Indian Farming **67**(11): 18–20; November 2017

Soybean

for good health and nutritional security

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Soybean not only provides vegetable protein and oil for millions of people but also ingredients for hundreds of cosmetic and pharmaceutical products globally. It is in cultivation in the eastern Asian countries (China, Japan and Korea) for thousands of years and constitutes an important component of their diet and medicines. Effective steps need to be taken to increase production, distribution and consumption of soybean. Development of specialty soybean should be enhanced to make it popular among the consumers. Breeding efforts need to be accelerated to make soybean free from anti-nutritional factors such as Kunitz trypsin inhibitor (KTI), phytate, etc. and lipoxygenase for off-flavor.

Key words: Health, Nutrition, Seeds, Soybean

SOYBEAN (*Glycine max* L. Merr.) is widely grown in many countries across the world. United States of America, Brazil, and Argentina, China and India are the major producer of soybean. In India, within a short span of its commercial cultivation (~40 years), soybean has become *numero uno* oilseed crop covering more than 10 million ha with 14 plus million tonne in production (www.agricoop.nic.in). However, because of limited consumption, India is yet to reap the full benefit of soybean in meeting the protein needs of its largely vegetarian consumers, and protein and energy malnourished population. Popularization of this 'functional food' among the consumers can combat cancer, blood serum cholesterol, osteoporosis, heart diseases etc.

Composition of soybean seeds

Fats and oil: Soybean seed contains 18 to 22% oil. The quality of soybean oil is considered to be good as it contains lesser saturated fats and more unsaturated fats. In general, per 100 g soybean oil contains 16 g of saturated fatty acids (SFA), 23 g of mono-unsaturated fatty acids (MUFA), and 58 g of polyunsaturated fatty acids (PUFA) (Table 1). The SFA includes palmitic acid (C-16:0) (~10%) and stearic acid (C-18:0) (~4%). The major unsaturated fatty acids found in soybean oil includes mono-unsaturated oleic acid (C-18:1) (23%), polyunsaturated linoleic acid (C-18:2) (51%), and α-linolenic acid (C-18:3) (7-10%). Thus, Omega-6 polyunsaturated fatty acid is the predominant fatty acid in soybean seeds. Presence of oxidation-prone linolenic acid in higher proportion reduces storability of soybean oil, thereby necessiating hydrogenation. The process of hydrogenation leaves behind trans fats, which are not good for health.

Table 1. Nutrient value in soybean mature seed (raw)

Nutrients	Value per 100g
Energy	446 Kcal
Protein	36.49 g
Total lipid (fat)	19.94 g
Fiber (total dietary)	9.3 g
Calcium, (Ca)	277 mg
Iron, (Fe)	15.70 mg
Magnesium, (Mg)	280 mg
Phosphorus, (P)	704 mg
Potassium, (K)	1797 mg
Sodium, (Na)	2 mg
Zinc, (Zn)	4.89 mg
Vitamin C, total ascorbic acid	6.0 mg
Thiamin (B_1)	0.874 mg
Riboflavin (B_2)	0.870 mg
Niacin	1.623 mg
Vitamin (B_6)	0.377 mg
Folate, DFE	375 µg
Vitamin A,	22 IU
Vitamin E (alpha-tocopherol)	0.85 mg
Vitamin K (phylloquinone)	47.0 µg
Fatty acids, total saturated	2.884 g
Fatty acids, total monounsaturated	4.404 g
Fatty acids, total polyunsaturated	11.255 g

Source: USDA National Nutrient Database (https://ndb.nal.usda.gov)

Protein: Among the legumes, soybean is the richest source of quality protein that contains optimum dietary essential amino acids profile for human and animal nutrition. Main types of protein prevalent in soybean are glycinin and conglycinin, which makes up about 80% of total protein content. As soybean contains negligible (1-3%) starch, and hence is considered as a

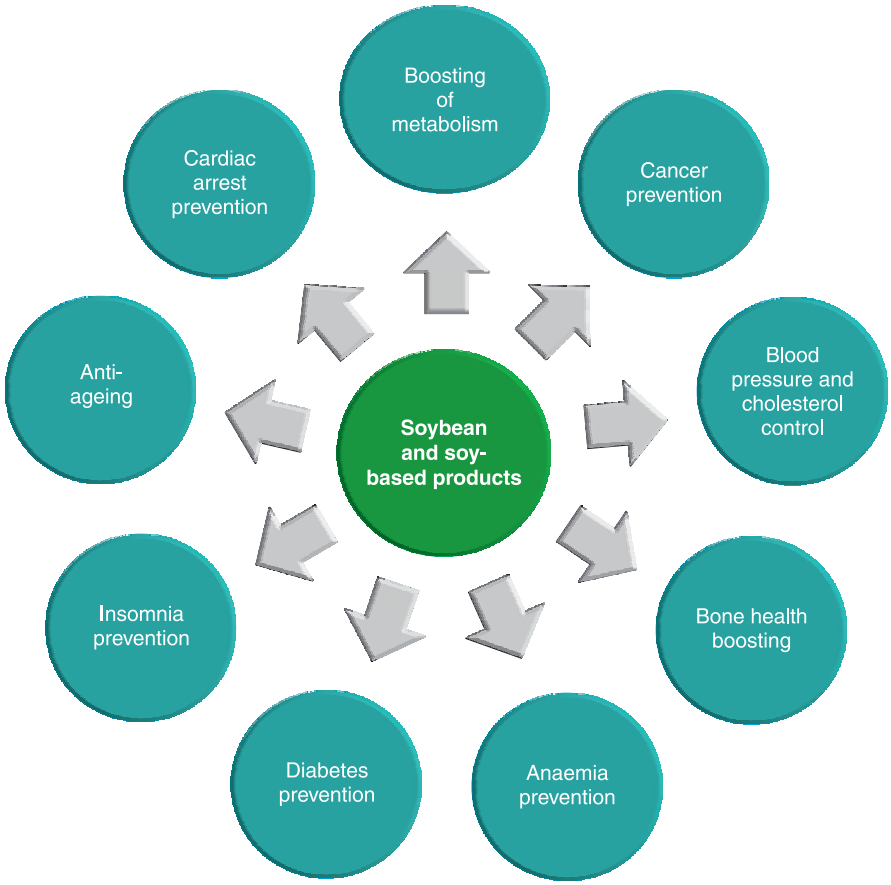


Fig. 1. Various health benefits of soybean and soy-based products

good source of protein for diabetics. Soybean also contains bioactive proteins viz., lectin and lunasin, which are reported to have anti-cancer activity. In spite of presence of 38 to 45% protein, India is yet to popularize soybean as an answer to the menace of protein and energy malnutrition (PEM) prevailing rampantly in the country.

Vitamins and minerals : Soybean seed contains a wealth of nutrients, vitamins, organic compounds and a significant amount of dietary fibre. Vitamins available in soybean include riboflavin, vitamin K, B_6, thiamin, folate and vitamin C. The mineral includes iron, zinc, phosphorus, copper, potassium, magnesium, manganese and calcium. It is also a rich source of organic compounds and antioxidants essential for good health. Tocopherols, the antioxidant molecules present in soybean seeds act as free radical quenchers preventing lipid peroxidation in the soybean oil and its products (Table 1). Soybean also contains higher amount of isoflavones that performs several important body functions.

Soy-based foods

Soybean can be consumed in a variety of ways. Soybean seeds can be germinated to consume as soy-sprout, salad or vegetable. The seeds can be fermented to produce tempeh, miso or fermented bean paste, which are regular food in China, Japan, Korea etc. Roasted soybean seeds are popularly consumed as snacks. Soaked soybean seeds can be used to extract soy-milk, a whitish liquid suspension, or tofu, a curd somewhat resembling cottage cheese. Young, tender soybean pods, commonly known as edamame, are usually boiled or steamed to eat the seeds. Soybean seeds are crushed with wheat and fermented in salt water to produce soy-sauce, a salty brown liquid which is ubiquitous ingredient in Asian cooking. Soybean seeds are treated to extract the soybean oil, which is a popular cooking medium worldwide. In India, soybean oil constitutes about 25% of the edible oil produced in the country. Soybean oil is processed in to margarine, shortening and vegetarian cheeses. Industrially, the oil is used as an ingredient in paints, adhesives, fertilizers, sizing for cloth, linoleum backing, and fire-extinguisher fluids, among other products. De-oiled cake or soybean meal is a rich source of protein and serves as a high-protein meat substitute in many food products, including baby foods and vegetarian foods. It is also used as protein-rich feed for the meat animals. India earns valuable foreign exchange (₹ 62,000 million during 2012-13) through export of soymeal. Soybean flour is mixed with wheat flour (1:9) to prepare 'chapatti' in India. Soy-flour can be used to prepare variety of crispy snacks as well. Soy-chunk is an important ingredient in Indian vegetarian dishes.

Nutritional value and health benefits of soybeans

Soybean has been found with pack of benefits toward maintaining good health of the consumers. It has the ability to improve digestion and metabolism leading to healthy growth. It can also maintain the health of heart, bones, defend against cancer, birth defects, reduce the ill-effects of menopause, increase blood circulation, decrease the risk of diabetes, and tones up the body (Fig. 1).

Metabolism and healthy growth: Proteins are essential for growth and development of human body. Adequate supply of protein boosts metabolic function and overall growth of the body. Soybean supplies quality proteins which are comparable to the protein obtained from animal sources viz., red meat, fish, egg, etc. Moreover, digestibility and bioavailability of the soy-protein is high enough to boost proper growth and maintaining good health. Soybean also provides a decent amount of fibre and protein promoting healthy gain of body weight.

Prevention of cancer: Free radicals are undesirable byproducts of cellular metabolism. It can cause harm to the cells. The antioxidants prevalent in soybean generally seek out and neutralize the free radicals preventing onset of various forms of cancer. High fibre present in soybean eases

the digestive process and reduces strain on the gastro-intestinal system, and is associated with reduction in colorectal and colon cancer.

Cholesterol and blood pressure control: Soybean is rich in omega-3 and omega-6 fatty acids, which helps in keeping cardiovascular diseases at check. The unsaturated fatty acids help in lowering the total cholesterol and thus prevent heart attacks and strokes. It is said that consumption of 50 g soybean per day can reduce LDL or bad cholesterol by about 3%. The poly-unsaturated fatty acids viz., linoleic and linolenic acid are necessary to maintain a healthy system of regulating muscle function and appropriate blood pressure level. Potassium present in the soybean seeds balances the concentration of sodium from the body and thus helps maintaining the blood pressure of the body.

Strengthening of bones: Soybean seed contains wealth of vitamin and minerals viz., calcium, magnesium, copper, selenium, and zinc, which are utilized in a variety of cellular processes especially osteotrophic activity involved in healthy growth and strengthening of the bones. It also speeds up the healing process of bones.

Blood cell formation and circulation: For up-keeping and proper functioning of the body cells, proper supply of oxygen is essential, which is performed by the blood. Regular formation of new blood cells and their proper circulation throughout the body maintains the momentum of growth and development of the body. Iron and copper, which are found in soybean seeds in abundance, facilitates formation of new blood cells and thus helps avoiding dangerous disease like anaemia.

Prevention of diabetes: Whole soybeans are very low on glycemic index (12). It has shown an ability to increase insulin receptors in the body. Thus, consumption of soybean helps in prevention and management of the Type 2 diabetes.

Sound sleep: Soybean contains magnesium, a mineral element which has role in increasing the quality, duration and restfulness of the body and sleep. Its role in metabolism also helps in reducing sleep disorders and occurrence of insomnia.

Anti-ageing: Soybean contains vitamin E that helps in formation of new skin cells and renewing of dead skin cells. Soybean also possesses phytoestrogens that promotes production of body estrogens. It has role in reduction of the visible signs of ageing like wrinkles, dark spots etc. Therefore, soy-protein has become an essential ingredient in the cosmetics, especially the anti-ageing creams.

SUMMARY

Soybean is the richest source of effective plant proteins which can be a powerful alternative to the pulses to address the menace of protein and energy malnutrition prevalent in our country. Of late, soybean genotypes free from Kunitz trypsin inhibitor (KTI) and lipoxygenase have been developed at the Indian Institute of Soybean Research, Indore. Further, the taste and aroma of the beans should be as per liking of the Indian consumers so that it can reach more households as a popular functional food. Government intervention will be needed to harvest the benefits of soybean and transfer it to the needy consumers. To reach the poor and disadvantaged category of consumers, soybean can be distributed through public distribution system (PDS), mid-day meal and similar other government programmes. Such initiative would not only make soybean a household food but also ensure nutritional security to the consumer, and thus would help realize the current Government's dream of '*swastha bharat*' (Healthy India).

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ICAR New Portals

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- ICAR-Enterprise resource planning (ERP) System to this manage the human resource in information of the council including pay roll, finance and budgeting.
- KVK Knowledge Network Portal (http://kvk.icar.gov.in) to share basic information and facilities of KVKs with contingency plans, demonstration schedule, and advisories.
- Management System for Post-Graduate Education (MSPGE) enabling academic and e-learning modules while also being a repository of academic records
- E-*Samvad,* an online interface of the Council to answer citizens queries.
- KRISHI –A knowledge repository portal of digital information pertaining to research experiments, outputs, publications, etc.
- E-office for digital filing of information to help speed up the processing time of files.
- E-*Krishi Manch*, a dedicated portal for farmer-scientist interaction.