

REVIEW ARTICLE

Modern approach in nutraceutical and functional application of soybean and its products to sustain human health: A review

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Novel healthcare strategies of the millennium have illuminated functional and nutraceutical foods as one of the functional therapeutic tools to combat various lifestyles related disorders especially hypercholesterolemia, hyperglycemia, cardiovascular diseases and cancer. In this context plan, derived foods enriched with bioactive ingredients are effective to tailor specific healthy diet for target population. Intake of these phytochemicals provides a vital approach toward nutrient optimization and food synergy. A large amount of phytochemicals and bioactive components are present in plants. Among them soybean showed rich phytochemical profile besides nutraceutical potential owing to presence of isoflavones, saponins and phytosterols against various physiological threats. In this modern era, use of soybean as nutraceutical in functional foods is the fame. The current review aims to explain various aspects of nutraceutical and functional properties of soybean in relation with chronic disorders.

Keywords: Soybean, functional food, nutraceutical properties, health benefits

INTRODUCTION

Soybean is one of the most harvesting plant worldwide and its products has been well known for its beneficial effects especially for reducing hormones related issues, certain types of cancers, retain bone mineral density and lower the serum lipid level due to the presence of antioxidative agents including isoflavone, dadiezein gentizien and phytosterols. Soy protein has anti-atherosclerotic properties due to their positive effect on blood plasma cholesterol. Antioxidants are the agents that scavenge the free radicals from the body and have a protective role to overcome certain diseases. Now a day's great interest has been developed in scientific study of soybean and its products due to anti-carcinogenic and therapeutic properties (Ranich et al. 2001; Shahidi, 2009). Due to these potential health benefits its focused on plant derived nutraceuticals for the management of onset of chronic ailments. Polyphenols are used for the remedy of various metabolic ailments from many years in human diet. It is due to chemical structure of polyphenols that give a lot of health beneficial properties and thus used for the management of different ailments. In this era, diet based therapy has been investigated globally and people are trying to access on utilization of natural materials for the prevention of various health related problems. Antioxidant foods from various sources nevertheless, plant based products are leading the issue due to their rich photochemistry that in turn proved beneficial for curtailing different maladies. Great interest has been developed in the utilization of these foods due to their acceptability, inexpensive and easy approach (Jayasekera et al. 2011). Presence of micronutrients and other substances in supplements or other food items have vital significance and benefits. Recent scientific evidences have showed that antioxidants, like flavonoids, isoflavones minimize the risk of metabolic syndromes i.e. hypercholesterolemia, hyperglycemia, obesity and some other ailments. Lack of physical activity and poor dietary intake increase the potential of metabolic disorders (Khan et al. 2007). Many opportunities are available for the development of novel products.

However, combination of bioactive components and phytochemicals are considered to be important while developing functional and nutraceutical foods (Hussein *et al.* 2005). Due to their health promoting potential antioxidant rich foods gaining fame all over the world.

Initially functional foods were investigated in Japan in 1980, s and defined as “foods that have some additional health advantages beyond the basic needs also known as food for special health use”. Moreover, In Japan approximately two hundred and seventy functional food products have been introduced (Serafini *et al.* 2012). Nutraceutical foods firstly used in 1989 in medicine field and defined as active substance that provide health benefits and prevent from chronic diseases (Alisaa *et al.* 2012). Now a day, many plant based foods are being in practice for increasing antioxidants, vitamins and minerals in regular diet. Fortification and supplementation of botanicals from plant based diets is an emerging trend to increase nutritional significance of food (Xin *et al.* 2011).

Phytochemicals present in foods becoming famous and important due to their natural and safe origin. Dietitians are emphasizing their attention to explore the significance of phytochemicals for beneficial health (Liu *et al.* 2007). Soybeans have innate therapeutic worth due to presence of having bioactive components like fiber, minerals, amino acids, and vitamins (ADA, 2009). Food has been utilized as an important medium to provide nutrients that helps in the maintenance of body normal functioning. Thus specific attention has been given to explore the therapeutic significance. Therefore, food in terms of their functional and nutraceuticals properties has been considered beneficial in minimizing diseases and improving health (Henson *et al.* 2008).

Burden of chronic disorders

In recent years' prevalence of chronic diseases has been increasing devastatingly. Among them diabetes mellitus, hypertension, obesity, cardiovascular disease, cancer and other gastrointestinal tract diseases are more prevalent. Major cause of these disorders have been reported dietary alterations and physical inactivity. Use of food that contain active components helps in minimizing the severity of these chronic diseases. Thus, many chronic and long term disorders have been treated by diet based therapies. In order to successfully managing diseases by diet therapies knowledge about active ingredients is required to plan successful strategies that helps target population (Steyn *et al.* 2008).

Among all these chronic disorders millions of people in all over the world has been suffering from hypercholesterolemia. A large number of people are conscious about harmful effects of cholesterol but they do not have knowledge about its pertinent values to our body. Cholesterol is soft and has fat like appearance and

belongs to sterol family. It is used in formation of cell membrane, synthesis of hormones and other substances. It is firstly produced by liver and secondly intake of food materials e.g. cheese, egg yolk, gravies, palm, deep fried foods, butter, whole milk, and coconut oil. Low density lipoproteins are transported across blood streams, provides insulation to nerves, builds new cells and it is required in less quantity (Stepleton *et al.* 2010).

According to United States Department of Agriculture (USDA) the average cholesterol level should be 200mg/dl. Both the American Heart Association and the National Education Cholesterol Program recommend <200mg/day for people at risk of coronary heart diseases. Low density lipoprotein (LDL) is about 65-75 percent of the total cholesterol in the body. It is helpful in cell membrane formation and converted cell into solid by preventing it from freezing. and protects the cell from melting, in this way maintain cell's fluidity. When LDL completes their tasks it removes via the bloodstreams from the body. Sometime its elimination process become slow, this decrease in elimination process in some people causes formation of fatty materials within the body walls. This accumulation of cholesterol can slower and prevent supply of blood to brain and heart that leads toward atherosclerosis. This is the reason that usually LDL called as bad cholesterol. As compared to LDL, high density lipoprotein (HDL) is about 20-30% of total cholesterol. Major organ in which HDL has been synthesized is liver. HDL constitutes of cholesterol and triglycerides among them triglycerides are present in high amount. Main function of HDL is to collect extra level of cholesterol, and pick it from arteries and bring it back to the liver where it breaks, resynthesized and eliminated. Its minimize its extra amount in blood vessels, and protects against CVDs, this is the reason HDL is known as good cholesterol (Stepleton *et al.* 2007.)

HDL and LDL are considered to be safe if not exceed from recommended amount. Two variables are important to checked concentration of cholesterol; one is amount of total cholesterol in blood and second is amount of HDL in blood. According to American Heart Association cholesterol level <200mg/dL is desirable amount of cholesterol in blood. An amount of 200-240mg/dL is considered to be at borderline and chances of heart attacks are more. If exceed more than 240mg/dL then chances of serious heart attacks are very common. For HDL desirable value is 35mg/dL the average value is 50 and 65mg/dL. According to AHA when 1mg/dL reduction in HDL, the chances of CVDs increases by 3-4%. HDL is also measured by cholesterol ration in blood. It is estimated by taking total amount of cholesterol in blood divided by the HDL level in the blood. According to AHA, a safe level is below 5:1 ratio, with the ideal level of being 3:5:1. LDL can be lower by many factors the most

important is the diet, avoid saturated fat in the diet. It will decrease total cholesterol ratio in blood (Alissa *et al.* 2012).

High plasma cholesterol level (above the normal ranges) called as hypercholesterolemia and it is considered as one of the strongest risk factor for heart diseases. It is a condition in which serum lipid level increase particularly LDL and total cholesterol. High cholesterol causes lesions, plaques formation, emboli and occlusion by interacting endothelial functions. Its high level minimizes the healing power and cause endothelial dysfunction (Jacob *et al.* 2008).

Soybean and its cultivation

For over many years, soybean (*glycine max*) has been known to man and it is the specie of legume that is rich in oil and protein. About one third of soybean constitute of protein and rest is the oil. Approximately 40% of soybeans seed consist of protein while 20% of fat. It has highest content of protein and has no cholesterol as compare to other conventional legumes. It is included in one of the cheap source and use as a medicine due to the presence of genistein, phytochemical and isoflavone contents. It provides protection against heart disease, cancer and diabetes mellitus. One of the most useful product of soybean is soy milk. It is the extract of ground soybeans, and soy protein isolates are purified fractioning contains 90% protein. Consumption of soy protein cause advances in achieving better taste and health benefits. FDA claims that soy protein prevents cardiovascular problems in human beings (Jenkins *et al.* 2002).

Table 1: Classification of soybean

Kingdom	Plantae
Order	Eudicots
Family	<i>Fabaceae</i>
Subfamily	<i>Faboideae</i>
Genus	<i>Glycine</i>
Species	<i>G. max</i>
Binomial name	<i>Glycine max</i>

Soybean (*glycine max*, legume of the pea family (*Fabeceae*) is world's most cultivated and economically successful legume. It has been originated from northern area of China and its cultivation started in new stone age. Soybean is the fourth major crop after rice, wheat and barley and therefore, has emerged as one of the most important agricultural commodities all over the world. Its worldwide production is about 180 million tons. Now a days China, USA, Argentina, Brazil and India are major producer of soybean. Brazil produces about 28% of world's soybean production. It is the second major producer and exporter of soy protein.

Soy bean is a branching plant that can grow Its height extending from 0.50 to 1.25 meters. Soy bean seeds have spherical and oval shape and available in multiple colors

including yellow green, black, dark brown or bicolored. (Sakurai *et al.* 2003).

Antioxidant perspectives and health claims of soybeans

Antioxidants are defined as the substances that are produces by the body against environmental pressure and prevent or reduces damage caused due to free radicals. Antioxidants works on the mechanisms that decrease the effect of reactive oxygen species (ROS). These species include superoxide 2 dismutase, glutathione peroxidase, catalase and thioredoxin reductase. Catalase causes reduction of hydrogen per oxide into oxygen molecules and water. Hypercholesterolemia leads toward free radical's production due to reaction between radicles of oxygen, lipoproteins and phospholipids (Mugge *et al.* 1991).

Oxidised phospholipids interact with the receptor of membrane and disturb the normal function of cell through a limited bioavailability of nitrogen oxide, stimulating an immune response, causing poor vascular function and eventually heart diseases. Interactions with oxidative phospholipids activates the variety of adhesion and inflammatory molecules leading toward diapedesisi, macrophages differentiation, and foam cell formation and delicate system by producing additional reactive oxygen species and inflammatory process (Berliner *et al.* 2005)

Soybean provides beneficial effect in renal disease, osteoporosis, lowering serum cholesterol level, and protect from atherosclerotic activities. Isoflavones belong to heterocyclic phenols present 0.1mg/g in soybeans and have estrogen like activity. Isoflavones have protective effect against cancer, vascular disease, osteoporosis, menopausal and cognitive function. Genistein and daidzein are major groups present in soybean. They are present in the form of glycosides. During digestion process they are hydrolyzed into aglycones and metabolized in intestinal tract, absorbed, transported to liver and undergo enterohepatic cycling. Glucosidases cleave the sugar contents and release active isoflavones, daidezein and genistein in young people. It is bio transformed into specific metabolites, equol and desmethylangolensin. They are excreted from kidney and therefor share physiological features and behavior of endogenous estrogens (Ricciotti *et al.* 2005).

The intake of high amount of soy isoflavones effected reproduction system and in premenopausal women daily intake of soy protein lengthen the menstrual period. It is present in soy products as therapy for hot flashes which are helpful in 75% menopausal women and improve the quality of life. Intake of soybean is used as alternative to hormone replacement therapy for postmenopausal women (Ho *et al.* 2002). Osteoporosis is defined as a condition in which bone mass is reduced, bones become swollen and inflammation of joints occur. In women osteoporosis is very common problem especially after menopause when ovaries stop to produce estrogen. A study has been

conducted for the duration of three months in which soy protein were given to female rats and shown to be more beneficial effect in the maintenance of bone formation as compared to casein based diets. It has been reported that isoflavones has the ability to selectively bind with estrogen receptors. These compounds have ability to activate osteoblasts and inhibit osteoclasts. Isoflavones reduce the bone loss in postmenopausal women (Blum *et al.* 2003).

Another study was done in which approximately ninety women aged between 47-57 years were given genistein as a standard hormone replacement therapy. Intake of genistein increases the bone density to the same extent as HRT. No adverse effects were seen on uterus and the breast. Evidence also showed that genistein present in soybean also helpful in the formation of new bones (Arjmandi *et al.* 2003). Isoflavones prevent from DNA oxidation in lymphocytes. Intake of soy genistein helps to prevent the osteoporosis and restore bone protection (Fernandes *et al.* 2003). Genistein present in soybeans interfere with cell signaling-inducing pathway and also inhibitor of receptor tyrosine kinases and inhibit angiogenesis. It has been reported that intake of 250 ppm/kg genistein increases the antioxidant activity in gastrointestinal tract, liver and kidney in mice (Cai *et al.* 1996).

Soy isoflavones also act as an anticarcinogenic agents. According to National Cancer Institute isoflavones helps in reducing breast cancers, prostate cancer, and lung cancer. Intake of >1 serving per day reduced 70% risk of prostate cancer (Yamaya *et al.* 2007). They act as an anticancer agent by managing free radicals. Parenteral intake of daidzein isoflavone induced mammary carcinogenesis by reducing N-methyl-nitrosourea. Intake of Soybean extract prevents from free radicles and it is added in different product for the prevention of skin from damaging due to reactive oxygen species (Guo *et al.* 2001).

Intake of soy bean helps in reducing the risk of developing atherosclerosis by decreasing blood lipid levels and arterial fatty streaks. Polyphenols present in soybeans have ability to manage free radicals and prevent from lipid oxidation. According to a study conducted on activity of genistein, it actively constrains LDL oxidation that plays an important part in development of atherosclerosis. This LDL oxidation can be actively controlled by controlling and blocking reactive oxygen species (ROS) that involved in many pathological proceedings (Hwang *et al.* 2003).

Isoflavones are the main hypolipidemic agents in soybeans due to their antioxidant and mild estrogenic activity (Lee *et al.* 2006). Soybean is one of the most important oil crop that is used for the production of many foods all over the world. It contains 0.2-0.3 percent phytosterols. They have the ability to reduced serum cholesterol levels by inhibiting the absorption of cholesterol. They are supplemented with functional foods to improve health. About 5g/day soybeans phytosterol

reduces approximately 10% of total cholesterol and 13% LDL.

According to Food and Drug Administration (FDA) , intake of almost 0.65 gram of plant sterol ester twice a day with meals for daily total intake of at least 1.3 g, as part of diet low in saturated fat and cholesterol decreases the risk of heart diseases (Yamaya *et al.* 2007).

Saponins have bitter taste and present in many plant species including soybeans. They are composed of a lipid soluble aglycone moiety linked to water soluble glycosidic chain which enables it to connect with cell membrane. They have anti-viral activity against HIV, cholesterol lowering and antioxidant activity. They also play role as anti-tumor or tumor cell lines by soy saponins also reported (Lai *et al.* 2002).

Soybeans contain 0.5-3% saponins. About 2% soybean saponins intake decrease chances of colon cancer. They have strong antioxidant activity equivalent to 17.1 units of super oxide dismutase. Inflammatory cells release many pro inflammatory mediators such as reactive nitrogen species and reactive oxygen species which damage the DNA of cell and cause tumor initiation and thus act as an anti-cancer agent (Jenkins *et al.* 2003).

Cytokine and chemokine released by inflammatory cells stimulate tumor cell invasion, angiogenesis and facilitates tumor growth. Soybean saponins not only inhibit the aflatoxin-DNA adduct but also induced colon aberrant crypt formation. They have anti-inflammatory activity by suppressing the release of pro inflammatory mediators. They also inhibit the release of prostaglandin, nitric oxide, tumor necrosis factor (NTF) and mRNA protein levels. They down regulate the cyclooxygenase 2 or inducible nitric oxide synthase. They have significant lipid peroxidation activity on plasma lipoproteins and prevent LDL from oxidizing and decrease their susceptibility to oxidation which is most important risk factor for atherosclerosis. They not only protect heart but also smooth vascular muscles (Arai *et al.* 2000).

Soy milk and its nutritional profile

Soy milk is creamy, milk like product made by soaking and grinding soybean in water. Soaking of soybean is directly related to changes in textural characteristics and grinding properties of soybean for processing. It is easily available and inexpensive source of protein. It is mostly used in confections, meat fillers, beverages and as part of infant formulas for children allergic to dairy milk. It has no cholesterol and fat and is rich in polyunsaturated fatty acids of phospholipids. It contains high amount of calcium and prevent from bone losses. It contains soluble fiber which helps to control hyperglycemia. It is best substitute for pregnant and lactating women. It helps to lower menopausal symptoms and restore bone mineralization. It contains calcium, magnesium and phosphorous which help to strengthen teeth and prevent nerve disorder. Regular intake of soy milk delays the aging process (Raja *et al.* 2014).

Soy milk contains 5 g fat, 1 g fatty acids, 4 g fiber, 7 g protein, 5 g carbohydrates, 0.00 lactose, and 228.51 water, 1.52 of iron and 79Kcal of calories. It contains 10 times more iron than milk from other sources. Humans are the only species to consume milk past childhood. About, at the age of four, some individuals become lactose intolerant, the carbohydrate present in milk and cause unpleasant abdominal symptoms that majorly includes stomach cramps, diarrhea and flatulence. About 75% of people suffering from lactose intolerance. However, a large number of populations cannot drink cow milk because of milk allergy or out of a values choice like a vegan. It is a healthy drink and is important for people with above mentioned problems. It is not only providing protein but also a source of carbohydrates, lipids, vitamins and minerals. The major difference between soy milk and cow milk is that one is derived from animal source and the second is from plant source (Rehman *et al.* 2007).

Soymilk replacement for lactose intolerance

All cow milk contains about 8g of protein and 13g of carbohydrates and is a rich source of other nutrients as well. About one cup of cow milk gives 30 percent of daily calcium and about 50 percent of vitamins such as B12 and riboflavin requirements. Depending on the selection of cow milk can have a significant amount of fat. Lactose is the primary carbohydrate present in cow milk poses some gastrointestinal problems for some individuals. These people have deficiency of lactase enzyme that's needed to breakdown. Soy milk is not technically milk but a beverage made from soybeans. It is a liquid that remains after soybeans are soaked, ground and the finally strained, since it does not contain any lactose, soy milk is suitable for lactose intolerance people. It is also a substitute for vegetarians and it's based on plant source (Clark *et al.* 2007).

About 75% of people and 30% in USA suffering from lactose intolerance due to lack of lactase enzyme which is necessary for the proper digestion of dairy products (Suarez *et al.* 1998). Lactose malabsorption occurs when lactose sugar is not completely digested by the small intestine of the digestive tract. Villi of the intestine contain lactase enzyme primarily in the jejunum and required to hydrolyze the lactose for intestinal absorption. Undigested lactose used by the intestinal bacteria as a substrate for fermentation process and provide short chain fatty acids and gas. It also accelerates the intestinal transit time because it affects the osmolality and causes water to be drawn into the bowel. As people get older level of lactase enzyme drop due to poor health conditions and can reduce the lactase production. The symptoms include bloating, diarrhea, flatulence, abdominal pain, distension and cramping. Treatment of lactose includes relief of symptoms ensuring good nutritional status. Lactose intolerance reported 28% in Brazil 18% in Finland and 55% in Mexico. This enhanced the demand for soy based products in industries for lactose intolerant people. Soy

milk is best substitute for these patients and people enjoy by using lactose free milk like soy milk (Daniel *et al.* 2010).

Plant based foods are rich in phytochemicals and lower in saturated fats as compared to animal based foods and have dietary fibers that's why many people are moving toward vegetarianism (consumption of only plant based diet). About 2.5% of people of USA are vegetarian; they do not eat meat, poultry, fish and dairy products. About 8.1% of Asian Americans do not consume dairy products. About 3.5% of African American are also following are also not consume dairy products. In USA there is a large market of desserts. It contains dairy ingredients so a large number of American populations are not able to consume it. Due to religious beliefs, vegetarianisms or other related ideologies, lactose intolerance and dietary habits. So, these people consume soy milk and it is full of soy protein which is only a complete plant protein and best alternate of animal protein (Fetto, 2010).

Now a day's fortified versions of soy beverages are accessible. These beverages are enriched in calcium and vitamin E, B₁₂ and D among nutrients. It is good for pregnant and lactating women and prevent from diabetes mellitus. It also reduced the menopausal symptoms and nerve disorders. Its long term consumption prevents from ageing process (McCray, 2003)

Soy milk is also a substitute for cow milk and prevent from malnutrition like problems in many countries. Its utilization is hampered by many factors e.g. biological and storage factors. But, by modification of processing methods its acceptability has been enhanced (Osundahunsi *et al.* 2007). Some methods are application of heat, soaking of soybeans in ethanol or alkali and acid grinding. There are natural flavorings to improve soy milk' acceptability. Owing to improving its health benefits, research focusing to enhance its acceptability should be undertaken. For this purpose, maize is an important crop for many people in developing countries. Maize protein is deficient in lysine and tryptophan, but has significant amount of sulphur-containing amino acids (Bello *et al.* 2003). By fortification of soybeans for the improvement of qualities of tortilla has been reported (Obatolu *et al.* 2007). Fortification of products of soybeans with maize has the potential for creating a valuable food product (Kolapo *et al.* 2006).

Products of soybean

About 5000 years ago it is known as (Shu now as da dou or huang dou). Soybeans gradually transformed into various types of tasty and nutritious soy foods, e.g. tofu, soy milk, soy sprouts, soy paste, and soy sauce. Methods to prepare different types of soy foods were introduced in Japan, Korea and some other eastern countries. Soy milk is a traditional popular drink. Soybean oil is the second important soy product. Soy sauce and its other fermented items is the third important product. It is used in the form of sprouts, as a fresh legume and also as a medicine.

Asian's population consuming soybean in different forms, including soybean milk, tofu, sufu, temph and miso. Soybean's milk used as a fermented product and soy yogurt is made due to its high solid contents and viscosity. (Kim et al. 2005). It gives distinct nutritional benefits as compared to animal milk yoghurt to customers. Such benefits include low level of saturated fat, lactose and cholesterol. Locally available sources of raw materials would help in the reduction of production cost of soy milk yoghurt. Due to a large number of its health benefits stimulated a lot of researchers on incorporating soybean into indigenous diet e.g. soybean fortified gari and tapioca (Sanni et al. 2005), soybean dada (Popoola et al. 2007) and soy yoghurt (Nsofar et al. 1996). Soy milk in all over the world getting popularity as traditional oriental food beverage (Olubamiwa et al. 2006).

In many products fortification of soy flour also done due to its remarkable properties. A fortified soy product was developed from soy flour about 54% (w/w) it was wheat based extruded cereal (Yeu et al. 2005). Shogren et al. 2006 reported wheat based spaghetti with good sensory attributes. Fortification of soy flour in wheat bread was also reported (Mashayekh et al. 2008).

Soy desserts contain soy protein at the range of 1%, 2% and 3%. With the addition of soy these products become a source of fibers, iron and copper and in case of sensory characteristics they gathered score above the level of liked slightly. Degree of liking of creaminess of desserts shown by surface response methodology (Daniel et al. 2010). Mayonnaise used in salad dressings also a product of soy protein. (Puppo et al. 2007). In a study to compare soy flour fortification Graham crackers and non-fortified peanut butter crackers prepared. The result showed that there was no change in their moisture contents by fortification of Graham crackers. Sensory evaluation was also done for its texture, aroma, color by using 9-point hedonic scale. Graham crackers that were fortified with 100% soy flour has less acceptability as compare to low level of soy flour for desirable flavor (Gercia et al. 2009; Joelle et al. 2011).

In another study reported, guava juice was fortified with soy flour and it is a good source of vitamin C, fibers, bioactive components and carotenoids and all of these are involved in different metabolic pathways and are health promoting substances for customer acceptance. So, in soy based desserts guava juice may be a convenient way of increasing a good taste and nutrition value of products (Yamaya et al. 2007).

Soybean and oxidative stress management

Production of free radicals is one of the factor that is involved in the onset of various metabolic disorders. There are many facts that oxidation occurs due to increased reactive oxygen species, major agent of many disorders that can be controlled by antioxidants rich diet. The increasing level of free radicals causes inactivation of nitric oxide and leads toward atherosclerosis and

impairment of vasodilation. The other factors that increase reactive oxygen species include diet, smoking, physical activity and environmental factors. Repairing capacity of antioxidant increased by consumption of plant based diet (Butt et al. 2008).

Imbalance between pro and antioxidant enzymes called oxidative stress and leading toward excess production of reactive oxygen species including superoxide, hydroxyl radicals, and lipid radicals which damage the components of cells. High cholesterol level enhances the activity of oxidant producing enzymes NADPH oxidases (NOX), xanthine oxidase, and myeloperoxidase (Ratnam et al. 2009)

Reactive oxygen species disturb the balance of antioxidant and increase the foam cell formation in arteries. It causes production of double allylic hydrogen and lipid oxidation start. Moreover, White blood cells catalyze the synthesis of hypochlorous acid that causes cellular damage. During this process body's defense system activate and release some enzymes such as superoxide dismutase and glutathione peroxidase. Superoxide dismutase produces single oxygen into hydrogen peroxide and acts as a first line defense system. Glutathione peroxidase change hydrogen peroxide into water. These enzymes work in balance but in case of increasing level of reactive oxygen species interruption occur resulting necrosis and apoptosis. In such condition, plant originates foods work as therapeutic agents to combat with over production of reactive oxygen species (Erdman, 2009).

Meta-analysis of soy milk showed that there is a direct relation between consumption of functional foods or bioactive components in lowering the chronic ailments. Oxidative stress has a vital role in the prevalence of chronic ailments. Production of free radicals are associated with various disease ailments including diabetes mellitus, CVDs, osteoporosis and cancer. Phytostreol a bioactive component present in soy products has significant role in lowering the plasma lipid level. The consumption of 4g of phytostreol per day contributes to about 10% reduction in total cholesterol and 13% in LDL cholesterol (Yamaya et al. 2007) (Gibbs et al. 2004).

Epidemiological evidences showed that individuals that consumed soy products have low risk of cardiovascular diseases and its favorable biomarkers such as low density lipoproteins. A meta-analysis on controlled humans trial shows that an average consumption of 47g per day of soy isoflavone reduce the 9% total cholesterol, 11% triglycerides and 13% LDL isolated soy protein and isoflavon dadizien are major contributors in prevention of metabolic disorders such as diabetes mellitus by increasing the metabolism of lipids and boost liver defense system (Guo et al. 2002). The intrinsic and extrinsic effect of soy protein was checked in USA to examine LDL cholesterol lowering effects. For this purpose, extrinsic effect of soy was determined by replacing the saturated and total fat rich foods with cholesterol lowering food and

13-58g/day soy protein while intrinsic effect with consumption of 30-133g/day. There was 3.0-6.0% reduction in LDL due to replacing of fatty foods from animal foods. The combined intrinsic and extrinsic effect of soy protein in lowering LDL cholesterol was 7-10%. Thus, addition of soy protein in diet decreases about 4% blood plasma cholesterol level (Anderson et al. 2002).

Another epidemiological study was done to determine the effect of infant nutrition on cholesterol synthesis rate. For this purpose, a total of approximately thirty-three infants (four months old) were selected and fed on exclusive breast milk with high cholesterol and low phytoestrogen. Cow milk based formulas having low cholesterol and low phytoestrogen. Soy based formula milk with zero cholesterol and high phytoestrogen was given and modified soy milk based formula with low cholesterol and high phytoestrogen was another treatment given to infants. Cholesterol fractional synthesis rates was determined by including deuterium in erythrocyte membranes of cholesterol rather than blood plasma membrane and excretion of soy active component (isoflavone) in urine was also measured. These were lower in soy milk based modified formula as compared to soy milk based formula due to high phytoestrogen level in modified formula milk of infants (Hwang et al. 2003).

Hypercholesterol has a significant association with atherosclerosis and LDL is a major atherogenic cholesterol which leading cause of heart attacks and strokes. Soy milk reduces the foam cell formation and oxidative stress. Hypercholesterol diet rats were treated with soy milk doses 0.81g/3mL, 1.62g/3mL and 3.24g/3mL, respectively. There was significant increase in HDL, decrease in LDL and triglycerides levels of rats (Widmer et al. 2013). Soy milk powder supplementation with phytosterols decrease serum lipid cholesterol. Phytosterol enriched Soy milk powder (3-4g) was given to people selected from different communities in china. After 3 months of intervention serum total cholesterol and low density lipoprotein cholesterol decreased by 9.3% and 11.4%, respectively (Kriengsinyos et al. 2011).

Isoflavone rich diet and without isoflavone soy diets were given to experimental animals and humans. Diet rich with isoflavone reduce the CVDs and its risk factors. Different studies were carried out to determine the outcome of soy protein on serum cholesterol level, LDL and HDL. Intake of soy protein reduce the serum lipid level concentration and beneficial effects were reported by some researchers. 47g/day consumption of soy protein reduce the 13% LDL, 9% total cholesterol and 11% triglycerides (Hoie et al. 2005).

(Jenkins, 2002) checked the effects of high and low isoflavones containing soy protein on lipid and non-lipid risk factors for heart diseases. They showed that as compared to control diet both soy containing diets resulted in significantly reduce the total cholesterol level, LDL and HDL ratios. However systolic blood pressure was low in men after taking the soy rich diets. Monkeys fed with

isoflavone poor soy protein diets. Antiestrogen tamoxifen is administered by an increase in serum triacylglycerol level, Soy protein intake associated with decrease in serum triacylglycerol level (Eradman et al. 2009).

Various epidemiological studies indicated that regular intake of soybeans lowered risk of cardiovascular diseases and some other chronic disease biomarkers, such as LDL and total cholesterol. Another study (meta-analysis) showed that 47g/day intake of soy protein lower 9% cholesterol, 13% low density lipoprotein and 11% triglycerides (Zhan et al. 2005).

Literature suggested according to Food and Drug Administration(FDA) dietary approach low in fat content including saturated fat and cholesterol accompanied with soy protein 25 gram per day reduces the risk of heart diseases (FDA 2009).

CONCLUSION

The current review reports that foods loaded with bioactive components have received increased attention due to their functionality in disease prevention and treatment. Soybeans contain abundant of bioactive phytochemicals such as isoflavones, phytosterols, saponins, phytic acids, trypsin inhibitors, and a rich source of dietary peptides. Being most economical and valuable crop soybean and its numerous products are easily available in market. A wide variety of food products are also fortified with soybeans such as flour, desserts, crackers and mayonnaise to enhance nutritional profile. Research has implicated soybean phytochemicals as therapeutic potential to tackle lactose intolerance, lowering cholesterol, prevent heart diseases and lower the risk of diabetes. Antioxidant activities of soybeans also appear to prevent certain types of cancer. The main objective of this article was to discuss the different soybean bioactive components and their implications to human health.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

AUTHOR CONTRIBUTIONS

AI designed and initial drafted the study. NJ reviewed and final draft the manuscript. SA, AA and TN collected and finalize the data, moreover, did final revision of manuscript. SB revised the final manuscript. FA and AA collected and refined the data utilized in manuscript writing. All authors read and approved the final version.

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