

Literature Review

Soy consumption and its relationship with heart disease and cancer prevention

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Abstract

Soybean is a subtropical annual plant, a species of legume native to Southeast Asia. It is a member of the pea family that is widely grown because of its edible beans that are processed to be used in many ways in making food and food additives. There are many categories of soy protein and it can be divided into many different types according to the production methods, to isolated concentrated and textured soy protein. Soy is one of those “wonder foods”; the issue of whether soybean has negative or positive effects on our health has been a continuing question. The potential effects of soybean, the health detriments or benefits of it remain a controversial issue. Extensive research has been conducted to investigate the health effects of using soybean products, some of them demonstrated the soybean products ability in preventing a wide range of many diseases, especially different types of cancer, while others found that soy products have no or negative effects on health. Despite all pro-soy studies, controversy about soy products positive and negative effects still exists and people are left with a choice whether they should consume soybean or not.

Keywords: protein, tofu, isoflavones, soybean, health benefits, *Glycine max*, Qatar.

Introduction

Soybean is one of the leguminous vegetables of the pea family that grows in subtropical, temperate, and tropical climates. It is one of the five commercial food crops, besides wheat, rice, millet and barley. It is considered as a staple source of dietary protein and oil, which grows mostly in China, Japan, Korea, and Southeast Asia. Soybean contains a good amount of carbohydrates, oil, protein, dietary fibre, vitamins and minerals, as well as isoflavones. Soybean can be used to create a variety of products such as soy milk, soy protein, tofu, soy sauce and soy flour [1]. Extensive research has been conducted to investigate the health effects of using soybean products; recent research and clinical trials have addressed the role of soybean and its products in preventing a wide range of many diseases such as different types of cancers. Soybean is one of the most potent dietary components to help in reducing blood low-density lipoprotein (LDL) and cholesterol levels [2].

In addition, scientists have been encouraged to investigate the role of soybean on the hormone-related cancers since they have found low rates of cancers seen in Asian countries. For women who consumed soybean products as teenagers in China, the risk of breast cancer has decreased by half [3]. However, other researchers found that soy products have negative effects on health. According to the University of Hawaii, much research has conducted to investigate the linkage between soy consumption and breast cancer and no difference was found between the high intake of soy products and decreased level of breast cancer [4]. A study conducted by the American Heart Association (AHA) found that the increased level of isoflavones found in the soy products had no effects on the blood lipid profile [5].

‘Thus, people are left with a choice; should they consume soybean or not?’

Literature Review

‘What is soybean?’

Soybean is a subtropical annual plant, a species of legume native to Southeast Asia. It is a member of the pea family that is widely grown because of its edible beans that are processed to be used in many ways in making food and food additives. Scientifically, soybean is known as *Glycine max* which is classified by the Food and Agriculture Organization (FAO) as oilseeds rather than pulses [3]. Soybean has been a dietary staple in Asia for more than 5,000 years and it was introduced for the first time to the United States in the 1800s and to Europe as well. The cultivation of soy began during World War II in the United States and currently it produces about half of the world’s supply [6].

Soy can be manufactured into many other forms including soy milk, tofu, soy sauce, tempeh and natto. Moreover, the oil extracted from soybean is used in several industrial applications. The main producers of soybean are the United States, Brazil, Argentina, China and India with percentages of 35%, 27%, 19%, 6%, and 4% respectively. Soy contains many nutrients, mostly protein and essential amino acids, it consists also of isoflavones, fibre, lecithin and phospholipid. Most of the soy’s contents have been studied scientifically for several health conditions. Some of them are believed to have strong effects on health while others suggest they do not and this point remains a controversial issue [1].

Different types of soybean products

There are many categories of soy protein and it can be divided into many different types according to the production methods [4]. Isolated soy protein contains approximately 90% of protein and it is the most refined form of soybean protein which is mostly used in improving the texture and the quality of meat production. Concentrated soy protein contains approximately 70% of protein and mainly it is made by removing the water soluble carbohydrates and it is used in improving the nutritional value and increasing fat and water retention. Moreover, textured soy protein (TSP) is compressed and processed into chunks, flakes or granules through extrusion technology. It has a ground beef texture and it can be added to the meat or used as a meat replacement [6]. Techniques can be used as well in preparing more digestible forms of soybean. Additionally, common types of soybean products have been mentioned such as green soybean, tofu, soy flour, soy milk, soy sauce, tofu, soy yogurt and tempeh [4].

Soy and health

Soy is one of those “wonder foods”; the issue of whether soybean has negative or positive effects on health has been a continuing question. The potential effects of soybean, the health detriments or benefits of it remain a controversial issue. There is an increase in soybean product consumption worldwide and soy is packed in a variety of products and regularly it has been showing up on the shelves of grocery stores. Nonetheless, despite all of the pro-soy studies, a controversy has been brewing about whether soy products are really healthy or not or if these products are positively/negatively linked to some of the diseases or not [7].

Effect of soy consumption on the heart

Cardiovascular disease (CVD) is a term which describes heart diseases in general; it is one of the most life-threatening diseases which can be prevented by addressing its risk factors. Diet has been shown to have a major impact on most of the modifiable risk for cardiovascular and coronary heart diseases (CHD), such as dyslipidemia that includes hypertriglyceridemia, low HDL-cholesterol, hypercholesterolemia and elevated LDL-cholesterol. In addition, the recommended low-fat high-protein diet helps decrease the risk of heart disease while other dietary factors can offer more additional benefits as well [8]. Soybean and its products are nutrient-dense, rich in fibre and a good source of protein. Soy’s protective and therapeutic roles have been documented for the prevention as well as treatment of some diseases. Furthermore, studies indicated that some dry beans as well as soybean have the potential to improve lipid profile through lowering the serum cholesterol in addition to improving diabetic state aspects and hypertension (HTN) state [9]. The insoluble fibres that are found in soy and its products have a significant role in reducing the serum LDL cholesterol and total cholesterol by 84% and 88% respectively. Additionally, some clinical studies have documented the mechanism of fibres in lowering cholesterol. When fibre is consumed, it binds to cholesterol particles in the small intestine and prevents cholesterol from entering the bloodstream and through faeces the cholesterol will exit the body [4].

Soybeans are a unique source of protein as well as isoflavones such as diadzein and genistein which have different biological functions. Different studies have illustrated that soybean and its products can apply multifaceted health-promoting effects which include improving the vascular health while reducing cholesterol levels [8]. Soybean contains a non-protein component which is known as ‘isoflavones’, this component is known to be endocrine disruptors, phytoestrogens and has the ability to act as selecting estrogen receptor modulators and to be involved in the production of estrogen metabolites in females. Structurally, it is similar to the estrogen hormone, it has an ability to bind and cooperate with estrogen receptors in order to decrease the concentration of serum cholesterol through stimulating the effects of estrogen in some cells and blocking some of those effects in other cells [10]. Isoflavones that are found in the soy and its products indicate a significant reduction in the level of both serum LDL-cholesterol and total cholesterol (TC) as well. The cholesterol’s homeostasis is sensitive to the estrogen hormone. Studies have shown that when the estrogen level is decreased, the concentration of serum total cholesterol is increased, however, the mechanism by which isoflavones decrease the cholesterol level is not clear yet. Furthermore, researchers have indicated that reducing the serum of total cholesterol through using soy isoflavones can be because of no presence of cholesterol in soy and consequently it can regulate the synthesis of cholesterol. In addition to that, isoflavones are able to slow and decrease the development and formation of the sticky substance called “plaque”. This can be achieved through two different mechanisms; either through altering cytokines activity that is known as growth factor, or by inhibiting the adhesion of the cells [10].

Isoflavones can reduce the peroxidation of lipids through antioxidant properties that they contain. Antioxidants play a significant role in reducing the risk of coronary heart disease, especially in postmenopausal women who have low estrogen levels. The hypocholesterolemia effect of isoflavones found in soy products counteracts the increased level of serum cholesterol and can play a role as an alternative to the hormone therapy in postmenopausal women [11]. Research undertaken on isoflavones indicates that they have significant roles in increasing HDL cholesterol level, decreasing total cholesterol, triglyceride and LDL cholesterol as well [4].

However, other researchers found that soy products have either negative effects on health or no effect at all. A study conducted by the American Heart Association (AHA) found that the increased the consumption of soy products had no effects on the blood lipid profile and decreased risk of heart disease [5]. The effect of fibre content of soy in lowering cholesterol levels was considered as being overstated as a result of the inclusion criteria which is used in the studies analysis which made it difficult to be settled with the current results of some metabolic studies. Additionally, the same study has investigated that the good response to soybean is driven by the initial concentration of blood cholesterol rather than the amount of dietary soybean itself [12]. Although FDA has approved a health claim of including soybean products in the diet for cardiovascular disease protection, that claim was revised in the current studies and stated that soybean and its contents do not appear to have significant effects which are superior to other protein contents, but still in general soybeans are beneficial for health. The FDA also admitted that consuming 25 grams of fibers daily may show some positive signs on cardiovascular incidence but in reality intake of 25 grams of fibre cannot be achieved easily [13].

In response to some studies that indicated the positive effects of isoflavones on estrogen hormone, a review found that the daily consumption of soy (32-200 mg) had negative effects on hormones. Moreover, it can lead to increase the menstrual cycle length and decrease the blood level of some hormones such as progesterone, estradiol and SHBG, which is known as a sex hormone-binding globulin. However, isoflavones have small effect on estrogen and it was shown that the major biological effect is on their ability to act as selective estrogen receptor modulators (SERMs) and to alter the endogenous estrogen metabolism as well for making anti-estrogenic like effects [14].

Although some studies have proved the effectiveness of isoflavone antioxidants in lowering cholesterol, there is still uncertainty towards the bioactive components which are responsible for physiological responses to soy. In addition, soybean products have been used in different clinical trials which indicated that during manufacturing and processing of soybean many components are lost especially isoflavones, which means that in order to have an effective modest change in cholesterol levels, the amount of soybean used should be increased, which may lead to other problems such as toxicity since an increased amount of antioxidant may serve as pro-oxidants which have the ability to destroy body cells [12]. A randomized trial was conducted to find the effect of both soy protein and animal protein on cardiovascular diseases and it was concluded that although soy protein had greater effects on lipid profile than animal protein, it did not show a significant change on vascular function [9].

Impact of soy products intake on cancer

Cancer is a disease that involves uncontrolled cell growth and malignant tumor formation and it can be considered as one of the life-threatening diseases. Healthy diet can play a vital role in preventing this disease from occurring, as well as effecting hormones, for example, postmenopausal women at an increased risk of developing cancer as a result of low level of estrogen. Scientists have been

encouraged to investigate the role of soybean on the hormone-related cancers, since they have observed low rates of cancer in Asian countries. In addition, many epidemiologic evidences have shown that for women who consumed soybean products as teenagers in China, the risk of breast cancer decreased by half. Also in comparison to Western women, Japanese patients have lower incidence in cancer with higher survival rates [3].

Endogenous estrogens are able to increase the breast cell multiplication and facilitate the growth of estrogen-sensitive neoplastic tumor cells or even pre-neoplastic cells. In postmenopausal women, the endogenous circulation level of estrogen will be higher and this might be related to increased risk of breast cancer [15]. Isoflavone contents of soy have a chemical structure that is similar to estrogen and they can bind to different estrogen receptors whether alpha ($ER\alpha$) or beta ($ER\beta$), which is why they are known as phytoestrogens. This evidence demonstrated that isoflavones have estrogen-like effects and they can help postmenopausal women by serving as natural alternative to estrogen therapy [16]. During 2006, the American Cancer Society advised that it was safe for patients with breast cancer to consume soy food without exceeding three servings per day and any concentrated form of isoflavone supplement was unacceptable [17]. Another mechanism of isoflavones in preventing breast cancer that has been studied is that isoflavones have the ability to act through estrogen independent mechanisms which includes the inhibition of Akt signaling pathway as well as a nuclear transcription factor κB DNA-binding activity. These pathways are important in creating a homeostatic condition among cell apoptosis, survival and formation [16].

It is well known that less estrogen exposure leads to lowering the chance of getting cancer and fibre content of soy products plays an efficient role in breast cancer prevention. Fibres are able to bind to estrogen and carry the excess estrogen out of the body and get rid of it which cuts the risk of breast cancer development. Also, a high-fat diet and high cholesterol levels in the blood can be considered as risk factors of developing breast cancer and this can be managed by fibre consumption as well [3]. Fibre has the ability to bind to cholesterol particles in the small intestine and prevent cholesterol from entering the bloodstream and through faeces the cholesterol will exit the body and this can explain why soy which is rich in fibre can help in reducing breast cancer risk [4]. Moreover, the protein source of soybean has a more positive effect than animal protein on reducing the risk of cancer when they are included daily in the diet [17].

In contrast, there are many other studies have shown that soy has no or negative effects regarding breast cancer. According to the University of Hawaii, much research has been conducted to investigate the linkage between soy consumption and breast cancer and no difference was found between the high intake of soy products and decreased level of breast cancer [18]. Some researchers do not support the use of any soy product that contains isoflavones for women with breast cancer or for others who are at high risk of developing that disease. Isoflavones contain many components and one of them is antioxidants, although these compounds are able to fight radical molecules, they can still alter the cancer cells which may lead to increasing the division of these cells and cause an increased the rate of the cell growth [19]. Although isoflavones have shown estrogen-like properties that may be able to prevent breast cancer under certain conditions, other studies have shown the opposite. Isoflavones can stimulate and increase the growth of estrogen sensitive breast cancer cells and some evidence showed the ability of isoflavones to bind and activate different estrogen receptors which can lead to an increased the cell growth rate [20]. A study conducted in 2007 indicated that soybeans are not pure, beside the major contents of protein, antioxidants, fibre and isoflavones, there are many other undefined components which are considered too unreliable to consume. These component mechanisms are unknown and there has not been enough study conducted to indicate how

those components work inside the body. Since there is already some controversy concerning soybean consumption as a result of many reasons, the presence of these unknown components would make the consumption of soybean more dangerous and increase the risk of toxicity [22].

There is also an uncertainty issue regarding the superior effects of soy protein rather than animal protein source. A study was conducted among Chinese women in Shanghai where two different protein-rich diets have been included among two groups of postmenopausal women to demonstrate the effect of soy protein diet versus animal protein diet on breast cancer. There was little positive effect in both groups, but there was no difference between the group who followed the soy protein rich diet and the other group who followed the diet rich in animal protein. This study concluded that using animal protein would be better than using soy protein since there is no controversy issue about animal protein consumption and it would be safer than consuming a soy protein rich diet which may end up with negative effects on health [21].

Conclusion

Legumes are a very important component to be added to the daily diet and include soybeans, dry beans, lentils and peas. Mostly these legumes are a nutrient-rich food which contains high amounts of dietary fibre as well as protein, low fat and no cholesterol. Soybean is one of the leguminous vegetables of the pea family that grows in subtropical, temperate, and tropical climates [1]. The potential effects of soybean, the health detriments or benefits of it remain a controversial issue, despite all pro-soy studies, a controversy has been brewing about whether soy products are really healthy or not, or if these products are positively/negatively linked to some of the diseases or not [7]. Numerous studies and research have been conducted to identify the effect of specific components of soy, including fibre, isoflavones and antioxidants. Different researchers submitted that soybean does have effects on health and especially on the heart. However, there is still uncertainty towards the bioactive components which are responsible for physiological responses to soy. While studies recommend the amount of soybean used should be increased, there is also evidence that this could lead to other problems such as toxicity because an increased amount of antioxidants may serve as pro-oxidants which have the ability to destroy body cells. Many other studies conducted to investigate the effect of soybean consumption on cancer indicated the efficient role of isoflavones in lowering the risk of breast cancer among postmenopausal women by its chemical structure that is similar to estrogen and its ability bind to different estrogen receptors. However, there are still many other undefined components which are too unreliable to consume and the presence of these unknown components would make the consumption of soybean more dangerous and increase the risk of toxicity.

This review of the literature to investigate the effects of soybean consumption on the rate of heart disease and cancer has shown that there is controversy regarding each component of soy and it is almost impossible to identify whether soy is good for health or bad since on each side the literatures have defended their point comprehensively. Soy is still considered as one of the “wonder foods” and the issue of whether soybean has negative or positive effects on health will be a continuing question. Thus, people are left with a choice; should they consume soybean or not?

References

1. Feng, C. and Ming, T. (2011). Beneficial Effects of Bioactive Peptides Derived from Soybean on Human Health and Their Production by Genetic Engineering. *Soybean and Health*, 14(1): 311-328.
2. Kinney, A. (2003). Engineering Soybeans for Food and Health. *AgBioForum*, 6(2): 18-22.
3. Kenneth, D. and Setchell, R. (2011). Soy Isoflavones-Benefits and Risks from Nature's Selective Estrogen Receptor Modulators (SERMs). *Journal of the American College of Nutrition*, 20(5): 354S–362S.
4. Messina, M., Watanabe, S. and Setchel, K.D.R. (2009). Report on the 8th International Symposium on the Role of Soy in Health Promotion and Chronic Disease Prevention and Treatment, *The Journal of Nutrition*, American Society for Nutrition. 139(4):796-802.
5. Frank, M., Alice, L. and Linda, V. (2006). Soy Protein, Isoflavones, and Cardiovascular Health. *Circulation*, 113: 1034-1044.
6. Jonas, C., Bernard, V., John, M., Akin. A. and Nteranya, S. (2006). Farmer evaluation of improved soybean varieties being screened in five locations in Kenya: Implications for research and development. *African Journal of Agricultural Research*, 1(5): 143-150.
7. Dillingham, B., McVeigh, B., Lampe, J. and Duncan, A. (2005). Soy Protein Isolates of Varying Isoflavones Content Exert Minor Effects on Serum Reproductive Hormones in Healthy Young Men. *Journal of Nutrition*, 135 (3): 584–591.
8. Oksana, A., Douglas, S. and Mike, S. (2002). Single daily dose of soybean phytosterols in ground beef decreases serum total cholesterol and LDL cholesterol in young, mildly hypercholesterolemic men. *American Journal of Clinical Nutrition*, 76:57–64.
9. Matthan, N., Jalbert, S. and Ausman, Karas, R. (2007). Lichtenstein AH. Effect of soy protein from differently processed products on cardiovascular disease risk factors and vascular endothelial function in hypercholesterolemic subjects. *American Journal of Clinical Nutrition*, 85:960–6.
10. Shawna, L., John, L. and Hong, S. (2010). Dietary intake of stearidonic acid–enriched soybean oil increases the omega-3 index: randomized, double-blind clinical study of efficacy and safety. *American Journal of Clinical Nutrition*, 92:766–75.
11. Xiao, C. (2008). Health Effects of Soy Proteins and Isoflavones in Humans. *The Journal of Nutrition*, American Society for Nutrition. 138(6):1244S-9S.
12. Francene, M. (2007). Soybeans or soymilk: does it make a difference for cardiovascular protection? Does it even matter? *American Journal of Clinical Nutrition*, 85:927–8.

13. Sacks, F.M., Lichtenstein, A., Linda Van Horn, L., Harris, W., Kris-Etherton, P. and Winston, M. (2006). Soy protein, isoflavones and cardiovascular health. A Summary of a Statement for Professionals from the American Heart Association Nutrition Committee. *Arteriosclerosis, Thrombosis and Vascular Biology*, 113:1034–44.
14. Persk, V., Turyk, M. and Wang, L. (2002). Effect of soy protein on endogenous hormones in postmenopausal women. *American Journal of Clinical Nutrition*, 75(1):145-53.
15. Yager, J. and Davidson, N. (2006). Estrogen carcinogenesis in breast cancer. *New England Journal of Medicine*, 354:270-282.
16. Lesle, M., Anna, H. and Mimi, C. (2010). A vegetable-fruit-soy dietary pattern protects against breast cancer among postmenopausal Singapore Chinese women. *American Journal of Clinical Nutrition*, 91:1013–1019.
17. Doyle, C., Kushi, L. and Andrews, K. (2006). Nutrition and physical activity during and after cancer treatment: an American Cancer Society guide for informed choices. *CA: A Cancer Journal for Clinicians*, 56:323-353.
18. Maskarinec, G., Morimoto, Y. and Franke, A. (2011). The Volume of Nipple Aspirate Fluid Is Not Affected by 6 Months of Treatment with Soy Foods in Premenopausal Women. *The Journal of Nutrition*, 141(4): 626-30.
19. Duffy, C., Perez, K. and Partridge, A. (2007). Implications of phytoestrogen intake for breast cancer. *CA: A Cancer Journal for Clinicians*, 57:260-277.
20. Mark, J. and Charles, E., (2008). Soy isoflavones, estrogen therapy, and breast cancer risk: analysis and commentary. *Nutrition Journal*, 17(7): 1-11
21. Hirose, K., Matsuo, K. and Iwata, H. (2007). Dietary patterns and the risk of breast cancer in Japanese women. *Cancer Science*, 98:1431–8.
22. Erika, B., Theresa, M. and Heide, S. (2013). Gender-Specific Modulation of Markers for Premalignancy by Nutritional Soy and Calcium in the Mouse Colon. *The Journal of Nutrition*, 137(1): 211-215.