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***REVIEW PAPER***

# Plant Proteins and their Health Effects: A Review

PARAS PORWAL[1], DILIP KUMAR*[2] AND SUDHIR KUMAR[3]

[1]*Amity Institute of Biotechnology, Amity University Uttar Pradesh, Lucknow Campus*
[2]*Department of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh*
[3]*Centre of Food Science and Technology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh*
**email : dilip.bhu@live.in*

## ABSTRACT

**Plant proteins are good substitutes for meats or animal proteins. Plant proteins have a less content of essential amino acids in comparison to animal proteins. Legumes include peas, beans, lentils, peanuts, and others that can be used as food. Vegetable protein is also used in the preparation of infant food. Soybeans are the best among legumes because of their concentrated source of isoflavones and gives hypolipidemic effects and lowering cholesterol from the human body. The clinical studies have shown that soy isoflavones may uses against breast cancer in women and prostate cancer in men. The milk can be replaced with Soy-based and meat-based formulas to infants who are allergic to milk. The anti-thyroid actions of soy appear to be consistent in both animals and humans.**

**Key words** *proteins, isoflavones, soybeans, health.*

Proteins are an essential component of the diet needed for the survival of animals and humans. They provide adequate amounts of required amino acids. Nutritional quality of a food depends on protein content, digestion, absorption, and utilization of proteins. Amino acids availability varies with protein sources, processing treatments, and interaction with other components of the diet. Proteins which lacks in one or more amino acids are considered to be of poor quality. For e.g. tryptophan and lysine are nutritionally limiting in corn, lysine in wheat and other cereals, and methionine in soybeans and other legumes (Young, 2001).

Source of proteins in human diet are mainly animal proteins (e.g. egg, milk, meat and fish) and plant proteins (e.g. pulses, cereals, nuts, beans and soy products). Animal proteins have high Biological value than vegetable proteins with regards to their amino acid composition and are more biologically complete. The "complete proteins" refers to foods that contain all the essential amino acids needed by the body and "incomplete proteins" refers to foods that are lacking in one or more essential amino acids. There are more complete proteins from animal sources as compared to vegetable proteins, which are "biologically incomplete". An incomplete protein can be transformed into a complete protein by combination of two or more proteins together that is called "complementarity of proteins". Two plant proteins such as legumes and grains or legumes and nuts/ seeds can be combined to formulate a complete protein from two incomplete proteins (Young, 2001). Legumes include peas, beans, lentils, peanuts, and others that can be used as food. Soybeans are the best among legumes because of their concentrated source of isoflavones. It has been hypothesized that isoflavones reduce the risk of cancer, heart disease, and osteoporosis, and also help relieve menopausal symptoms (Mark, 1999).

Soybeans hold 35-40% protein on a dry-weight basis, of which 90% is comprise of two storage globulins, 11S glycinin and 7S b-conglycinin. Glycinin have A (acidic) & B (basic) subunits, whereas b-conglycinin has $\alpha$, $\alpha'$ & $\beta$ subunits (Torres *et al.,* 2006). These proteins are full of all amino acids essential to human nutrition which makes soy products almost equivalent to animal sources in protein quality with less saturated fat and no cholesterol (Young, 1991) Isoflavones are biologically active in soybeans. Soy isoflavone supplements contain up to 500 mg ISF/g (Anthony *et al.,* 1996). Genistin, daidzin and glycitein are the main soy isoflavones.

### Animal proteins

The major source of animal protein is meat, poultry and seafood that almost contains equal amount of proteins. For example beef, lamb, pork, fish and poultry almost contains equal proteins. Other sources include organs and glands such as liver, kidney, brain, heart and sweetbreads, which are also rich in vitamins and minerals. Milk is an important source of protein but also with a rich source of calcium and vitamins. Egg is a complete protein with excellent quality; one egg is equivalent to 6 g of protein. The egg yolk contains protein, fat and cholesterol and egg white contains mostly protein with no fat or cholesterol (Young, 2001).

### Plant proteins

The proteins from plant sources are mostly incomplete proteins and have smaller amounts of proteins than animal sources. Legumes are an exception of this: peas, lentils, beans, chickpeas, lima beans, soybeans and peanuts contain large amounts of proteins in their seeds. In some legumes the protein contents in their dried form are higher than in fresh. Plant proteins are good substitutes for meats or animal proteins. Proteins from legumes are not equal in quality with animal proteins but even than can be an alternate substitute when consumed in combination with other foods (Young, 2001).

The anti-nutritional factors such as inhibitors of digestive enzymes and lectins in soybeans and other legumes have been reported to lower nutritional value (Mendel and David, 2001). Inhibitors are generally inactivated by heat treatment during food processing or can partially remove by fractionation to improve nutritional quality. The commercially heated flours mostly retain 5-

20% of the original trypsin and chymotrypsin inhibitor activity. The prolonged heating is required to destroy all inhibitor activity can damage the nutritive value of soy proteins. So, soy proteins can be changed into dough like materials under certain circumstances, but they lack the dough-forming properties inimitable to wheat proteins. The addition of soy proteins to bread dilutes the wheat gluten and starch, depresses loaf volume, and affects crumb texture. Thus, soy proteins cannot be used simply to replace wheat flour (Mendel and David, 2001).

**Use of vegetable protein in infant formula**

The milk can be replaced with Soy-based and meat-based formulas to infants who are allergic to milk. Soy proteins are deficient in methionine. The infant formulas are mostly made by first preparing the aqueous portion containing protein source, carbohydrate and minerals and a separate fat portion generally containing an emulsifier. These two portions are then mixed, homogenized, analyzed and formulation adjustments are made if required. The heat and oxygen sensitive ingredients (e.g., vitamin C and the B vitamins) are then added collectively with the required amount of water to standardize the formula. The product is then either spray dried to yield a powder or heat treated. The source of carbohydrate is usually sucrose, corn syrup (hydrolyzed corn starch) or a mixture of sucrose and corn syrup in a soy protein infant formula. Soy protein formulas are suitable for feeding infants who exhibit lactose intolerance or have lactase deficiency (Thomson, 1979).

**Table 1. Undesirable potential contaminants to be considered in infant formulas**

| Protein source | Potential contaminant |
|---|---|
| Cottonseed | Gossypol |
| Cereal grains | Gluten |
| Peanut | Aflatoxin |
| Rapeseed | Erucic acid |

**Beneficial effects of soy protein rich diet**

- Prevention of coronary heart disease.
- Hypolipidemic effects and rich source of isoflavones.
- Improves bone health.
- Improves menopausal symptoms.
- Prevents breast and prostate cancers.

**Hypolipidemic effects and rich source of isoflavones**

The first human study on the cholesterol-lowering effect of soy protein was reported by Hodges *et al.*(1967) and demonstrated that replacement of mixed proteins by mainly isolated soy protein products at an intake of 100 g/ day reduced mean cholesterol levels by >2.59 mmol/L in hypercholesterolemicmen. Anderson *et al.* (1995) analyzed 38 controlled clinical studies published between 1977 and 1994. Among them, 30 studies were conducted with hypercholesterolemic subjects. The results suggested that mean intakes of 47 g/day, ranging from 17 to 124 g, of isolated or textured soy protein resulted insignificant reduction in total cholesterol by 9.3%, LDL-cholesterol by 12.9% and triglycerides by 10.5%, with an insignificant change in HDL cholesterol levels, compared with animal protein.

The USFDA approved a food-labeling health claim for soy protein in the prevention of coronary heart disease in 1999 but clearly indicated that ''the evidence did not support a signiûcant role for soy isoflavones in cholesterol-lowering effects of soy protein'' (USFDA, 1999). Since then, retail of soy consumption has significantly increased.

**Improves bone health**

Meta-analyses of randomized controlled trials suggested that soy isoflavones intervention significantly reduced bone loss of the spine (Ma *et al.,* 2007) and markedly decreased urinary deoxypyridinoline, a bone resorption marker, and increased serum bone speciûc alkaline phosphatase, a bone formation marker, in menopausal women (Ma *et al.,* 2008).Studies in postmenopausal women have shown similar results (Morabito *et al.,* 2002; Lydeking-Olsen *et al.,* 2004). However, no signiûcant effects of isoflavones on bone mass density or biomarkers of bone metabolism have been reported in other studies in which soy protein was supplemented and isoflavones poor soy protein was used as control (Gallagher *et al.,* 2004; Cheong *et al.,* 2007). These data indicate that soy protein may interfere with the effects of isoflavones either by masking or antagonizing its effect. A non-soy control group could be addressed this issue for future studies. Although increasing data, especially those from more recent studies, tend to support a positive role of soy intake in the prevention of bone loss, especially on the biomarkers of bone metabolism, in postmenopausal women, more human trials are needed to verify this action.

**Improves menopausal symptoms**

A meta-analysis of 25 trials published between 1966 and 2004indicates that soy phytoestrogens does not improve hot flashes or other menopausal symptoms. Intake of soy supplements for treatment of menopausal symptoms in patients with early breast cancer did not show any significant effect on menopausal symptom scores or quality of life after 12 week compared with placebo (Mac Gregor *et al.,* 2005).

**Prevents breast and prostate cancers**

Many animal and human studies have been conducted to determine the association between soy intake and breast and prostate cancers. A variety of human cancer cell lines have also been used *in vitro* studies to understand the cellular and molecular events involved in the regulation of cell proliferation and apoptosis by soy components. Case-control studies have shown that high soy intakes in adolescence are associated with low risk for breast cancer in adulthood (Shu *et al.,* 2001).But a recently published Japanese collaborative cohort study suggested that consumption of soy foods such as tofu, boiled beans and miso soup has no protective effects against breast cancer (Nishio *et al.,* 2007). Soy isoflavones may stimulate epithelial cell proliferation in the breasts of premenopausal women in clinical studies (McMichael-Phillips *et al.,*1998). Dietary isoflavones significantly decreased the risk of prostate cancer in Japanese men (Nagata *et al.,* 2007). Supplementation with soy protein or soy isoflavones decreased the markers of cancer development and

**Table 2. Health claims for soy protein in different countries**

| Country | Description | Reference (s) |
|---|---|---|
| Malaysia | Soy protein helps reduce cholesterol levels. | The Solae Company, 2006 |
| Japan | Helps improve diet for those with high cholesterol level. | Paul G, 2007 |
| Korea | Soy protein helps improve elevated levels of blood cholesterol. | Paul G, 2007 |
| France | Soya protein, as part of a diet low in fat and saturated fat, may reduce blood cholesterol. | Paul G, 2007 |
| United Kingdom | The inclusion of at least 25 g of soy protein per day, as part of a diet low in saturated fat, can help reduce blood cholesterol levels | Joint Health Claims Initiative, 2002 |
| Brazil | Daily consumption of at least 25 g of soy protein could help the cholesterol reduction. Its consumption should be associated with a balanced diet and a healthy lifestyle. | Paul G, 2007 |
| Canada | The consumption of 25 g of soy protein per day reduces the risk of heart disease. | Paul G, 2007 |
| South Africa | Diets which contain at least 25 g soy protein (4 servings) daily and which are low in saturated fat and cholesterol may reduce the risk of heart disease by lowering cholesterol levels. | Paul G, 2007 |
| United States, Philippines, Indonesia | 25 g of soy protein a day, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease. | Paul G, 2007; U.S FDA, 1999 |

progression in prostate cells including prostate-specific antigen (PSA), testosterone, and androgen receptor in patients with prostate cancer or in men at high risk for developing advanced prostate cancer(Kumar *et al.,*2004; Dalais *et al.,*2004)

## CONCLUSION

Consumption of soy protein appears to consistently lower blood LDL cholesterol in hyperlipidemic subjects. However, the magnitude of the effect and the required intake to achieve the effect are variable in different studies. Increasing evidence, especially in light of results from recent human studies, tends to support the beneûcial effects of soy isoflavones in the prevention of bone loss in postmenopausal women. Although soy protein or isoflavones positively impact biomarkers of prostate cancer, their potential benefits have not been substantiated in clinical trials. The effects of soy protein and isoflavones in relieving menopause symptoms and prevention of breast cancer have been proved. The antithyroid actions of soy appear to be consistent in both animals and humans. Present evidence indicates that soy protein may be responsible for at least the hypolipidemic effects.

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