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## Review Paper:

# Food fortification of soy protein isolate for human health

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## Abstract

Growing malnutrition and health problem in India can be well tackled with supplementary diet containing soy proteins as soy proteins are one of the best quality proteins offering many health benefits. Health care profession across the globe considers the quality of soy protein equivalent to that of other high-quality protein such as egg and milk.

Soy protein helps to prevent cancer, lowers cholesterol level, combat osteoporosis and regulate menopause. Presence of bioactive components arginine and isoflavones is responsible for the health benefit of soy protein. From food fortification point of view, soy protein isolate is best among all the sources of soy proteins. Biscuits are the ideal food vehicle for soy protein isolate fortification.

**Keywords:** Soy protein isolates, malnutrition, fortification, protein quality, bioactive component.

## Introduction

Twenty one percent of the current population of Indian is undernourished. Regarding children, about 33 percent of infants are born with low birth weight. The prevalence of underweight in children from 1-5 years is also enormous in India and about 53 percent of infants born are moderately underweight and 21 percent are severely underweight.

The prevalence of stunting is also very high in some of the Indian states. On an average, 52 percent of children have moderate to severe stunt growth. Among adults, almost one-third of the population has Chronic Energy Deficiency (CED). The prevalence of CED is high (around 50 percent) in some States of India such as Bihar and Rajasthan<sup>1</sup>. Infant mortality rate (IMR) in India is about 56. Malnutrition is one of the reasons for infant mortality. Malnutrition is a situation where person's diet does not contain enough nutrients like energy/ carbohydrate, fats, proteins, minerals and vitamins.

Malnutrition first leads to poor physical and mental growth of the infant and if it continues for long time, it becomes cause for the death. Malnourished children cannot achieve their full potential and hence they cannot become a productive community<sup>2</sup>. The malnutrition problem in Maharashtra (one state in India) is more severe. Maharashtra's IMR is 58. Every year many cases of deaths

of tribal kids due to malnutrition are reported in Maharashtra. The most malnutrition affected region of Maharashtra is Vidarbha. Places of Vidarbha like Melghat (Amravati), Yevatmal, Dhule, Chandrapur, Gondia are always in news due to malnutrition deaths.

Yet, like developed countries, India is experiencing diet related chronic diseases (non-insulin dependent diabetes and coronary vascular diseases) which are now among the top causes of death in most parts of India, especially among the urban population. It has been recently reported that India ranks number one in the world in the heart related death. India will be a new capital of non-communicable diseases, every day about 8,112 deaths occur in India due to cardiovascular diseases which account to almost 300,000 deaths every year (TB kills 20 lacks people every year). By year 2020, mortality from cardiovascular diseases will exceed combined deaths from tuberculosis, hepatitis and AIDS and by the year 2025. India will be home for largest number of diabetic and heart patient in the world.

Indian diets are generally rich in carbohydrate and less in proteins. Carbohydrate (starches, sugars, celluloses) are the compounds of carbon, hydrogen and oxygen. Carbohydrates are therefore said to be the hydrate of carbon and are presented by the general chemical formula  $\text{CH}_2\text{O}$ . Carbohydrates basically provide energy to human body. Proteins are the polymers of amino acids linked by peptide bonds to form polypeptide chain.

There are 20 different amino acids involved in the making of proteins. Each amino acid consists of a central carbon atom to which carboxyl group ( $\text{COOH}$ ), an amine group ( $\text{NH}_2$ ), a hydrogen atom (H) and R group are attached. Amino acids with proteins are grouped on the basis of the characteristics of side chain R groups and are: Aromatic amino acids (phenylalanine:  $\text{C}_9\text{H}_{11}\text{NO}_2$ , tryptophan:  $\text{C}_{11}\text{H}_{12}\text{N}_2\text{O}_2$ , tyrosine:  $\text{C}_9\text{H}_{11}\text{NO}_3$ ), Aliphatic amino acids (alanine:  $\text{C}_3\text{H}_7\text{NO}_2$ , glycine:  $\text{C}_2\text{H}_5\text{NO}_2$ , isoleucine:  $\text{C}_6\text{H}_{13}\text{NO}_2$ , leucine:  $\text{C}_6\text{H}_{13}\text{NO}_2$ , proline:  $\text{C}_5\text{H}_9\text{NO}_2$ , valine:  $\text{C}_5\text{H}_{11}\text{NO}_2$ ), Basic amino acids (arginine:  $\text{C}_6\text{H}_{14}\text{N}_4\text{O}_2$ , histidine:  $\text{C}_6\text{H}_9\text{N}_3\text{O}_2$ , lysine:  $\text{C}_6\text{H}_{14}\text{N}_2\text{O}_2$ ), Acidic amino acid (aspartic acid:  $\text{C}_4\text{H}_7\text{NO}_4$ , glutamic acid:  $\text{C}_5\text{H}_9\text{NO}_4$ ), Sulphur-containing amino acids (cysteine:  $\text{C}_3\text{H}_7\text{NO}_2\text{S}$ , methionine:  $\text{C}_5\text{H}_{11}\text{NO}_2\text{S}$ ), Hydroxylic amino acids (serine:  $\text{C}_3\text{H}_7\text{NO}_3$ , threonine:  $\text{C}_4\text{H}_9\text{NO}_3$ ), Amidic amino acid (asparagines:  $\text{C}_4\text{H}_8\text{N}_2\text{O}_3$ , glutamine:  $\text{C}_5\text{H}_{10}\text{N}_2\text{O}_3$ ).

From nutrition point of view, protein provide energy to human body but at the same time play important role in proper functioning and growth of body as component of blood, muscle, antibody, enzymes etc.

Cereals are the major source of protein in India which have inferior quality of protein as compared to other vegetable and animal protein sources. One of the reasons for malnutrition and other diet related diseases is low consumption of proteins as proteins are vital to living process and carry out a wide range of functions essential for the sustenance of life. As the person is getting protein from diet only, therefore protein supplementary feeding or protein fortification in diet is one of the ways to control low protein diet related problems.

In fortification, a nutrient is added to commonly consumed foods to improve the quality of diet. In fortification the food in which nutrient is incorporated is referred to as the vehicle and the nutrient as the fortificant. The criteria for choosing vehicle are that it should be consumed by all population groups in regular amount. It should have good organoleptic characteristics and should be easily processed and stored. The criteria for choosing protein fortificant are that it should have rich amount of quality proteins which should be easily and economically available<sup>3</sup>. As soy proteins are satisfying the said criteria and at the same time offering many health benefits, therefore judged as one of the best fortificant in protein fortification.

#### Soybean: A source of quality protein

About 40 percent of calories from soybeans are derived from proteins, making soybean higher in proteins than other legumes and many animal's products. However, it is the quality of soy proteins that is most remarkable<sup>4</sup>.

The protein quality of soy proteins can be judged on the basis of Essential Amino Acid Pattern (EAAP), Biological Value (BV), Protein Efficiency Ratio (PER) and Protein Digestibility Corrected Amino Acid Score (PDCAAS). The essential amino acids are: Lysine ( $C_6H_{14}N_2O_2$ ), Leucine ( $C_6H_{13}NO_2$ ), Isoleucine ( $C_6H_{13}NO_2$ ), Tryptophan ( $C_{11}H_{12}N_2O_2$ ), Valine ( $C_5H_{11}NO_2$ ), Methionine ( $C_5H_{11}NO_2S$ ), Phenylalanine ( $C_9H_{11}NO_2$ ), Threonine ( $C_4H_9NO_3$ ) and Histidine ( $C_6H_9N_3O_2$ ). The comparison of EAAP of soy protein with reference protein is shown in table 1. Health care profession across the globe recognized the superiority of soybean protein and considers it equivalent to that of other high-quality protein such as egg and milk (reference protein) as it provides all the nine essential amino acids in the amounts needed for human health<sup>5</sup>.

The 1990's FAO/WHO protein evaluation committee put soy protein at par with egg and milk protein. If the quality of soy protein is compared with other sources on the basis of BV, then the quality of soy protein seems to be inferior than reference protein source as shown in table 2. Soy has BV 59 as compared to whole egg, egg white, casine, rice having BV

100, 88, 77 and 74 respectively<sup>6</sup>. That has been long-standing misconception that soy protein is inferior to protein from animal sources. This misunderstanding is mainly due to the criteria routinely used to evaluate protein quality. A common method for evaluating protein quality since 1919 has been PER. If the quality of soy protein is compared with reference protein sources on the basis of PER, then the quality of soy protein is found to be very closer but not superior than reference protein sources shown in table 3.

**Table 1**  
**Comparison of Essential Amino Acid Profile**  
**Reference Protein v/s Soy Protein**

Essential amino acids	Reference protein Mg/g protein	Soy protein mg/g proteins
Isoleucine	28	49
Leucine	66	82
Lysine	58	63
Methionine	25	26
Phenylalanine	63	90
Threonine	34	38
Tryptophane	11	14
Valine	35	50
Histidine	19	26

Source: FAO/WHO (1989)

**Table 2**  
**BV of Different Protein Sources**

Protein source	BV
Whole egg	100
Egg white (albumine)	88
Casine	77
Rice	74
Soy	59
Wheat	54

Source: Europe Dairy Association Report (1997)

**Table 3**  
**PER of Different Protein Sources**

Protein source	PER value
Lactalbumin	2.86
Casine	2.50
Soy	2.12
Rice	1.25
Wheat	1.00

Source: Newzealand Dairy Board  
Annual Report (1999)

The PER of soy is 2.12 as compared to lactalbumin having PER 2.86 and casine having PER 2.5<sup>7</sup>. It is only through increased knowledge about human amino acids needs that the PER's shortcomings were recognized. The basic flaw in the PER method is that it measures the ability of a protein to support growth in young, rapidly growing rats and not in

young rapid growing humans. The use of rat requirements instead of human requirements in an overestimation of the quality of protein. Growing rats have much higher needs than humans for the sulfur containing amino acid methionine to support growth. Consequently, the sulfur containing amino acids have typically been considered the "limiting" amino acids in soy protein.

Food and Agriculture Organization (FAO) and World Health Organization (WHO) constituted a committee in 1989 to revise protein quality evaluation techniques, as then existing method was over estimating quality of animal protein and under estimating vegetable proteins. The committee evaluated protein quality based on amino acid requirement in 2-5 years of children where the amino acid requirement is maximum. Based on amino acid requirement and digestibility of a particular protein, the committee suggested a new protein quality evaluation technique PDCAAS. Table 4 is showing PDCAAS of different protein source.

**Table 4**  
**PDCAAS of Different Protein Sources**

PER value	PDCAAS
Soy	1.00
Casine	1.00
Egg white	1.00
Beef protein	0.92
Pea flour	0.69
Kidney bean (canned)	0.68
Whole wheat	0.40

Source: FAO/WHO 1989

PDCAAS of soy, casine and egg white is found to 1.00 whereas of beef is found to be 0.92. As per this universally accepted method, the quality of soy protein is at par with milk and egg protein and in fact superior to beef. The soy proteins have PDCAAS equal to 1.0, the highest possible score.

**Benefits of soy protein:** Analysis of extensive data on diet and disease concluded that a diet rich in animal protein, may have the greatest potential for enhancing risk for chronic degenerative diseases such as heart disease and cancer whereas diet rich in soy protein has a beneficial effect on health. Consumption of soy protein helps to prevent cancer, lowers cholesterol level, combats osteoporosis and regulates menopause<sup>8</sup>.

Soy foods are rich in ant carcinogens particularly isoflavones. Isoflavones are found in abundant quantity in soybean and soy foods. Human epidemiological studies suggest that as little as one serving of soy foods each day may be protecting against many types of cancer including cancer of the lung, colon, rectum, stomach, prostate and breast<sup>9,10</sup>.

High blood cholesterol levels have been shown to increase the risk of atherosclerosis, the underlying cause of cardiovascular disease (CVD) i.e. heart disease, heart attacks, heart failure etc. Diet is the basic elements in the development of CV, so the dietary modification is the first step in the treatment of elevated blood cholesterol level. Cholesterol lowering dietary therapy is recommended over drug therapy which can produce negative side effect and is expensive. Investigators have shown that consumption of soy protein selectively decreases total and LDL (low-density-lipoprotein) or bad cholesterol and maintains HDL (high-density-cholesterol) cholesterol in individuals with elevated normal blood cholesterol levels<sup>11</sup>.

Another important aspect of soy protein is combating osteoporosis. Osteoporosis is characterized by low bone mass and deterioration of bone tissue. One important factor in bone health is that there should be less calcium loss from the body. Although protein, in general, contributes to calcium loss, soy protein exhibits less calcium-wasting effect. Also, the isoflavones found in soy proteins are responsible for its bone sparing effects and stop bone deterioration<sup>12</sup>.

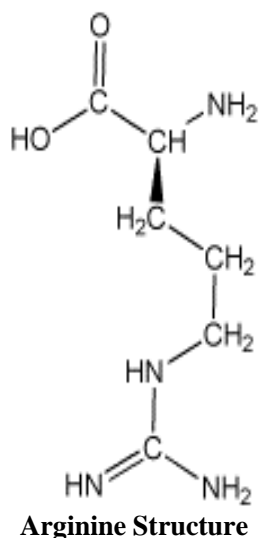
Recent research has shown that soy food may be able to relieve most menopause symptoms. In one study, night sweats and hot flashes were reduced by 40 % in women fed to soy foods. Soy foods are a rich source of phytoestrogens (plant estrogens), which may help compensate for the lack of estrogen production. Because soy protein also lowers cholesterol and promotes bone health, soy foods may eventually be viewed as natural alternatives to estrogen replacement therapies<sup>13,14</sup>. Use of soy protein is also found beneficial in diabetes<sup>15</sup>.

The study conducted by the Coimbatore based Avinashilingam Institute for Home Science and Higher Education for Women has evaluated the efficacy of soy protein isolate (SPI) based food mix in improving the nutritional status of malnourished children two years of age. The study stated that the phenomenal improvements noticed in children on SPI based food mix in physical growth parameter, bio-chemical indices (hemoglobin) and other clinical parameters bring out clearly the importance of using a protein of high biological efficacy and inherently rich in micronutrient like iron (Fe) and zinc (Zn)<sup>16</sup>.

Soy protein materials are used as functional food ingredients and have numerous applications in enhancing desirable characteristics in food products. Soy protein materials are used as an emulsifier in meats including frankfurters, sausages, bologna, ground and minced meats and meat patties to bind the meat and give the meat a good texture and a firm bite. Another common application for soy protein materials as functional food ingredients is in creamed soups, gravies and yogurts where the soy protein material acts as a thickening agent and provides a creamy viscosity to the food product.

Soy protein materials are also used as functional food ingredients in numerous other food products such as dips, dairy products, tuna, breads, cakes, macaroni, confections, whipped toppings, baked goods and many other applications<sup>17</sup>.

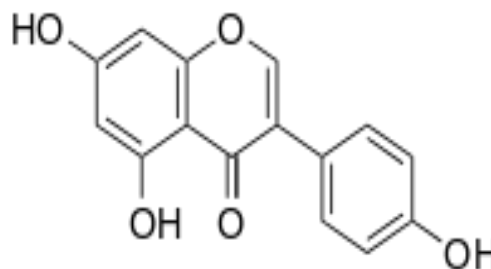
**Bioactive components of soy proteins:** The bioactive components present in soy proteins or associated with soy proteins, responsible for all these health benefits are arginine and isoflavones. Arginine ( $C_6H_{14}N_4O_2$ ) is a semi-essential or conditionally essential amino acid found in soy protein. 100 g of soy protein contains 7.6 g of arginine. Following is the molecular structure of arginine:



Arginine stimulates the release of growth hormone, retards the growth of tumors and cancer by enhancing the immune system, reduces healing time of injuries (particularly bone), quickens repair time of damaged tissue, increases muscle mass, reduces adipose tissue body fat, helps improve insulin sensitivity and treats osteoporosis. The body also uses arginine to produce nitric oxide, which relaxes blood vessels due to which blood circulation get increased resulting decrease in blood pressure. For this reason, it has been used to treat cardiovascular disorders. It also reduces the risk of heart disease by lowering low density lipoprotein (bad cholesterol) and total cholesterol levels<sup>18-25</sup>.

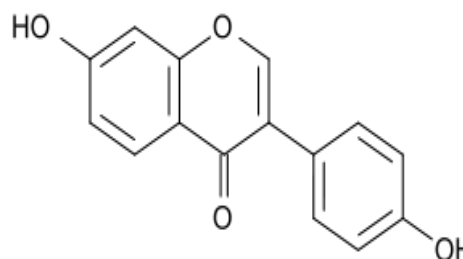
The soy isoflavones are responsible for most of the soy health benefits. Isoflavones are phytochemicals (phyto means plant) i.e. compounds found only in plants. As isoflavones are plant compounds where chemical structure resembles to human steroid hormone estrogen, therefore also called as phytoestrogen or plant hormone. But isoflavones are non-steroidal and weaker than human steroid hormone. Isoflavones can be found in many foods like chick peas and other legumes but the best-known source is the soy bean because they have the highest concentration of these powerful compounds. The soybean contains about 200 mg isoflavones per 100 g. Soy contains many isoflavones, but the most beneficial are genistein ( $C_{15}H_{10}O_5$ ) and daidzein

( $C_{15}H_{10}O_4$ ). Following is the molecular structural formula of genistein.



**Genistein Structure**

Following is the molecular structural formula of daidzein



**Daidzein Structure**

The chemical structure of isoflavones is very similar to that of human due to which they can interfere with the action of human estrogen. Depending on the type of estrogen receptor on the cells, isoflavones may reduce or activate the activity of estrogen<sup>26-32</sup>.

The action of isoflavones as weak estrogens allows them to bind to estrogen receptors and block some of the detrimental effects of estrogen such as promotion of cancer cell growth. Isoflavones can compete with estrogen for the same receptor sites thereby decreasing the health risks of excess estrogen. Being a weak form of estrogen, isoflavones compete at estrogen receptor sites, blocking the stronger version naturally produced by the body from exerting its full effect. Since high blood levels of estrogen are an established risk factor for breast cancer; weaker forms of estrogen may provide protection against this disease.

Studies show isoflavones slowed prostate cancer growth by hindering cell growth and caused prostate cancer cells to die. Isoflavones may help reduce breast cancer by blocking the cancer-causing effects of human estrogen. Isoflavones seem to be protecting against tumors because they act against cancer cells in a way similar to many common cancer-treating drugs<sup>33-37</sup>.

The similarities, at molecular level, of estrogens and phytoestrogens allow them to sometimes act as antagonists to estrogen. The isoflavones therefore can increase the estrogen activity causing effects in the body similar to those caused by the hormone estrogen. If during menopause the body's natural level of estrogen drops, isoflavones can compensate this by binding to the same receptor, thereby

overcome menopause symptoms such as hot flushes and increase bone density in women<sup>38</sup>.

Being polyphenols, the isoflavones are antioxidants. Genistein is the most potent antioxidant among the soy isoflavones followed by daidzein. The antioxidant properties of isoflavones are well comparable to that of the well-known antioxidant vitamin E (tocopherols and tocotrienols, C<sub>29</sub>H<sub>50</sub>O<sub>2</sub>). The antioxidant powers of isoflavones can reduce the long-term risk of cancer by preventing free radical damage to DNA. It also controls cholesterol (organic molecule, type of lipid molecule sterol, C<sub>27</sub>H<sub>46</sub>O) in blood. Also, the isoflavones antioxidant's properties protect the cardiovascular system from oxidation of LDL (the bad) cholesterol.

The antioxidant action of isoflavones not only helps to decrease the bad LDL cholesterol, but also increase the beneficial HDL cholesterol. Oxidized LDL cholesterol accumulates in the arteries as patches of fatty buildup which blocks the flow of blood resulting in atherosclerosis. Genistein inhibits the growth of cells that form this artery clogging plaque. Arteries damaged by atherosclerosis usually form blood clots. This can lead to a heart attack if the clot goes to the heart or a stroke if it goes to the brain<sup>39-43</sup>.

Isoflavones can fight osteoporosis by stimulating bone formation or helping in the preservation of the bone substance and inhibiting bone resorption. Unlike estrogen, which helps prevent the destruction of bone, evidence suggests that isoflavones may also assist in creating new bone. Other studies are not entirely consistent, but evidence suggests that genistein and other soy isoflavones can help prevent osteoporosis. Isoflavones consumption has been shown to reduce bone loss and slow calcium loss in an animal model of osteoporosis, suggesting a possible beneficial role in preventing osteoporosis in humans. It is also interesting to note that soy protein seems to cause less loss of calcium from the body compared to other dietary sources of protein, which may promote calcium loss and bone breakdown at high levels<sup>44</sup>.

#### Soy protein isolate: A best source of soy protein

Defatted soy flour, soy protein concentrate and soy protein isolate can be used as a source of soy proteins. Defatted soy flours are made by grinding defatted soy flakes. This soy flour is approximately 50 percent protein by weight and contains the carbohydrate components of the soybean sugars, oligosaccharides and fiber<sup>45</sup>. Soy Protein Concentrates are made by removing a portion of the carbohydrates from defatted and dehulled soybeans. Soy protein concentrates retain most of the fiber in the original soybeans and must contain at least 65 percent protein on a moisture-free basis. Soy protein isolate is prepared by dissolving the defatted soy flakes or soy products above or below the isoelectric point of the soy protein and then

adjusting the pH of the solution to the isoelectric point to precipitate the purified protein.

In one of the methods, the aqueous extraction of defatted soy flakes at pH 6-10.5 is done to form a solution of the soy protein, removing insoluble materials, precipitating the extracted protein at pH 4.5, re-dissolving the curd at pH 6 and drying<sup>46</sup>. This product is nearly carbohydrate and fat-free, with no characteristic "beany" flavor. Soy protein isolates prepared this way are 90 percent protein by dry-weight. SPI is a highly digestible source of amino acids and because of the bland taste can be added to foods without jeopardizing flavor.

Food fortification point of view SPI is better as it has higher amount of proteins and higher sensory acceptability than soy flour and concentrate. In the production of SPI in India, the manufacturer generally follows Bureau of Indian Standards (BIS) specifications, shown in table 5 and maintains minimum 86 percent of protein in SPI<sup>47</sup>. Thus, SPI is the richest source of protein than any other source of soy. Also, SPI contains low moisture (less than 6 percent) and low fat (less than 0.3 percent) due to which development of product rancidity during storage does not normally occur which ensures that SPI can be stored for long periods of time even when storage conditions are less than favorable. The minimum shelf life of SPI is one year.

**Table 5**  
**BIS specification for edible soy protein isolate**

Parameter	Limit
Moisture (% by mass)	Max. 6.0
Fat (% by mass)	Max. 0.3
Protein (% by mass)	Min. 86.0
Total ash (% by mass)	Max. 7.0
Acid insoluble ash (% by mass)	Max. 0.3
Crude fiber (% by mass)	Max. 0.8

Source: IS: 8211 - 1976

**SPI fortification:** The food vehicle that can be chosen for SPI fortification may include dairy foods, nutritional supplements, meat systems, infant formulas, nutritional beverages, cream soups, sauces, bakery products and snacks. The choice of food vehicle for SPI fortification depends upon the requirement and purpose of fortification. SPI fortified food supplements may be prepared for malnourished group of people, obese persons, sport persons etc. Whatever is the intention of SPI fortified food supplement, the food vehicle chosen for the incorporation SPI should have excellent sensory characteristic to allow maximum incorporation of SPI to take the maximum benefit from this nature's wonderful gift.

Due to plain taste and smell one cannot consume SPI as it is in bulk quantity. However, SPI can be consumed in appreciable quantity if incorporated in some food. However, the quantity of SPI incorporation will depend upon the

sensory characteristics of food. Better is the sensory characteristics of food, higher the amount of SPI can be incorporated.

If the supplementary food is planned for malnourished group of people (schooling children, pregnant and lactating women), then it is recommended to incorporate SPI in food vehicle having high energy value. The reason behind this is, earlier the low protein in diet was considered the only cause for malnutrition but now realizing the gap in the current dietaries, the low energy of diet is also found responsible for the same rather than only protein. This condition of malnutrition due to low protein and energy in diet is known as Protein Energy Malnutrition (PER)<sup>48</sup>.

The PER may occur in pregnant as well as lactating women because during this stage additional requirement of protein and energy is produced for the development of fetus and formation of milk. All this vulnerable group of population like pregnant and lactating women, pre-school children which are more prone to malnutrition should be given daily food supplements which contribute significantly to the protein and energy intake.

The recent nutritional survey conducted by Food and Nutrition Board of Government of India suggests that India is facing protein calories malnutrition. This is because as far as food consumption is concerned, consumption of cereals, roots and tuber is found to be adequate. However, total energy intake does not meet requirements due to inadequate consumption of energy rich foods like pulses, fats and oils. The consumption of milk and milk product is lower than the RDA (Recommended Daily Allowance). Therefore, in dealing malnutrition, there is a need not only to elevate the protein level of supplementary foods but also to increase its calories density. The said criteria can be achieved with various food products but out of all these products, bakery products are most suitable.

Particularly biscuits are recommended for the fortification of SPI to tackle malnutrition problem as they have excellent sensory characteristics (attractive colour, texture and flavour), high calories density (with sweet or cookies variety biscuits more than 400 kcal per 100g), long shelf life (minimum six months), easy in carrying and popular among children and other age group. Also, incorporation of SPI in biscuits will help to improve the nutritional quality of biscuits as biscuits are low in protein content (6-7 % protein) and inferior in protein quality due to lack of essential amino acid lysine<sup>49</sup>. If protein quantity and quality of biscuits are improved by incorporating SPI, it can be used as effective weapon against malnutrition.

If the supplementary food is planned for persons more susceptible to suffering from diabetes, high blood pressure and cholesterol i.e. like obese persons, the incorporation of SPI in such food may prove beneficial provided the fat content as well as sugar of the food are kept low for low

energy value. Consumption of high fat or sugar in said health problems may make the problem more severe. Therefore, the supplementary diet chosen for the incorporation of SPI for such cases should have low fat content and low energy value. Here also fewer sweet biscuits (semi sweet variety) characterized by low fat and low energy value can be considered as vehicle for the incorporation SPI. Not only SPI but other sources of soy proteins are also easily accommodated in the various formulations of biscuits<sup>50-59</sup>.

## Conclusion

It is concluded that soy protein isolate is wonderful source of proteins containing superior quality proteins in plenty capable of maintaining good human health. The soy protein isolate can be used as most effective weapon against malnutrition and many health problems.

From food fortification points of view also, the soy protein isolate is useful and has numerous applications in enhancing desirable characteristics in food products. Depending upon the intended use, the low-fat biscuits or high fat biscuits are the ideal food vehicle for the fortification of soy protein isolate.

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