PJN
ISSN 1680-5194

Pakistan Journal of Nutrition

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

Pakistan Journal of Nutrition 15 (6): 600-606, 2016
ISSN 1680-5194

A Review on Nutrient Quality of Soymilk Powder for Malnourished Population

Md. Anisur Rahman Mazumder[1,2] and Parichat Hongsprabhas[2]
[1]Department of Food Technology and Rural Industries, Faculty of Agricultural Engineering and Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
[2]Department of Food Science and Technology, Faculty of Agro-Industry, Kasetsart University, 50 Phahonyothin Road, Chatuchak, Bangkok, 10900, Thailand

Abstract: This study was conducted to find out the nutritional factors that can help the developing countries to reduce malnutrition problem through use of spray dried soymilk powder. The main advantage of powdered milk is the reduction of bulk volume. It results extension of the storage life, stability of the appropriately packaged product, saving of storage and transportation costs. Soy protein is an important source of high-quality protein for a long time. The present article focuses on nutritional and non-nutritional such as phytochemicals aspects of soymilk powder and the probable use of soymilk powder as a source of protein, vitamins and minerals for malnourished people. Soy powder contained considerable amount of essential and branched chain amino acids except methionine and a good source of B-vitamins particularly niacin, pyridoxine and folacin. Nonetheless, a growing number of calcium-fortified soymilks are available. However, soy powder is rich in copper, zinc and magnesium.

Key words: Soymilk powder, amino acids, vitamin, minerals, phytochemicals

INTRODUCTION

Soybean is one of the best sources of plant protein containing about 40% of protein (dry basis), the highest protein content among legumes and cereals (Giri and Mangaraj, 2012). Soy proteins are highly digestible after proper heat treatment and its amino acid profile is almost well balanced except methionine to meet the requirements for human nutrition. Soybean contains protein (38-40%), carbohydrates (30%) and fat (18%). 70% of total soy proteins are glycinin and β-conglycinin (Liu, 1997). Most fatty acids and its derivatives are unsaturated therefore; they are susceptible to oxidation (Orthoefer, 1978; Penalvo *et al*., 2004). Other components include varying concentration of isoflavone; high levels of minerals including iron, calcium, zinc; vitamins including α-tocopherol, niacin, pyridoxine and folacin. Soy products has advantages in preventing heart disease, obesity, blood cholesterol, cancer, diabetes, kidney disease, osteoporosis and blood pressure regulation (Garcia *et al*., 1997; Hassler, 1998; Liu, 1997; Riaz, 1999). In 1999, the US Food and Drug Administration approved a health claim for the cholesterol-lowering effects of soy protein, largely based on a meta-analysis of 38 clinical trials that reported significant decreases in total and low-density lipoprotein (LDL) cholesterol and triglycerides with soy protein intake (25 g/day) compared with animal protein consumption (Adlercreutz *et al*., 1995).

Health concerns also necessitate the development of functional food containing isoflavones. Soy protein and soy isoflavone containing soymilk and soymilk powder can be used to enrich or fortify the milk products. Therefore, soymilk and soymilk products will not only help to produce functional food, but also in the later application, adding the value of soy which is becoming important crop in the developing countries such as Bangladesh. This article try to find the nutritional factors that can help the developing countries to reduce malnutrition problem through use of spray dried soymilk powder.

Malnutrition problems in developing countries: Malnutrition arises from eating a diet which cannot provide sufficient nutrients or provide too much nutrients. The nutrients are calories, protein, carbohydrates, vitamins or minerals. Lack of enough calories, protein or micronutrients specifically refer as under nutrition. Permanent physical and mental development problems may results if under nutrition occurs during either pregnancy or before the two years of age. Extreme under nourishment called starvation. It may have several symptoms such as short height, thin body, very poor energy levels and swollen legs and abdomen. Micronutrient deficiencies symptoms mainly depend on the micronutrient that is lacking. Common deficiencies of micronutrient are lack of iron, iodine and vitamin A (Young, 2012). During pregnancy stage the deficiencies become more common and severe due to increased demand of nutrition (Konje *et al*., 2007). On the other hand, some developing countries obesity is the over

Corresponding Author: Md. Anisur Rahman Mazumder, Department of Food Technology and Rural Industries, Faculty of Agricultural Engineering and Technology, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh

nutrition within the same communities as under nutrition. But the elderly malnutrition arises due to physical, psychological and social factors (Ronnie *et al.*, 2011). Undernourishment is the result due to insufficient high quality food available to eat. This might be related to high food prices and poverty (WHO, 2014). Basically, there are two main types of under nutrition (i) protein-energy malnutrition and (ii) dietary deficiencies. Protein-energy malnutrition also has two severe forms: (i) lack of protein and calories, known as marasmus and (ii) lack of just protein, called kwashiorkor (Young, 2012).

In Bangladesh, chronic malnutrition is associated with poor socioeconomic position which retards the purchasing power of nutritious foods such as milk, meat, poultry and fruits (Khan and Kraemer, 2009). Food shortage might also be a contributing factor to malnutrition in developing countries with lack of proper technology. Food and Agriculture Organization (FAO) has estimated that eighty percent of malnourished children are living in the developing world even those countries produce food surpluses (Gardner and Halweil, 2000). Nowadays, famine is one of the most critical problems for food distribution and/or poverty. Though there has been sufficient food to feed the whole population of the world, malnutrition and famine are more related to problems of food distribution and purchasing power (Sen, 1981).

Protein sources in developing countries: Humans in developing countries consume more low-quality proteins compared to those living in developed countries (USDA, 1993). Proteins are very much essential component of the diet needed for survival of both animals and humans. The basic functions of protein are the supply adequate amounts of essential and non-essential amino acids. However, soymilk powder could be a good source of protein for developing countries. Table 1 shows the protein consumption in developing countries vs developed countries.

Preparation of soymilk powder by spray-drying: Soybeans may transform into different varieties of soyfoods to provide tasty and easily digestible products. Among them soymilk and soymilk powder are most popular. Soymilk is the aqueous extract of whole soybeans, which closely resembles dairy milk in physical appearance and composition (Penalvo *et al.*, 2004). Soymilk is a stable emulsion of oil, water and protein. The traditional soymilk is made from soaking the beans in water, wet grinding the beans, steaming the wet mash to improve flavor and nutritional value and filtering (Howell and Caldwell, 1978). In recent years, spray-drying becomes the most important method of drying milk and milk products (Hall and Hedrick, 1972). Spray-drying has the advantages of minimizing thermal damage due to short residence time with heat contact and increased the rate of evaporation. These characteristics are especially important in the drying of a heat sensitive product like soymilk where retention of nutrients and flavor are necessary. Dry product is highly desirable since it is not only possesses long shelf-life, but also increases the stability of the appropriately packaged product, saving of storage and transportation costs and the product can be distributed over a wide area. Thus, spray drying can produce high quality soymilk powder that is soluble and without loss of nutrient.

The pH could markedly affect the dispersibility of reconstituted soymilk protein after spray-drying. Increasing the pH is of the soy milk base to 9 before spray drying increased the dispersibility of soymilk powder. The protein dispersibility index of spray-dried whole soybean milk was found to increase after addition of sodium bisulfite to the soymilk before drying (Aminlari *et al.*, 1977).

Extraction of soymilk for spray drying: The soybeans (Raitip brand, Nonthaburi, Thailand) were soaked in 0.5% sodium bicarbonate solution at 50°C for 2 h in a water bath (Schufzart DIN 40050IP20; MembartGmBH+ Co., Buchenbach, Germany). The ratio between soybean and water for soaking was 1:3. The beans were drained well afterwards. After discarding the water, the soaked soybean was dehulled before grinding of soybean. Soaked soybean was dehulled to remove unwanted substances using hands. Two methods were applied for blanching of hydrated soybeans to inactivate lipoxygenase and off flavor:

a: Hydrated beans were blanched in 0.5% sodium bicarbonate solution at 80°C for 10 min; solution was drained well and washed with water for three times
b: Hydrated beans were blanched of hydrated soybean at 95°C for 10 min in 0.5% sodium bicarbonate solution. The solution was drained well and washed with water for three times

The blanched soybean was ground with the addition of hot water (95°C) using super mass colloider (Masuko Sangyo Co., Ltd. MK- PB6-2, Kawaguchi, Japan) and a basket centrifuge (Wasino, Samutprakarn, Thailand). The ratio of soybean to water was 1:4. Soymilk was obtained after filtering through double layered cheese cloths. Soymilk was pasteurized under low temperature long time (LTLT) method. LTLT involves heating the milk to 63°C and holding it for 30 min. The pasteurized soymilk was in -20°C for further studies. Soymilk prepared by different methods was analyzed for the following parameters: refractive index and total solid was determined immediately after extraction of soymilk (day 0). On the other hand, protein and fat were determined on the 2nd day after extraction of soymilk.

The composition of extracted soymilk by two different treatment methods is shown in Table 2. Although the treatments did not significantly affect the refractive index, soymilk had different total solid, protein, fat and thiobarbituric reactive substances (TBAR). Soymilk obtained from blanching at 80°C for 10 min showed the highest solid content. Increasing the temperature during blanching decreased the extracted solid content (Table 2). This might be due to the formation of matrices capable of holding water. When the matrices are formed before extraction of soymilk, the amount of solid extraction reduced along with liquid content. Increasing blanching temperature to 95°C could not increase the extraction of soymilk due to fixation of matrix at high temperature. Blanching at high temperature denatured soy protein and increased the water holding capacity of soybean, extraction of protein was dramatically reduced after denaturation and matrix formation.

Spray drying of soymilk: The soymilk blanched at 80°C for 10 min was selected due to its extractability for high solid content for spray drying. The extracted soymilk was homogenized (1st stage 2500 psi and 2nd stage 500 psi) with a two-stage homogenizer (15 MR-8TA, SR. 109713623, APV Gualin, Inc. West Sussex, UK). The soymilk was fed into the spray-drier (GEA Niro, Soeborg, Denmark) by a peristaltic pump and atomized into small droplets by a centrifugal vaned atomizer wheel with a rotational speed of 200 rpm (4-5 bar air pressure) in a co-current air flow system. The liquid was fed at 16 mL/min and dried using inlet air of 170°C and outlet air of 85°C, with the flow of drying air of 1 m^3/min by varying the feed rate in the range of 5 to 8 rpm speed of feed pump. The powder was collected from a cyclone. The powder was kept in phosphorus pentaoxide (P_2O_5) to reduce the moisture content below 2.5%. Finally, the powder was kept in a seal aluminum foil laminated with polyethylene bag and kept at -20°C prior to analysis for moisture content, protein content, genistein content and fat content.

Composition of soymilk powder: The composition of spray-dried soymilk powder was shown in Table 3. Soymilk powder prepared from soymilk blanched at 80°C for 10 min contained 57.26% protein, 27.60% fat and 89.67 mg% genistein. However, after spray-drying, soymilk powder usually contained moisture 4%, protein 40%, fat 18%, carbohydrate 32% (dietary fibre 16%) and ash 6% (Anonymous, 2010), genistein around 78.90 mg/100 g (USDA, 1999). It is apparent that not only soymilk power (SMP) contained isoflavone around 177.89 mg/100 g and genistein around 96.83 mg/100 g (USDA, 1999) but also SMP can be used as the source of indigenous isoflavones. Geisntein concentration in spray dried soymilk powder (Table 3) was slightly higher than that recommended by USDA (1999) of 78.90 mg/100 g soymilk powder (Table 5).

Table 1: Sources of protein in the developing and developed countries

Source	Developing (%)	Developed (%)
Cereals	58.8	29.1
Meat	8.6	26.4
Pulses	7.4	1.7
Milk and dairy	5.6	16.7
Fish, seafood	4.1	7.3
Oil crops	3.8	1.9
Vegetables	3.5	3.5
Starchy roots	3.1	3.2
Eggs	1.6	4.3
Offals	1.2	2.2
Fruit	1.0	1.1

Source: USDA, 1993

Table 2: Composition of extracted soy milk by different treatments

	------------ Blanching conditions ------------	
Parameter	80°C 10 min	95°C 10 min
Refractive index	1.345±0.005[a]	1.339±0.001[a]
Total solids %	7.65±0.03[a]	5.37±0.05[b]
Protein %	4.46±0.07[a]	4.02±0.05[b]
Fat %	2.15±0.06[a]	1.80±0.10[b]

Means in the same row followed by different superscript are significantly different ($p<0.05$)

Table 3: Protein and fat content in spray dried soy milk powder (100 g)

Component	Amount
Moisture content (g)	1.93±0.05
Total solid (g)	98.07±0.05
Protein (g)	57.26±0.10
Fat (g)	27.60±0.08
Crude fiber (g)	3.59±0.09
Ash (g)	3.05±0.18
Genistein (mg)	89.67±5.16

Amino acid profile of soymilk powder: Soymilk powder contained considerable amount of essential and branched chain amino acids (Table 4). However, soy protein is not an ideal protein, because it is deficient in the essential amino acid methionine. Soy contains methionine for only 1.39 g/16 g of N; while the recommendation by the Food and Agricultural Organization (FAO) is 3.5 g/16 g of N (Friedman, 1996; Friedman and Brandon, 2001). Methionine undergoes oxidation to methionine sulfoxides and methionine sulfone, racemization to D-methionine and general degradation to compounds with undesirable odors and flavors such as methional. Protein-bound methionine from some plants is poorly utilized, presumably because of poor digestibility (Begbie and Pusztai, 1989).

Soy isoflavone: Soy flour contained the highest amount of isoflavone than other soyfoods (Table 5). Isoflavones are generally consisting of two benzyl rings joined by a three-carbon bridge, which may or may not be closed in a pyran ring. They are known as flavonoids, which are the largest and found in wide range of plant phenolics (Erickson, 1995; Liu, 1997). The isoflavones have basically three types, with each type being present in four chemical forms. Isoflavones in soybean are mainly

Table 4: Amino acid composition of soymilk powder

Amino acid	Soymilk powder g/16 N	FAO,[a] g/16 g of N	mg/kg per day	mg/g protein[1]
Alanine	3.9±0.17	-	-	
Arginine	7.10±0.09	-	-	-
Aspartic acid	10.95±0.15	-	-	-
Cystine	1.88±0.11	-	-	-
Glutamic acid	16.59±0.05	-	-	-
Glycine	3.90±0.06	-	-	-
Histidine	2.55±0.10	-	-	-
Isoleucine	4.77±0.03	4.0	20	30
Leucine	7.89±0.07	7.0	39	59
Lysine	5.95±0.04	5.5	30	45
Methionine	1.48±0.09	3.5[b]	10	16
Phenylalanine	4.78±0.05	-	-	-
Proline	7.7±0.01	-	-	-
Serine	4.90±0.13	-	-	-
Threonine	3.89±0.06	4.0	15	23
Tryptophan	1.64±0.04		4	6
Tyrosine	3.90±0.05	6.0[c]	25	38
Valine	4.45±0.05	5.0	26	39

[a]Scoring pattern for an ideal protein (USDA, 1993; Friedman, 1996)
[1]Mean nitrogen requirement of 105 mg nitrogen/kg per day (0.66 g protein/kg per day). [b]Cys + Met; [c] Tyr + Phe

Table 5: Isoflavone content of soy products

Soy products	Total isoflavone	Daidzein	Genistein
Soy flour, full-fat	177.89	71.19	96.83
Soy flour, textured	148.61	59.62	78.90
Soy flour, defatted	131.19	57.47	71.21
Soy protein concentrate, aqueous washed	102.07	43.04	55.59
Soy protein concentrate, alcohol extracted	12.47	6.83	5.33
Soy protein isolate	97.43	33.59	59.62
Tofu, fried	48.35	17.83	28.00
Tempeh	43.52	17.59	24.85
Tofu, soft	29.24	8.59	20.65
Tofu, silken	27.91	11.13	15.58
Tofu, firm	22.70	8.00	12.75
Soy milk	9.65	4.45	6.06

Source: USDA (1993)

Table 6: A brief descriptions of clinical deficiency symptoms of vitamin B-complex

Thiamin (B_1)	Beri-beri, polyneuritis and Wernicke-Korsakoff syndrome
Riboflavin (B_2)	Growth, cheilosis, angular stomatitis and dermatitis
Niacin (B_3)-nicotinic acid and nicotinamide	Pellagra with diarrhea, dermatitis and dementia
Vitamin B_6 (pyridoxine, pyridoxamine and pyridoxal)	Naso-lateral seborrhea, glossitis and peripheral neuropathy (epileptiform convulsions in infants)
Pantothenic acid (B_5)	Fatigue, sleep disturbances, impaired coordination and nausea

Source: FAO/WHO (1991)

found as aglycones (genistein, daidzein, glycitein), β-glucosides (daidzin, genistin, glycitin), malonyl-β-glucosides (6''-O-malonyldaidzin, 6''-O-malonylgenistin, 6''-O-malonylglycitin) and acetyl-β-glucosides (6''-O-acetyldaidzin, 6''-O-acetylgenistin, 6''-O-acetylglycitin) (Erickson, 1995). Aglycones are flavonoid molecules without any attached sugars or other derivatives. Aglycones are especially important among other isoflavone because they are readily bioavailable to humans (Lee and Lee, 2009). β-glucosides may also carry additional small molecular modifiers, such as malonyl and acetyl groups. Sugar-linked flavonoids are called glucosides due to their glucose linkage to flavonoids.

Researches revealed that soy isoflavones and their glycosides which are available on soymilk are associated with a lower incidence of cardiovascular disease (Adlercreutz, 1990), hormone-dependent breast and prostate cancers (Yu *et al*., 1991), colon cancer (Rose *et al*., 1986), menopausal symptoms (Clarkson, 2000) and osteoporosis (Adlercreutz *et al*., 1992). Isoflavones also have antioxidant activity (Wei *et al*., 1995), which may act to reduce cancer risk. Among isoflavones, genistein is a powerful inhibitor of tyrosine kinase activity *in vitro* (Akyiama *et al*., 1987) and, thus, inhibits cell growth proliferation. It has also been shown to inhibit cell cycle progression and normalizes transformed cells, both of which are consistent with a

Table 7: Vitamin content of soymilk powder

		FAO/WHO, Recommended nutrient intake (mg/day)			
	Soymilk powder/100 g	Adults (Men) 19+	Adults (Women) 19+	Pregnant	Lactation
Components		1.2	1.1	1.4	1.5
Riboflavin (vitamin B_2)	1.16 (mg)	1.3	1.1	1.4	1.6
Niacin (vitamin B_3)*	4.32 (mg)	16	14	18	17
Panthothenic acid (vitamin B_5)	1.59 (mg)	5	5	6	7
Vitamin B_6	0.46 (mg)	1.3-1.7	1.3-1.5	1.9	2.0
Folic acid (vitamin B_9)	345 (µg)	200	200	420	270
Vitamin A**	6.0 (µg)	600	600	600	850
Vitamin E	1.95 (mg)	-	-	-	-
Vitamin K	70 (µg)	-	-	-	-

Source: Soya Bluebook Plus (1995). *NEs: niacin equivalents, **Vitamin A as provitamin A

Table 8: Minerals content of soymilk powder

		FAO Recommended intake (mg/day)					
		Men (years)		Women (years)			
Components	Soymilk powder mg/100 g	19-65	65+	19-menopause	Post-menopause	Pregnant	Lactation
Calcium, Ca	206	750	800	750	800	800	750
Iron, Fe	6.37	23	23	48**	19***	76	26
Magnesium, Mg	429	260	224	220[1]	190[2]	220	270
Phosphorus, P	494	-	-	-	-	-	-
Potassium, K	2515	-	-	-	-	-	-
Manganese, Mn	2.28	-	-	-	-	-	-
Sodium, Na	13	-	-	-	-	-	-
Zinc, Zn	3.92	7.0	7.0	4.9	4.9	5.5[7] 7.0[8] 10.0[9]	9.5[a] 8.8[b] 7.2[c]
Copper, Cu	2.92	-	-	-	-	-	-
Sodium	13	-	-	-	-	-	-
Selenium, Se (µg)	7.5	34	33	26[1]	25[2]	28[3] 30[4]	35[5] 42[6]

Source: Soya Bluebook Plus (1995). Calcium (theoretical) allowances based on an animal protein intake of 20-40 g
*16-18 years; **Non pregnant or lactating women;***Above 60 years
[1]Adults, 19-65 years; [2]Above 65 years
[3]2nd trimester; [4]3rd trimester; [5]0-6 months' post-partum; [6]7-12 months post-partum
[7]1st trimester; [8]2nd trimester; [9]3rd trimester
[a]0-3 months; [b]3-6 months; [c]9-12 months

protective effect against cancer. Isoflavones have both estrogenic activity and antioxidant capacity. The former could increase high endogenous hormone levels linked with the development of cancers; while the latter helps in reducing cancer and cardiovascular diseases (Zheng and Zhu, 1999). The anti-estrogenic activity of isoflavones is an important role in reducing risk of hormone-dependent cancers (Adlercreutz *et al*., 1987). This health-promoting effect from soy consumption leads to the development of functional food containing isoflavones, which can be used to enrich or fortify soy and milk products.

Vitamins content of soymilk powder: Vitamin A is the most common deficiency of vitamin in the developing countries (Young, 2012). During pregnancy stage the deficiencies become more common and severe due to increased demand of nutrition (Konje *et al*., 2007). Soymilk powder contained negligible amount of vitamin A as provitamin A (Table 7), though it is very low in terms of per day requirements. Provitamin A is non-animal source vitamin A which turned into vitamin A by the liver following the oxidation process. Provitamin A is grouped in different molecules and the body uses them to produce vitamin A. The common deficiency symptoms of vitamin B-complex are shown in Table 6. Nonetheless, soymilk powder is a very good source of vitamin B-complex (Table 7).

Vitamin E is the major lipid-soluble phenolic antioxidant in the cell antioxidant defense system and could be obtained from the soymilk powder (Table 7). The major biologic role of vitamin E is to protect poly unsaturated fatty acids (PUFAs) and other components of cell membranes and low-density lipoprotein (LDL) from oxidation by free radicals. But human studies have been less consistent in providing evidence for a role of vitamin E in preventing heart disease (Dieber-Rotheneder *et al*., 1991). Vitamin K is an essential fat-soluble micronutrient. Vitamin K is needed for a unique post-translational chemical modification in a small group of proteins with calcium-binding properties, collectively known as vitamin K-dependent proteins or

Gla-proteins. Vitamin K deficiency represents a significant public health problem throughout the world (Lane and Hathaway, 1985; Shearer, 1992, 1995), although it's rare and age dependent (>6 months). The deficiency syndrome is traditionally known as haemorrhagic disease of the newborn. More recently it's known as vitamin K deficiency bleeding (VKDB). In adults, vitamin K-deficient states that manifest as bleeding are almost unknown except when the absorption of the vitamin is impaired as a result of an underlying pathology (Suttie, 1985).

Minerals content of soymilk powder: Net calcium retention is required particularly growing stage of life such as first 2 years of life, during puberty and adolescence. These age groups of populations at risk for calcium deficiency, as are pregnant women (especially in the last trimester), lactating women, postmenopausal women and, possibly, elderly men. Soymilk powder contains about 206 mg of calcium per 100 g powder (Table 8) and also rich in copper and magnesium. Nowadays, growing number of calcium-fortified soy products are available in the markets. Soyfoods are rich in both oxalates and phytate, could inhibit the calcium absorption, the calcium from soyfoods is very well absorbed and has a fractional absorption rate equal to that of milk. Both phytate and soy protein reduce iron absorption, resulted the iron in soyfoods is generally poorly absorbed. But vitamin C can increase the amount of iron absorbed from soyfoods, although absorption rates are still low. Iron may be better absorbed from fermented soyfoods like tempeh and miso than soymilk. However, zinc is poorly absorbed from soyfoods.

Conclusions: Soymilk powder is a very good source of low-cost protein and polyphenols. Soymilk powder also contains high vitamin B-complex and minerals but very low amount of vitamin K and E. Fortification of iodine and enrichment of vitamin A, iron and zinc could help soymilk powder to be a very good source of nutrient for malnourished population in the developing countries.

Compliance with ethical standards: This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of interest: The authors declare that they have no conflict of interest.

REFERENCES

Adlercreutz, C.H.T., B.R. Goldin, S.L. Gorbach, K.A.V. Hockerstedt, S. Watanabe, E.K. Hamalainen, M.H. Markkanen, T.H.W. Makela, K.T. Adahala, T.A. Hase and T. Fotsis, 1995. Soybean phytoestrogen intake and cancer risk. J. Nut., 125: S757-S770.

Adlercreutz, H., E. Hamalainen, S. Gorbachv and B. Goldin, 1992. Dietary phytoestrogens and the menopause in Japan. Lancet., 339: 1233.

Adlercreutz, H., 1990. Western diet and Western diseases: some hormonal and biochemical mechanisms and associations. Scand. J. Clin. Lab. Invest. Suppl., 50: 3-23.

Adlercreutz, H., K. Hockerstedt, C. Bannwart, S. Bloigu, E. Hamalainen, T. Fotsis and A. Ollus, 1987. Effect of dietary components, including lignans and phytoestrogens, on entherohepatic circulation and liver metabolism of estrogens and on sex hormone binding globulin (SHBG). J. Steroid Biochem., 27: 1135-1144.

Akyiama, T., J. Ishida, S. Nakagawa, H. Ogarawa, S. Watanabe, N. Itoh, M. Shibuya and Y. Fukami, 1987. Genistein, a specific inhibitor of tyrosine-specific protein kinases. J. Biol. Chem., 262: 5592-5595.

Aminlari, M., L.K. Ferrier and A.I. Nelson, 1977. Protein dispersibility of spray dried whole soybean milk base: Effect of processing variables. J. Food Sci., 42: 985-988.

Anonymous, 2010. Soy ingredients: soymilk-liquid and powder. Sunopta.com/ingredients http://www.sunopta.com/soy-ingredients-soymilk-liquids-powder. Accessed 10 January 2015.

Begbie, R. and A. Pusztai, 1989. The resistance to proteolytic breakdown of some plant (seed) proteins and their effects on nutrient utilization and gut metabolism. In: Friedman, M. (Ed.), Absorption and Utilization of Amino Acids. CRC: Boca Raton., pp: 243-263.

Clarkson, T., 2000. Soy phytoestrogens: what will be their role in postmenopausal hormone replacement therapy? Menopause: J. North Am. Menopause Soc., 7: 71-75.

Dieber-Rotheneder, M., H. Puhl, G. Waeg, G. Striegl and H. Esterbauer, 1991. Effect of oral supplementation with D-alpha-tocopherol on the vitamin E content of Human low density lipoprotein and resistance to oxidation. J. Lip. Res., 32: 1325-1332.

Erickson, D.R., 1995. Practical Handbook of soybean processing and utilization. USA: AOCS.

FAO/WHO, 1991. Protein quality evaluation. Rome: Food and Agricultural Organization of the United Nations.

Friedman, M., 1996. Nutritional value of food proteins from different food sources. J. Agric. Food Chem., 44: 6-29.

Friedman, M. and D.L. Brandon, 2001. Nutritional and health benefits of soy proteins. J. Agric. Food Chem., 49: 1070-1086.

Garcia, M.C., M. Torre, M.L. Marina and F. Laborda, 1997. Composition and characterization of soyabean and related products. Crit. Rev. Food. Sci. Nutr. 37: 361-391.

Gardner, G. and B. Halweil, 2000. Escaping hunger, Escaping excess. World Watch, 13: 24.

Giri, S.K. and S. Mangaraj, 2012. Processing influences on composition and quality attributes of soymilk and its powder. Food Eng. Rev., 4: 149-164.

Hall, C.W. and T.I. Hedrick, 1972. Drying of milk and milk products. AVI Publishing Co., Westport, Conn.

Hassler, C.M., 1998. Functional foods: their role in disease prevention and health promotion. Food Technol., 52: 63-70.

Howell, R.W. and B.E. Caldwell, 1978. Genetic and other biological characteristics. In Smith, A.K. and S.J. Circle (Eds.), Soybeans: Chemistry and Technology. AVI Publishing Co., USA, pp: 27-60.

Khan, M.M. and A. Kraemer, 2009. Factors associated with being underweight, overweight and obese among ever-married non-pregnant urban women in Bangladesh. Sin. Med. J., 50: 804-813.

Konje, J.C., A. Mala and K.A. Rao, 2007. Recurrent pregnancy loss. 2nd ed. Jaypee Bros. Medical Publishers, New Delhi.

Lane, P.A. and W.E. Hathaway, 1985. Vitamin K in infancy. J. Pediatr., 106: 351-359.

Lee, S.W. and J.H. Lee, 2009. Effects of oven-drying, roasting and explosive puffing process on isoflavone distribution in soybeans. Food Chem., 112: 316-320.

Liu, K., 1997. Soybeans: chemistry, technology and utilization. Chapman and Hall, New York.

Orthoefer, F.T., 1978. Processing and utilization. In: Norman, G.A. (Ed.), Soybean physiology, agronomy and utilization. Academic Press, New York, USA.

Penalvo, J.L., M.C. Matallana and M.E. Torija, 2004. Chemical composition and nutritional value of traditional soymilk. J. Nut., 134: 1254S.

Ronnie, A.R., E.Z. Michael, E. Zenilman and R.K. Mark, 2011. Principles and practice of geriatric surgery. 2nd ed. Springer, Berlin.

Rose, D., A. Boyar and E. Wynder, 1986. International comparisons of mortality rates for cancer of the breast, ovary, prostate and colon and per capita food consumption, Cancer, 58: 2363-2371.

Riaz, M.N., 1999. Soybeans as functional foods. Cereal Food World, 44: 88-92.

Sen, A.K., 1981. Poverty and famines: An essay on entitlement and deprivation. Oxford University Press, UK.

Shearer, M.J., 1992. Vitamin K metabolism and nutriture. Blood Revs., 6: 92-104.

Shearer, M.J., 1995. Fat-soluble vitamins: vitamin K. Lancet., 345: 229-234.

Soya Bluebook Plus, 1995. Soyatech, Inc., Bar Harbor, ME.

Suttie, J.W., 1985. Vitamin K. In: Diplock, A.D. (Ed.), Fat-soluble vitamins: their biochemistry and applications. Heinemann, London, pp: 225-311.

USDA, 1993. Nutritions eating for good health. U.S. Department of Agriculture: Agricultural Bulletin 685, Washington, DC.

USDA, 1999. USDA-Iowa State University database on the isoflavone content of foods.

Young, E.M., 2012. Food and development. Abingdon, Oxon: Routledge.

Yu, H., R. Harris, Y. Gao and E. Wynder, 1991. Comparative epidemiology of cancers of the colon, rectum, prostate and breast in Shanghai, China versus the United States. Int. J. Epi., 20: 76-81.

WHO, 2014. Maternal, newborn, child and adolescent health. http://www.who.int/maternal_child_adolescent. Accessed 25 June 2015.

Wei, H., R. Bowen, Q. Cai, S. Barnes and Y. Wang, 1995. Antioxidant and antipromotional effects of the soybean isoflavone genistein. Proc. Soc. Exp. Biol. Med., 208: 124-130.

Zheng, G. and S. Zhu, 1999. Antioxidant effects of soybean isoflavones. In: Basu, T.K,, N.J. Temple and M.L. Garg, (Eds.), Antioxidants in human health, CAB Publishing, Oxon, pp: 123-130.