced, shredded, or in blocks. Soy parmesan, cream cheese and sour cream alternatives are also on the market.

Tofu, also called soybean curd, is manufactured by adding coagulant to soymilk extracted from ground soaked soybean. Two types of coagulants (salts and acids) are used commercially. The third type of coagulant, enzymes, is not yet used commercially but shows potential for producing both firm and soft tofu. Depending on the amount of water that is extracted from the tofu curds, fresh tofu can be divided into three main varieties: soft/silken, firm and dried tofu. Extra firm tofu is best used for marinating and cutting in to cubes for a stir-fry. The softer one is used for desserts or other foods those require wetter consistency [49]. Among the few calcium-fortified foods, tofu provides calcium in concentrations (128 mg/100g) comparable to milk (117mg/100g) in an acceptable serving-size portion [57].

Cereal Based Products: In bakery products, soy protein ingredients are being used for a variety of functional and nutritional reasons. Soy protein can help reduce fat, increase protein content and improve overall baking characteristics of baked goods, such as breads, crackers, doughnuts, cakes, pies, muffins and other bakery items [5]. Soy protein is a rich source of lysine, the first limiting essential amino acid in most cereal proteins.

Meat and Seafood Products: Soy products also are used as a low cost substitute in meat, fish and poultry products. Soy protein binds, emulsifies and hydrates meat products. It makes meat products juicer, which improves flavor, color, texture, shelf life, sliceability and yield. It can be used to lower the percentage of fat in ham, sausage, luncheon meats and hot dogs. Textured soy protein ingredients have been advocated as seafood extenders. Many processors of seafood items, including surimi products, have become interested in soy concentrates because of their water-binding and holding capacity. The fiber-like structure, for example, adds texture and mouthfeel to poultry rolls. The largest area of current domestic food utilization is in emulsified meats (frankfurters) and coarse ground meats (ground beef patties) [58].

Beverages: The beverage industry has currently realized the application and marketing benefits of soy proteins. Beverages seem to be an easy way for consumers to add soy protein into their diets. Soy protein concentrates and isolates are an ideal source of highly digestible protein in beverages [5]. Solubility is one of the most important properties of a soy protein when used in a beverage application. Other requirements include that the protein should form a clear and translucent solution that is bland, possess low viscosity and demonstrate stability over a wide range of pH, ionic strength and temperature conditions. The interactions of soy proteins with water are important in relation to dispersibility, water absorption and swelling, viscosity, gelation and surfactant properties. These properties directly influence the important functions of soy proteins in beverages [45]. The viscosity contributed by soy isolate makes it ideal for other nutritious liquid products, such as infant formulas, creamers, milk replacers and spray-dried products. Isolates may be lecithinated to improve dispersibility and to reduce dusting.

Daily Intake: According to the Food and Drug Administration (FDA), foods containing soy protein may reduce the risk of coronary heart disease. To get the heart-healthy benefits of soy protein, the FDA recommends that consumers incorporate four servings of at least 6.25 grams of soy protein into their daily diet for a total of at least 25 grams of soy protein each day. Numerous clinical investigations have found that daily intake up to 50 g of soy protein is not only safe, but may also be effective in improving risk factors for chronic disease such as some types of cancer, diabetes and cardiovascular disease. Even if nutraceutical and functional properties of soy are in demand, flavor is still the ultimately drive consumer liking and the major obstruct to achieve product success. Nevertheless, approximately 33% of U.S. consumers seek out products containing soy and approximately 31% of consumers are aware of specific health benefits of soy in their diet; on an aided basis, consumers are most aware of the health benefits of soy in relation to weight management (31%), reduced risk of heart disease (27%) and some cancers (20%); over 34% of consumers said they are aware of the FDA claim that consuming 25 g of soy protein per day reduces the risk of coronary heart disease; and 84% of consumers perceive soy products as healthy [59].

Future Trends: Consumers are becoming more and more interested in healthful foods. Soy beans and soy products have gained significant consideration for their potential role in improving health hazards such as risk factors for cardiovascular disease. Soy foods such as soymilk, tofu, natto, miso, tempeh, textured vegetable protein like soy burgers, soy nuts and whole soybeans may offer various health benefits. These benefits are attributed to soy protein and soy isoflavones (phytoestrogens). Soybeans are the majority source of isoflavones in human food. Besides soy proteins and isoflavones, soybeans are very versatile and a rich source of essential nutrients, i.e. polyunsaturated fats, fiber, vitamins and minerals. Providing consumers with information about the health benefits associated with soy ingredients even may improve the perceived sensory quality of soy products.

As a suitable alternative for probiotic dairy products, soy-based foods that contain probiotic strains will be more considered. Soy beverages and yogurts will be the next food category for which the healthy bacteria will make their mark.

Oriental soy foods, both fermented and nonfermented products, are part of the daily diet in many areas of the world. Products such as soy sauce (shoyu), tofu, tempeh and others are becoming more popular in the United States and Europe.

Soy protein products will provide the desired protein balance in formulated foods because they can simulate the textural properties of traditional foods. The emphasis will be on new manufacturing and formulation methods and on new products rather than just variations. There will be a revolution in product formulation, primarily in the traditionally conservative dairy and meat industries. Old ideas will change as new foods are designed around ingredient availability, advances in processing and distribution technologies, marketing requirements and nutritional guidelines. These new trends will also offer opportunities for the soy protein industry. For instance, Like the milk proteins (particularly whey proteins), the soy industry is doing extensive researches to separate proteins into specific peptides with certain functional and bioactive properties. Application of non-thermal processing is another example in these advances. Heat treatment has negative effects on soy protein solubility and water absorption characteristics. On the contrary, gently heat-treated products produce strong off-flavors, which is the main problem for developing soy protein foods. Thus, it is important to develop novel soy foods or a range of new food formulations through innovative technology such as high hydrostatic pressure.

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