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SOY IN HUMAN HEALTH

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QUARTERLY
MEDICAL REVIEW

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ASIAN FOOD PHARMACY

DR. NIRANJANA SHAH* AND DR. G. SUBBULAKSHMI**

LET FOOD BE YOUR MEDICINE BUT NOT MEDICINE BE YOUR FOOD

Our country is known for its rich heritage of food pharmacy. The saddest part of it is that for years we have criticised the ancient practices as fads, fallacies, superstitions, false beliefs, blind faith and so on. Suddenly, there is a serious awakening to do something to protect our intellectual property! The rich traditional knowledge may soon disappear unless steps to unearth these practices are chalked out before it is too late.

Our ancestors knew that; apples can cleanse the blood, control the blood pressure and increase the urine output. Today it is proved scientifically that apples are rich in potassium and can therefore increase the alkaline reserve.

Westernisation has made us blind and deaf to our own wealth. Let us take the example of breast-feeding. Our grand mothers knew the merits of breast milk. The children used to be fed with breast milk even till the age of >2 years.

Colostrum was believed to be good for the newborn and it is only in the middle somewhere this practice lost ground. Immunological properties of breast milk, though not spelt out by the older generation in words, were well understood as it was used as a carrier for many ayurvedic drugs or home remedies. But alas! What are we doing today – copying the west and teaching our mothers their own lessons? Westerners believe in scientific proof first and then decide whether to follow the practice or not. But our tradition is to follow the practices handed over to the younger generation over the years and later reason out the same on scientific grounds.

Similarly, majority of our Indians are vegetarians and consumption of vegetables and beans is in-built in our food pattern. But the non-vegetarians who learnt by research that vegetarianism prevents many metabolic and infective disorders now realise the rich healthy Indian traditional food practices. Let us look at our traditional remedies – "Methi" or "Karela" for diabetes. These have been, today, scientifically proved to be beneficial.

Today it is soybean, a very traditional Asian Food that has caught the attention of the whole world. While it has taken Western scientists decades to establish that soy is equal in quality of animal protein, the Chinese have instinctively known this for years. In China the nickname for 'tofu' is meat without bones – 'Tofu' is Soy paneer.

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Cultivation of the soybeans first appeared in Japan in the Eighth Century A.D., but did not appear in the Europe until almost 1000 years later. In the Far East the growing of Soybeans is a tradition that can be traced back more than 4,700 years. By the late 1800, European Scientists were analysing the nutrient content of soyfoods (tofu) that was most likely introduced to Europe by European traders and missionaries to Asia. Soybeans are thought to have arrived in the United States in 1804, aboard a Yankee Clipper arriving from China. Americans took a little more than a century though to realize the potential of soybeans as a substantive food source. Soy got a surge from an unlikely ally founder of the Seventh Day Adventist Church, Ellen White, who promoted Vegetarianism. Soybean is also believed to have been first cultivated in China approximately 4000 years ago for their nutritional value, rich protein content. Soy bean is a suitable substitute for animal milk, and hence is often called as the 'China Cow'.

Madhya Pradesh has its major share in area and production of Soybean in India (nearly 69 per cent) and is hence designated as 'Soya State'. The other states with sizable hectarage and production are Maharashtra and Rajasthan.

The nutritional and therapeutic value of soy, proved through clinical studies, have led to increased production, improved processing technology and convinced the consumers to enhance the intake of soy and soy products.

Early in the 20th Century, J. Kellogg of Battle creek Mich was one of the first proponents of Soy based diets when he recognized their value in diabetes mellitus management. For centuries China and Japan where soy is a staple food, consistently exhibit lower rates of many chronic diseases that plague Western civilization.

Thus, soy could be a MIRACLE MEDICINE IN THE MODERN WORLD.

Therefore, in order to preserve our rich heritage and traditional wisdom, we, the medical and para-medical professionals will need to work as a team on a common table.

The present issue, therefore, has been devoted to the nutritional and health benefits of soy. It is an era of nutrition transition with therapeutics based on plants, vegetables, fruits and grains or in other words Herbal age.

Let us look forward to future issues with a focus on **Food Pharmacy**.

NUTRITIONAL ASPECTS OF SOY

DR. G. SUBBULAKSHMI

For centuries soybeans have been consumed as a staple food and an important source of high quality protein by a considerable share of the world's population. It was considered both as food as well as a medicine in Asia. The records reveal that soybeans were actually introduced to North America in 1765. Benjamin Franklin sent a friend in 1770, some of the seeds he described as being used to produce Chinese cheese (Tofu). Soybeans are now the second largest cash crop in the United States, having grown to an estimated $12.3 billion business in 1999. On the other hand the soy production in our country, though increasing steadily from 2.5 million tons in 1993, today accounts for only 6-7 million tons. While the per capita consumption is the highest in Japan (30 – 50 g. per day), and the same in Taiwan, Korea and Indonesia are 36, 25 and 17g. per day respectively, it is just 4 g. in the USA. Interestingly, soybean oil consumption amounts to 58 % of the total fats and oils consumed in the United States. Though Mahatma Gandhi introduced soybean in India in 1935 in the form of cooked whole or split beans; because of extensive cooking required to make it digestible by humans, soybean did not significantly enter the Indian diet at that time.

MACRONUTRIENTS

Soybean as any other legume comprises of about 8% hull, 90 %cotyledon and 2 % hypocotyls. The proximate composition of soybean is influenced by genetic as well as environmental factors. However, on an average, it contains 40 % protein, 23 % carbohydrates, 20 % oil, 9 % moisture and 5 % minerals and 3 % fibre.

Soy Protein: Not many years ago, soy foods were primarily the domain of vegetarians with infants thriving on soy-based formula. Now, however, new technology has made possible a wide variety of fourth generation soy foods. Unlike the first generation foods such as tofu and soy sauce, second generation foods such as soy flour and whole bean soy milks and third generation foods such as textured or structured soy products, these fourth generation foods can be uniquely bio-engineered to meet end product specifications for taste, texture and nutrition.

As Indian diets tend to be lower in animal proteins due mainly to socio economic condition and to a great extent to the religious restrictions, the economics of soy protein has been compared to other vegetable and animal proteins in Table 1.

TABLE 1 : Economics of Soy Protein

Food	Price/kg Food (Rs)	Protein %	Price/Kg Protein (Rs)
Wheat	15	12	125
Legumes	30	20	150
Rice	15	8	185
Soybean	**20**	**40**	**50**
Milk	18	4	500
Chicken	100	20	500
Meat	80	18	450

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It is well known that protein yield per hectare from soybean is the highest (509 kg per hectare) among all other animal or plant sources (50 in cow's milk and 250in other legumes). Thus no other source has as much protein and that too nutritionally good quality protein. Quality depends upon the amino acid composition and the biological availability of the proteins. Just as any other legume soybean is rich in Lysine but deficient in Methionine + Cysteine. Soy thus can serve, as a complementary protein for cereals that are deficient in Lysine and rich in Methionine. It has been shown by many studies that the amino acid content of defatted soy flour far excels that of red gram dal that is most commonly used in our country. It is found that 10 % of defatted soy flour with 90 % wheat flour can give an excellent amino acid composition though threonine is somewhat in excess which is also said to be harmless.

Protein Quality: It is well established that it is not just the quantity of protein present in the food that is important but it is the quality also that is important from nutritional point of view. A common method of evaluating the quality of protein since 1919 has been the Protein Efficiency Ratio. It is only later when the amino acid needs of the humans were understood that the PER's shortcomings were recognised. In this method the use of rat requirements instead of human requirements resulted in overestimation of the quality of animal protein and underestimation of the quality of plant proteins. Growing rats have much higher needs than humans for the sulphur containing amino acid methionine to support growth. As a result the plant proteins have been typically labelled, as poor quality proteins as the sulphur containing amino acids are deficient in them. Thus soy protein was considered to be inferior to animal protein. Later, the protein quality was assessed by the Amino Acid score, Protein Digestibility Index (PDI), Nitrogen Solubility Index (NSI) and such other parameters. While Protein Digestibility Index requires the sample to be stirred with water in a high-speed blender for 10 minutes the Nitrogen Solubility Index requires the sample to be stirred at a low speed for 2 hours. The difference in the values is quite significant, the NSI being generally somewhat lower than the PDI. But the Joint Expert Consultation of FAO and WHO - 1989 recommended Protein Digestibility-Corrected Amino Acid Score (PDCAAS) for evaluating protein quality as a more accurate method of assessing protein quality. PDCAAS is determined by:

$$\frac{\text{Amino Acid Content (mg/g protein) in Food Protein x Digestibility}}{\text{Amino Acid Content}}$$

PDCAAS takes several factors into account including a food protein's indispensable amino acid content and its true digestibility. In order to meet even the most stringent protein requirements, the PDCAAS compares the amino acid content of food protein to the needs of a 2 to 5 year old child. The PDCAAS of the different sources of protein as shown in Table 2 reaffirms that well processed soy protein products can replace meat and fish proteins without affecting the overall utilization of dietary nitrogen.

TABLE 2. PDCAAS of Some Food Proteins

Protein source	PDCAAS	Protein source	PDCAAS
Soy Protein	1.00	Peanut meal	0.52
Casein and Whey	1.00	Rice	0.47
Egg white	1.00	Corn	0.42
Beef Protein	0.92	Whole Wheat	0.40
Pea Protein	0.73	Wheat Gluten	0.25

The amino acid composition of defatted soy flour has been compared with red gram dal which is the most common split legume consumed by majority of Indians (Fig.1). It can be seen that soy protein excels in all essential amino acids assuring its high quality.

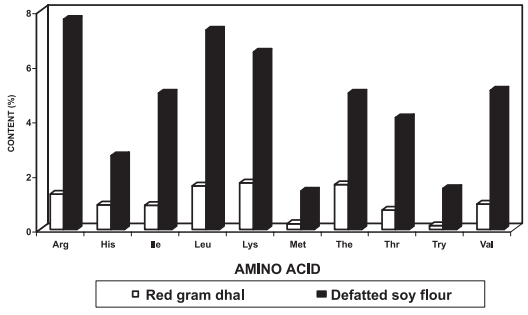


Fig.1. AMINO ACID PROFILE OF DEFATTED SOY FLOUR AND RED GRAM DAL

Soy protein contains naturally higher levels of arginine and glutamine than whey, casein or egg white and these two amino acids are conditionally essential and they enhance immune system. The high level of Arginine thus results in a favourable ratio of arginine to lysine in soy, which seems to be responsible for lowering cholesterol. The major storage proteins in soybeans are two globulins, termed 11S and 7S. (Lovati et al, 1992) suggest that 7S globulin may stimulate high-affinity LDL receptors in human liver cell cultures. But Potter et al (1993) did not find the addition of **soy protein** to increase the hypocholesterolemic effect in humans. It may well be seen that the observed cholesterol lowering effect of soy protein is the result of not one component or action but of a number of individual or interrelated factors.

Soy Oil: It is worth mentioning here that the Executive Director of the Rabobank International of New York, Mr. Alejandro Reca told the participants at the 6th annual convention of the Canola Council of Canada, that global soybean output will continue to expand and Canola must overcome the cost and efficiency of challenges if it is to successfully compete with soy oil. He also said the reason for the dominance of soy oil is that it is no longer considered as just a meal driven oil seed but is now viewed as a significant oil producing oil seed.

The fat content of soy is just about 20 %, but it is low in saturated fats, high in polyunsaturated fats and a rich source of essential fatty acids. The P/S ratio in Soybean oil is found to be 3.8 as the saturated (15) mono unsaturated (24) and polyunsaturated fatty acids (61) have been found to be in a better proportion (Table 3).

TABLE 3. Fatty Acid composition of Soy Oil as compared to the other edible oils

		Saturates			Unsaturated		
Fat or oil	**P/S Ratio**	**14:0**	**16:0**	**18:0**	**18:1w9**	**18:2w6**	**18:3w3**
Soybean	3.81	0.0	12.0	4.0	23.0	53.0	8.0
Sunflower	6.57	0.0	5.5	5.0	20.5	69.0	
Cotton seed	1.95	1.4	23.0	1.0	24.0	49.6	
Peanut	2.00	0.0	14.0	3.0	43.0	34.0	
Olive	0.98	0.0	11.0	2.3	73.7	13.0	
Palm	0.28	1.5	33.0	4.5	50.0	11.0	
Butter	0.08	24.0	29.0	11.0	30.8	5.0	0.2
Coconut	0.03	76.0	10.0	4.0	7.0	3.0	

In recent years, a major topic that calls the attention of the consumers is omega 3 fatty acids. Soybean oil is unique among the different vegetable oils in its fatty acid composition with a high linoleic acid 50% (Omega 6), linolenic acid 7-8% (Omega 3), the latter being negligible in most vegetable oils and 24 % oleic acid. Ratio of saturated: olein: omega 6: omega 3 fatty acids in soybean compares well with other PUFA oils. Soybean oil is a good source of tocopherols and as the polyunsaturated fat intake increases, the need for dietary vitamin E increases. The health benefits of Omega 3 and 6 fatty acids are well established. Pakaenkitvatana *et al* (1989) showed that adequate intake of soybean oil providing 10.6 % of total energy as linoleic acid can increase serum n-6 level with a concomitant decrease in serum total cholesterol and LDL cholesterol levels in the presence or absence of cholesterol intake. The high polyunsaturated fatty acid level and the presence of linolenic acids target its use as a unique vegetable oil with cholesterol lowering function.

In order to provide semi-solid fats for shortening the fatty acid composition of vegetable oils are modified by hydrogenation that reduces the level of PUFA and increases the saturated fatty acid content and forms cis and trans isomers. In soybean oil, C18 trans fatty acids generated during hydrogenation are mainly monoenoic acid and smaller amounts of geometric and / or positional isomers of dienoic acids.

SOY FIBRES

Soy contains fibre to the extent of just 3-5 % of which 75% is dietary fibre, which is a mixture of cellulosic (10%) and noncellulosic (65%). Soy fibre aids in controlling constipation, assists in the management of blood cholesterol and glucose and helps regulate blood insulin levels. In addition, soy fibre does not interfere with the body's optimal utilization of essential minerals, such as calcium, magnesium and iron.

Generally, it is not consumed as a whole legume like other legumes mainly because of its hard seed coat. Germination of the whole legume can provide good amount of fibre but the unacceptable off flavour of the legume necessitates employing processing techniques, which may reduce the fibre content. But nevertheless, the beneficial effects of the fibre have definitely been proved as it is shown to improve glucose tolerance and insulin response in diabetic patients. The insoluble fibre of soybean of course is associated with enhanced bowel function. Tsai *et al* (1983) showed that faecal wet weight and faecal water content increased significantly when 25 g. of **soy fibre** was consumed. Lo *et al* (1986) found that an addition of 25 g. of soy polysaccharide reduced significantly the fasting glucose levels by 8.5 % and the insulin response to oral glucose challenges by 20 % in patients with type II-A hypercholesterolemia. Again, Shorey et al (1985) found that **soy polysaccharide** reduced the total cholesterol by 5-11% in mild to moderate hypercholesterolemic patients and Bakhit et al (1994) reported that soy fibre when added to other foods and **not to soy protein** showed hypocholesterolemic effect. Other studies using **isolated soy protein** with no fibre at all showed hypocholesterolemic effect suggesting that it may not be the fibre that accompanies the soy protein that is responsible for this effect.

Soy fibre appears to be extremely fermentable in human subjects. This may explain some of its physiological effects. Compared to other fibre sources, soy fibre provides a broad range of positive functional, nutritional and physiological effects. There was also no significant increase in faecal excretion of minerals or nitrogen even at a high level of soy fibre ingestion.

MICRO NUTRIENT COMPOSITION OF SOY

The micronutrient content of soybean is again very exciting with special reference to Beta-carotene, Calcium and Iron (Table 4). Soybeans are high in iron but also contain phytate, which binds divalent cations. Lynch

et al (1985) has however shown that in non-vegetarians soy increases the absorption of heme iron. As it is well known that in conditions of deficiency the rate of iron absorption increases, Hertrampt et *al* (1986) and Worthington-Roberts *et al* (1988) found no disturbances in iron nutrition in vulnerable population group of pre-menopausal women and infants. It has been reported by Mac Farlane et al (1990) that some traditional Asian soy foods such as soy sauce, Tempeh, natto and miso actually promote iron absorption when compared to soy flour due to the processing methods.

Soy foods may help prevent and treat osteoporosis, as it is a fair source of calcium. But there is a need for fortification with calcium as the amount of calcium, vitamin D and B_{12} do not occur in soybean in sufficient amounts. Some researchers say that we absorb as much calcium from soymilk as we do from cow's milk. But at least one study suggests that we absorb 25% less calcium from soymilk. Calcium fortified soymilk is reported to be easily absorbed by the body.

TABLE 4 : Beta - Carotene, Iron and Calcium content of Defatted soya flour in comparison with other pulses

Pulses	Beta Carotene (mcg)	Iron (mg)	Calcium (mg)
Soy flour	210	4.6	210
Redgram dhal	132	2.7	73
Bengalgram dhal	129	5.3	56
Greengram dhal	49	3.9	75
Blackgram dhal	38	3.8	154

ANTIOXIDANTS IN SOY

Soybeans are rich in antioxidant content. University of Nebraska researchers have found that antioxidant rich soy can prevent damage caused by free radicals which are believed to be responsible for aging and age related forms of diseases. Studies are being conducted by the University of Alabama to ascertain whether a soy-based diet can attenuate Alzheimer's disease like memory deficit in older animals. Alzheimer's disease, especially among postmenopausal women, may be caused by an oestrogen deficiency and affects 10 % of all Americans over the age of 50 years. Soy isoflavone Genistein has been found to have antioxidant properties, which may be partially responsible for its anti carcinogenic effects.

According to Kanazawa et al (1995) soy creme product reduced peroxidation in molecules of LDL cholesterol, VLDL cholesterol and HDL cholesterol. The antioxidant properties of soy isoflavones protect the cardiovascular system from oxidation of LDL (the bad) cholesterol. Oxidized LDL cholesterol accumulates in the arteries as patches of fatty buildup, which block the flow of blood, resulting in atherosclerosis. Genistein inhibits the growth of cells that form this artery-clogging plaque.

Anti nutritional Factors?

The anti nutritional factors such as saponins, phytates and protease inhibitors that were viewed negatively in the past are also present in soy just as any other legumes. But what is intriguing is that they have a positive side of their faces, which give them a new look.

- **Saponins** are antioxidants and thus prevent cell damage; inhibit colon cancer cells.

- **Phytates** prevent formation of free radicals in excess iron intake.
- **Protease inhibitors** prevent the activation of oncogens.

Phytic acid: Varying amounts of phytic acid present in soy foods may chelate calcium, iron, zinc and magnesium in the intestinal tract, thereby decreasing absorption of these minerals. Diets that are deficient in copper or have a high Zn/Cu ratio are associated with hypercholesterolemia. It is suggested that phytic acid may help lower blood cholesterol by chelating zinc and allowing more copper to be absorbed. Soy-rich diets provide both phytic acid and copper.

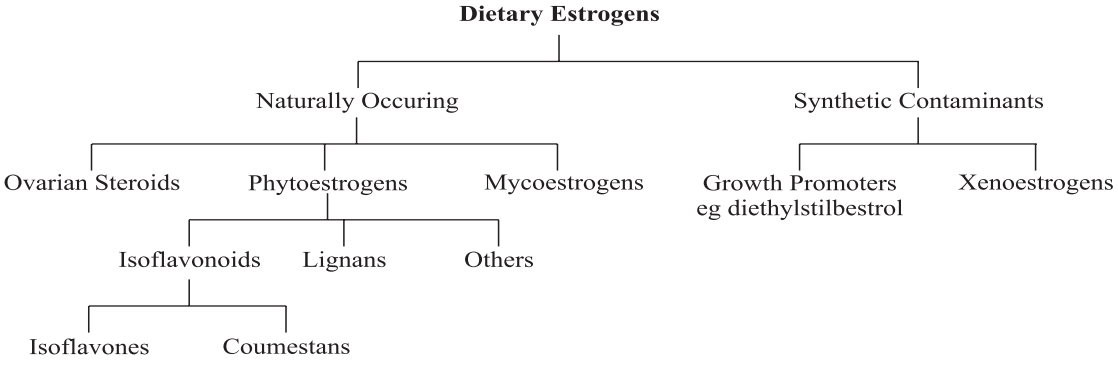
Saponins: Animal studies have shown that addition of soy saponins to the diet decreases blood cholesterol by increasing the excretion of bile. But human studies are needed to confirm the same.

Trypsin Inhibitors: Although all soy protein foods are now heated which inactivates virtually all trypsin inhibitor, it is theorized that the remaining Bowman Birk inhibitor may increase the secretion of cholecystokinin, which in turn stimulates the gallbladder and increases secretion of bile into the gastrointestinal tract.

The Bowman–Birk inhibitor found in soy is particularly effective in preventing or suppressing carcinogen induced transformation in vitro and carcinogenesis in animals.and without toxicity.

Phytochemicals in Soy: Soybeans contain a variety of phytochemicals and are the only food source with significant amounts of one important class of phytochemicals isoflavones. Although chickpea and other legumes contain isoflavones, soybeans have the highest concentration of this beneficial compound in addition to other phytochemicals such as protease inhibitor, saponins and phytosterols. Protease inhibitors have been shown to slow the rate of cancer division in cells. Saponins may prevent cells from multiplying and phytosterols seem to block estrogens.

Phytoestrogens, such as the soy isoflavones mainly genistein and diadzein are currently being



(Classification of dietary estrogens)

extensively investigated through molecular, preclinical and clinical studies to determine their potential health benefits. (Isoflavones belong to the polyphenol family. Due to their structural similarity to synthesized estrogens in the animal or human, they can be described as phytoestrogens).

Comparison of the structure of the isoflavone metabolite equol with that of estradiol showing the striking similarity in planar spatial arrangement of the two molecules. A population-based case-control study of soy

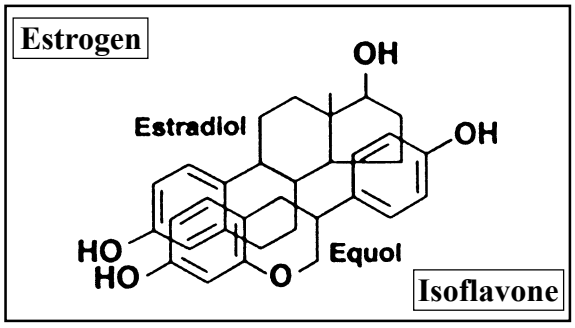


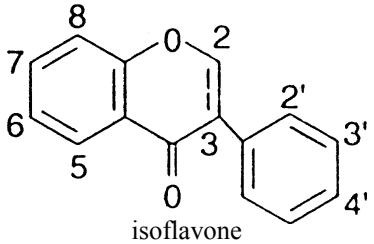
Figure-2: Similarity of Isoflavones to Estrogens

food intake and breast cancer risk in Shanghai showed a higher bone mineral density in premenopausal women with dietary intake of phytoestrogens. Thus it is possible that consumption of phytoestrogens has a potential role in preventing trabecular bone loss. However, further studies are warranted to evaluate definitely the efficacy of phytoestrogens in preventing premenopausal osteoporosis.

TABLE 5. Relative Biologic Potency of Isoflavones in Cell Cultures Compared With Estradiol*

Compound	Relative potency
Estradiol	100
Genistein	0.084
Daidzein	0.013
Equol	0.016

* Based on studies performed with human breast cancer cell cultures Estradiol is given an arbitrary value of 100. Adapted from Marklewrex



isoflavone

Common Name	Substituents			
	5	7	4′	5′
Daidzein	H	OH	OH	H
Genistein	OH	OH	OH	H
Formonetin	H	OH	CH_3	H
Biochanin A	OH	OH	OCH_3	H
Genistin	OH	O glucose	OH	H
Prunectin	OH	OCH_3	OCH_3	H
Prunetin	OH	OCH_3	OH	H
Oroboi	OH	OH	OH	OH
Tectorigenin	OH	OH	OH	H

Figure-3: Chemical structure of the phytoestrogens

Isoflavones: Genistein and diadzein constitute over 95% of the soy isoflavones. They differ in structure only slightly, with genistein having a hydroxyl (OH) group on one of the carbons. The isoflavones act as very weak estrogens, exerting an estrogenic effect about 1/1000th that of estradiol. In most individuals, bacteria in the gastrointestinal tract convert these isoflavones into equol, another weak estrogen. In foods, isoflavones are present in their aglycone form as genestein and diadzein, which are conjugated with a glucose moiety to form a glycoside.

Absorption and Metabolism

Intestinal microflora play a key role in metabolism and bioavailability of isoflavones. After ingestion soybean isoflavones are hydrolyzed by intestinal glucosidases, which release the aglycones, daidzein, genistein, and glycitein. These may be absorbed or further metabolized to secondary metabolites such as equol and p-ethylptenol The degree of metabolism is highly variable among individuals and is influenced by other components of the diet. A high carbohydrate milieu, which causes increased intestinal fermentation, results in increased formation of equol. This is important, as the estrogenic potency of equol is higher than its precursor daidzein. The estrogenic potency of the different Phytoestrogens is as listed in the table above. Both the intact and free form of metabolized isoflavones freely circulate in the blood, and is excreted in the urine within 24 hours mainly as glucoronide conjugates.

Isoflavones exhibit a multitude of biological effects that influence cell growth and regulation, and thus, may have potential value in the prevention and treatment of cancer. Isoflavones are weak estrogens and can function both as oestrogen agonists and antagonists depending on the hormonal milieu and the target tissue and species under investigation.

To conclude, genistein and may be other Isoflavones in soy has a beneficial role to play in maintenance of health and prevention of many ailments:

- Is anti estrogenic in animal models and thus reduces the risk of hormone related cancers.
- Decreases the activity of the enzymes that convert normal cells into cancer cells.
- May interfere with the supply of nutrients and oxygen to the tumour cells.
- Inhibits angiogenesis, growth of blood vessels and blood supply to tumour cells.
  - A potent antioxidant that blocks the action of free radicals.

The isoflavone content of soy products is shown in Fig.4.

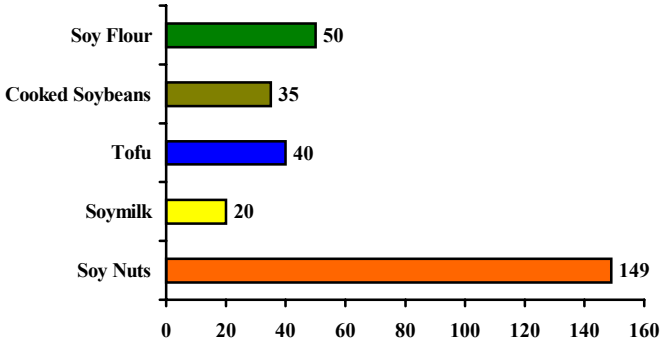


Fig.4. Concentration (mg per 1/2 cup) of Isoflavones in Soy Foods

Studies show that isoflavones account for approximately three-fourths of soy's protection, while its protein is responsible for about one-fourth. The best way to consume isoflavones is in food form, so that you can benefit from all of soy's nutrients and beneficial compounds. The highest amounts of isoflavones and soy protein are found in tempeh, whole soybeans (like edamame), textured soy protein, soynuts, tofu and soymilk. Researchers recommend consuming at least one to two servings a day. A serving is equal to 1 ounce of soynuts; 4 ounces of tempeh, textured soy protein (cooked) or 8 ounces of soymilk.

OTHER MERITS OF SOY

Lecithin: Lecithin is a natural soybean derivative with intrinsic nutritional value and plays extremely important roles in manufacturing. It is separated from the oil by the addition of water and centrifuged and purified. It is phosphatidylcholine with the major components of choline, phosphoric acid, glycerine and fatty acids. It is widely used as emulsifier, stabilizer and antioxidant in foods. Lecithin is found to have a number of health benefits in addition to functional benefits.

Used as a food additive. In baked foods, it can replace the phosphotides found in egg-yolk. Thus is a cheaper alternative. Lecithinated soy flour contains 6-15% lecithin added to flour. Lecithin helps to obtain smooth and easily formed dough. Cookies made with lecithin remain pleasantly crumbly and so reduce the fat content. Lecithin retards the oxidation of fat and so cookies stay fresh longer.

Okara: This is the undissolved residual portion left after extracting soymilk from soybeans and is rich in protein and fibre. Adding okara to wheat flour, almost at 50% w/w, makes high protein high fibre bakery products at lower cost. Excellent biscuits can be made using okara. Biscuits made with okara give a highly desirable coconut like texture to regular biscuits.

Conclusion: The versatility of this legume opens up new venues of research in the present era of natural / plant / herbal products as the most promising area of therapeutics. The rich fauna and flora of this country needs to be delved into in the aim of " health for all" in the coming decades.

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SOY IN THE WORLD OF FITNESS

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The term fitness includes both physical and mental aspects of human body and this fitness term is subjective when we talk about fitness of an athlete or a normal sedentary person or even fitness of a person recovering from certain illness. There is a large difference in degree of fitness among these groups and the requirements of nutrients are also different for them.

Sport today has evolved to be an extremely competitive profession where one has pride, money and health at stake. In this field, the scenario today is very conducive to winning and reaping the rich cash awards through the game. The athletes in a bid to win these awards try to improve their performance each time they enter a tournament. This has led them to seek various types of supplements to improve their fitness.

On the other hand, with the technological development and push button life style, health and fitness for general population is going in a complete opposite direction. Today several life-style related metabolic diseases, which were initially restricted only to privileged group has become common to general population also. But fortunately enough even the sedentary people are becoming more and more conscious about their fitness today. Different health centers can give a lot of support to achieve this, provided they are equipped with the proper knowledge. In fact health and fitness world has become a very big industry, where these supplements find a big market. Thus, the growth of the supplement market due to demand of this fitness group and extensive marketing strategies, has witnessed a tremendous increase in the recent years.

A supplement may either provide a nutrient that is normally supplied to cells like protein supplements or may exert a pharmacological effect on cellular processes. In the first case optimal function is achieved when a nutrient required by the organism reaches a specific concentration within the cell. A supplement has beneficial effect only when the normal intake of a bio-available form of a nutrient is lower than the amount that would provide maximum benefit as judged from all biological perspective. It has been found that the most popular supplement amongst the entire sports and fitness community is protein supplement. These products had their origins in gyms back in the early 50s to help bodybuilders get more protein to build muscle. They have certainly evolved since then and have been embraced by the public as beneficial to living an active and healthy life but certainly require an experienced and able guidance and strict monitoring.

Normally one third of protein intake during rapid growth in infancy and childhood is used for tissue anabolism. As growth rate declines, so does percentage of the protein retained for anabolic processes. A continual turnover of tissue protein occurs when a person attains a stable body size and growth ceases. Normal protein dynamics for adults require adequate protein intake simply to replace the amino acids continually degraded in turnover process.

Exercise increases this protein requirement of the body as observed by the experiment where a person in nitrogen-balance, goes into negative nitrogen balance after starting the exercise. In recent years, the results of several investigations involving both strength and endurance athletes indicate that in fact exercise does increase protein / amino acid needs.

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The claims for beneficial effects of protein supplements are:

Builds muscle	Improves endurance
Increases strength	Boosts energy levels
Controls appetite	Promotes immune function
Aids weight loss	

Increased intake of protein along with muscular activity is expected to promote muscle strength, function and possibly size. Studies have also been cited to highlight the psychological effect of these supplements, which sometimes are found to be more powerful than the physiological one.

Effects of exercise on protein turnover in man

1.	Exercise causes a substantial rise in amino acid catabolism
2.	Amino acid catabolised during exercise appear to become available through a fall in whole body protein synthesis and a rise in whole body protein breakdown.
3.	After exercise, protein balance becomes positive through a rise in the rate of whole body synthesis in excess of breakdown.
4.	Studies of free 3-methylhistidine in muscle, plasma and urine samples suggest that exercise decreases the fractional rate of myofibrillar protein breakdown, in contrast with the apparent rise in whole body breakdown.
5.	In contrast to exercise, most of the increased proteolysis during fasting is due to the degradation of myofibrillar proteins in skeletal muscle.

Why should there be an increased protein need in athletes?

- Training leads to increased muscle mass
- Intensive endurance work leads to muscle cell damages
- Increased energy turnover in muscle tissue leads to increased oxidation of muscle protein
- Increased nitrogen losses in urine and sweat
- Negative energy balance leads to increased use of muscle protein as energy source.

Therefore the mechanisms suggested to increase athletes' protein requirements include:

- The need to repair exercise-induced micro damage to muscle fibres
- Use of small amount of protein as an energy source for exercise and
- The need for additional protein to support gains in lean tissue mass
- Training

A variety of factors interact to increase the rate of protein synthesis and therefore dietary protein requirements of individuals who exercise regularly.

Conditions and factors that affect protein synthesis

Rate of protein synthesis	
Decrease	**Increase**
• Low protein intake • Low energy intake • Decreased cellular hydration • Lack of nervous stimulation • Over training • Excess Thyroxine level • Glucocorticoids • Physical trauma/ infection	• Increased protein • Increased cellular hydration • Increased intake of leucine along with other amino acids. • Increased intake of glutamine along with other amino acids. • Muscle stretch or exercise • Testosterone and anabolic steroids • Growth hormone • Normal thyroxine level • Insulin • Catecholamines

The overall consensus has been that all athletes need more protein than sedentary people and that strength athletes need the most. But the question of how much dietary protein a physically active person requires to support training and optimize improvements continues to intrigue nutritionists and exercise physiologists.

Athletes as a whole and particularly the strength athletes and body builders usually consume large amount of protein through diet and through supplement. Increased protein consumption may result a concomitant caloric and fat intake, resulting in more fat mass than muscle mass.

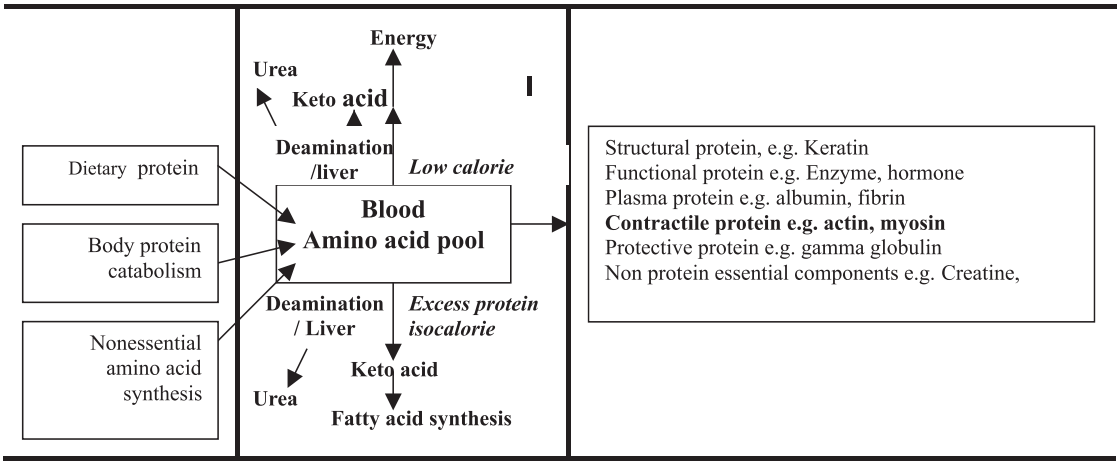
In the 1950s and 1960s athletes increased their protein intakes through diet and focused on high quality source such as milk and meat. This changed in the 1970s and 1980s to preparation of isolated protein powders and amino acids. Today dietary protein supplements have become an issue of discussion and an intense study in this field is of utmost importance.

There exists a serious concern about the necessity and long- term effects of this high protein intake.

Human body does not have any storehouse for protein and therefore if taken more than the required amount, gets deaminated, either to serve as a source of energy or store as fat. This process of deamination gives rise to large amount of nitrogenous excretory product that makes the kidney to over work to clear this extra load along with elimination of extra water causing dehydration. If the energy requirement increases, protein requirement will increase proportionately. But beyond the amount required, it will not give any advantage but a negative effect of kidney loading is expected to result. This is the point of concern for long-term use of excess protein intake raising the main controversy regarding the protein supplementation. Again if an individual is trying to increase lean body mass, the goal is not zero balance but a positive nitrogen balance.

Following scheme will illustrate the importance of protein metabolism and its specific pathways during high calorie and low calorie intake.

Different metabolic pathways for protein in human body



RDA for Dietary protein (g/kg b.wt / day)

Normal sedentary subjects	0.8
Strength athletes	1.4 to 1.8
Endurance athletes	1.2 to 1.4
Indian std for reference athletes	2.0

Protein makes up 3/4th of body solids and daily optimum supply of protein is very important. To ensure the optimum supply of protein, enough care has been taken at every stage while calculating the RDA for protein and most of the people will have more than enough supply if they follow the RDA.

Dietary allowance for protein may be calculated on the following basis:

Obligatory urinary N_2 losses of young adults	About 37 mg/kg b wt. Average 12 mg/kg b wt
Fecal N_2 losses	3 mg/kg b wt
N_2 loss in the respiration, hair, fingernails and skins	2 mg/kg b wt
Minor routes (saliva, menstruation and seminal ejaculation)	
Total obligatory N_2 loss	54 mg/kg b wt
In terms of protein loss	0.34 g /kg b wt
To account for individual variation, the daily loss is **increased by 30%**	70 mg/kg b wt
In terms of protein loss	0.45 g /kg b wt

To account for the loss of efficiency (Even a high quality protein), this protein loss is **further increased by 30%**	0.6 g /kg b wt
For the **75% efficiency** of utilization of protein in the typical mixed diet, the RDA for protein of normal healthy adult M and F	0.8 g /kg b wt
79 kg Man 63kg woman	63 g of protein / day 50 g of protein / day

But it is sometimes difficult to fulfill this RDA for protein for the athletes through the normal Indian diet and more so through vegetarian diet. Protein supplements have proliferated because of these reasons. Selected populations may be at increased risk of not consuming sufficient protein due to increased requirements for a variety of other reasons

- Strict vegetarianism
- Inadequate energy intake (dieters or athletes with high energy expenditure, especially women athletes)
- Higher baseline requirements (growing age or the elderly) etc.

Intensive training session may disturb the regular meal pattern. We must supply to satisfy the increased requirements but not more than requirement. It is important to take the guidance from a nutritionist to calculate the individual's protein requirement.

Who are the consumers of Active Nutrition Supplements?

More recently we are using the term Active Nutrition Supplements, traditionally known as sports supplements, as it is consumed by any one, who needs more than average protein supply. No longer are nutrition supplements used exclusively by athletes and bodybuilders.

There exists confusion regarding the quality, consumption timings, types of supplements for specific sporting activity, efficiency of those supplements and effect of long term use of these supplements and are still lacking the definite answers. These requires in depth studies for specific conditions. It is essential to assess the protein requirement before going for supplementation to avoid any untoward effect of excess protein intake.

There are few easy ways of calculating one's gross Optimum Daily Requirements for Protein in grams. These methods are not used by scientific community but are commonly practiced in athletic and fitness world.

Method-1 : **Optimum Daily Requirements For Protein (In Grams)**

Body wt (lb)	Protein Requirement (gm)		
	Sedentary work (b. wt x 0.6)	Light work (b. wt x 0.7)	Moderate work (b. wt x 0.8)
90	54	63	72
100	60	70	80
110	66	77	88
120	72	84	96

For Example: To determine Protein Requirement:
0 .7 (light Exercise) x 120 lb. = 84 grams of Protein Required
If the person is getting about 45 g protein daily in diet, he will need to supplement his diet with 40 g of protein / day.

Method-2

Multiply the body weight in kilograms by 1.6 to 1.8 to find grams of protein needed per day. If the body weight is about 80 kilos, multiply body weight in kilograms by 1.8 to find grams of protein needed per day (80 x 1.8= 162 g). Then divide by number of meals per day and make sure to get that much protein per meal. So if our 80 kg person ate 5 times a day, they would try to get 33 grams of protein per meal (162 divided by 5 =32.4, then round up to 33).

Method-3

To find out average individual need, simply perform the following calculation:
Body weight (in pounds) X 0.36 = recommended protein intake

NEED FOR PROTEIN SUPPLEMENTS

Higher physical activity increases the requirement of protein. Therefore questions have been asked regarding protein needs in athletes:

- Does strength training and endurance training affect protein turnover in the same way?
- Can increased protein compensate protein catabolism secondary to energy deficiency?
- Is protein quality of importance?
- Is there a need for special protein supplements?
- When is optimal effect of protein intake obtained: before, during or after exercise?

A variety of factors interact to increase dietary protein needs of individuals who exercise regularly. Increasing exercise intensity and duration, at least with aerobic endurance exercise, causes increased use of protein, presumably as an auxiliary fuel. Based primarily on nitrogen balance experiments, this results in an increased daily protein need of about 50% to 75%.

Although heavy resistance (strength) exercise appears to increase protein need by about 100% based on nitrogen balance experiments, isotope tracer studies have revealed that the underlying mechanism is not increased fuel use. Rather, it is the result of changes in muscle protein synthetic rate and the need to maintain a greater overall muscle mass. There is no indication that these intakes will cause any adverse side effects in healthy humans. On the other hand there is no valid scientific evidence that protein intakes exceeding about 1.8 to 2.0 g/kg/day will provide an additional advantage.

Increased protein intake may compensate for protein catabolism secondary to energy deficiency as this excess intake will be used as source of energy in an energy deficient person.

If the energy supply is normal, N_2 retention will increase with increasing exercise. But if the person is in –ve N_2 balance, the exercise will further increase the N_2 excretion. Use of protein supplementation along with physical exercise for muscle growth is possible only when energy supply is optimum.

When energy intake and output are balanced, the improvement in N_2 retention accomplished by exercise seems to be fairly constant at protein intake greater than 0.8 g/kg/day. But falls off rapidly at protein intakes below this value. When energy balance is –ve, the magnitude of the effect of exercise on protein retention

may be decreased as the activity increased. N_2 loss through urea N_2 will increase. Protein requirement will be higher than when energy balance is maintained**.** If the energy supply is normal and protein intake is lower than RDA or a vegetarian athlete with low quality protein, protein supplementation may be functional.

Continuous high-level physical stress demands a continuous supply of high quality dietary protein. The quality of protein in a food is determined by its indispensable amino acid content. Some foods contain all of these indispensable amino acids and in amounts sufficient to maintain protein synthesis, while others are lacking in at least one amino acid. The former are called complete protein foods and include such foods as dairy products, eggs, meat and fish, while the latter include grains, vegetables and fruits.

Moreover, it has been shown, in adult men, that strength training produced greater muscle mass gains with a meat-containing diet in comparison to a lacto-vegetarian diet. These data suggest that type of protein may play an important role in muscle growth with strength training.

If one is able to eat 5-6 wholesome and nutritionally balanced meals every day and at the right times, they don't need supplements. But supplements can help to make up any deficiencies one may have in the nutrition program, enhance the results and accelerate progress, with convenience. Athletes involved in different types of sporting activities, regularly state that they use protein supplements many grams above the RDA because they perceive this recommendations to be insufficient.

TIMING FOR PROTEIN SUPPLEMENTS

Regarding the timing for protein supplementation is another area of great interest. It is well established that immediate source of energy for any short-term physical activity is carbohydrate and then for endurance activity, it is mainly fatty acids. A very small fraction of protein is used as source of energy, which increases to a very limited scale after long term physical activities. The main use of protein takes place during recovery phase when body starts compensating for the wear and tear of the muscle protein due to physical strain. This is the time when normal physiologic techniques of super compensation during muscle regeneration takes place and body develops a greater muscle mass provided enough proteins / amino acids are available. During recovery phase protein is also helpful in resynthesis of higher level of muscle glycogen when supplied along with carbohydrate as compare to CHO alone. Therefore protein supplementation is suggested to have better effect during the post event session. But for regular high intensity training the total protein requirement can be distributed in different meal intake along with immediately after the practice session.

SOURCES OF PROTEIN

Three major protein sources are used in protein supplements: Milk, Egg, and Soy. Out of these three natural high protein sources, **soybean** is drawing attention as one of the best health foods. The soybeans are so rich in protein and fat as to be called garden meat. As compared to other two sources, soy protein has many unique benefits that make it a top-notch protein. It is probably one of the most important aspects of a vegetarians diet, consumed by both vegetarian and non-vegetarian people. It is the closest vegetable protein that resembles meat proteins. The main reason for soy protein to become a substitute for animal protein is because it offers a complete amino acid profile. It contains all the amino acids that are essential to human nutrition. It has 1.0 PDCAAS score, which is the highest possible PDCAAS.

SOY PROTEIN

Soy protein has become the most commonly used protein supplements and have been a subject for extensive industrial research to produce different varieties, starting from soybean flour and grits to a virtually pure

protein isolate in commercial quantities. These refer to the process by which the proteins are produced, and the quality of the protein.

Soybean flours and grits: Essentially soybean meals have been ground to the appropriate mesh size. The starting material is dehulled beans. It is the simplest of all edible soybean protein products. The extent of processing for its production is minimal. It is obtained by finely grinding full fat dehulled soybeans or defatted flakes made from dehulled soybean. To be called soy flour, at least 97% of the product must pass through a 100 mesh standard screen. Grit has coarser granules.

Defatted soy flours with 50-75% protein dispersibility are extensively used in bakery products. Nutritionally, soybean protein is an excellent complement to lysine-limited cereal protein and hence an economical protein supplement in bread, pasta or other cereal products.

Material	Protein %	Moisture %	Fat %	Fibre %	Ash %
Soybeans	42.6	11.0	20.0	5.3	5.0
Full fat Soy flour	46.6	5.0	22.1	2.1	5.2
Defatted soy flour	59.0	7.0	0.9	2.6	6.4
Soy protein concentrate (SPC)	70.0	8.0	1.0	4.5	7.0

Soy Protein Concentrate is prepared from high quality sound, clean, dehulled soybean seeds by removing most of the oil and water soluble non protein constituents and must contain not less than 70% protein on a moisture free basis. Products containing about 70% protein are prepared from defatted meal by selective extraction of the soluble non protein constituents (CHO, low molecular weight nitrogenous substances and minerals). Extraction with aqueous alcohol is the most common process. The concentrates are essentially bland. Their availability as commercial products dates from 1959. In the last 30 years, these versatile products have become important ingredients, well accepted by many food industries. In many applications they simply replace soy flours or may have specific function, which can not be performed by soy flour. It was developed primarily from two considerations: (1) To increase protein concentration and (2) To improve flavor. The objective of the further processing of flours into concentrates is to extract the particular components, which are responsible for the bitterness and beany taste. Soy protein concentrate normally cost 2 - 2.5 times more than defatted soy flour.

Soybean protein Isolates: Soy protein isolates (ISP) are the most pure and refined soy protein available. Isolates are made from defatted soybeans, with most other ingredients removed leaving almost all protein. About 96% proteins are obtained by selective solubilization of the protein (e.g. alkaline extraction), followed by purification of the extract and precipitation of the protein. They are converted to Na or K proteinate to make it water-soluble. Protein isolates will always be more pure than concentrates. Actual concentration will depend on how the protein content is reported, either as “dry basis” or “as-is basis”. Reporting by as-is basis is more reflective of the true protein contents, since all protein supplements will have some moisture. Reporting as “dry basis” allows to look like there is about 4 to 8% extra protein than an “as-is basis”. Usually, soy protein isolates contain 90% + protein on a moisture free (dry) basis. Soy protein isolates will also be more ‘neutral’ flavored, compared to soy concentrates, mainly because almost everything else is removed except the protein. Unlike soy concentrate, the carbohydrates are also removed, so the soybean taste is also removed.

SPECIAL ATTRIBUTES OF SOY PROTEIN

The amino acid profile shows extremely high levels of arginine and glutamine (more than 2x the amount than in whey protein). These two amino acids play a key role in recovery for athletes because they enhance healing, reduce physiological stress and help to maintain the immune system. Aside from these most well known fact of high protein quality, soy protein has many other attributes that need special mention. Soy protein possesses some unique characteristics that separate it from animal – derived proteins and it appears to benefit exercising individuals.

1. Soy protein isolates contain isoflavone glucosides (mostly genistein and diadzein 0.68 to 2.49 mg/g). Extensive research is going on the health promoting benefits of soy isoflavones and soy products. The result shows that isoflavones are mostly responsible for antioxidant actions, thyromimetic properties, cancer prevention, reduction of CVD risk factors, maintenance of bone mass and amelioration of female gynecological complaints. Studies on soy protein as compare to other protein types showed that soy has the exclusive ability to raise plasma antioxidant, which is an important aspect of soy for the athletic and fitness conscious group as higher level of physical activity does increase the oxidative stress in the body that can contribute to muscle soreness, inflammation and the development of free radicals. Research shows that soy protein may speed up muscle recovery after exercise. The antioxidant effect of isoflavones found in soy protein may help reduce soreness and inflammation and may help athletes recover more quickly. This is why soy protein has greater advantage as compared to protein from other sources like casein.

2. There are five critical cluster amino acids including glutamine, lysine and the BCAAs, which actually determine the nutritional quality of a specific protein. These critical cluster amino acids in theory are the amino acids used for fortification of proteins by the dietary supplement industry and they claim to have special benefits for exercising individuals. The critical cluster branched chain amino acids are hypothetically used as an important energy source during exercise.

Amino acid composition of SCP and Soy flour (g. / 16g. nitrogen)

Amino acid	Soy flour	SCP- alcohol wash	Amino acid	Soy flour	SCP- alcohol wash
Alanine	4.0	4.86	Lysine	5.70	6.40
Arginine	6.95	7.98	Methionine	1.34	1.40
Aspartic acid	11.26	1.40	Phenylalanine	4.72	5.20
Cystine	1.45	12.84	Proline	4.72	6.00
Glutamic acid	17.18	20.20	Serine	5.00	5.70
Glycine	3.99	4.60	Theonine	4.27	4.46
Histidine	2.60	2.64	Tryptophan	1.80	1.60
Isoleucine	4.80	*4.80*	Tyrosine	3.40	3.70
Leucine	6.50	***7.90***	***Valine***	***4.60***	***5.00***

3. Soy proteins are rich sources of these BCAAs and contains almost similar amount of five critical cluster amino acids as compare to other proteins, such as whey, casein and egg. It shows that whey protein has the highest amount of five critical amino acids but the cost of the whey protein is almost 2-3 times more as of soy protein. This has given the soy protein a preference of getting the comparable advantage with much lower cost.

4. Several amino acids including the BCAAs especially leucine are used directly as oxidizable fuels during exercise. Depending on the duration, intensity of exercise and factors like glycogen stores and energy intake, these amino acids can provide from a few to approximately 10% of the total energy for sustained exercise.

5. Soy protein contributes to improve metabolic responses during a low glycemic diet for weight management. It also seems to induce a greater release of glucagons, an enhancer of fat oxidation, compared to animal protein. Soy protein combined with a low polyunsaturated fat diet may promote insulin receptor gene expression, thus supporting insulin function.

6. Effects of Branch chain amino acid on exercise time: Several studies have shown the usefulness of BCAAs. In one study the use of BCAAs prior to exercise significantly increased the exercising time to exhaustion in rats compared to placebo.

7. BCAAs and Visceral Adipose Tissue (VAT): The use of BCAAs along with a restricted caloric intake in a study with wrestlers wanting to loose weight, resulted in a decrease in percent body fat and a significant reduction in abdominal visceral adipose tissue (VAT- most pot bellies are made of) as compared to the group with only calorie restriction without BCAAs. The authors concluded that the combination of moderate energy restriction and BCAA supplementation induced significant and preferential losses of VAT and maintenance of a high level of performance. BCAAs also prolong exercise duration during heat stress in both men and women. So supplementing with protein rich in BCAAs like soy protein may benefit for endurance with decreased body fat, especially VAT.

Branched Chain Amino Acid composition in different protein sources

BCAA mg/100 g protein	**Milk Protein isolate**	**Whey Protein**		**Soy protein**		**Egg albumin**
		concentrate (85)	**isolate**	**concentrate**	**isolate**	
Isolucine	4.40	6.41	6.80	5.20	4.90	5.66
Leucine	10.30	11.60	10.90	8.50	8.20	8.41
Valine	5.70	6.09	6.40	5.40	5.00	6.37
Glutaminee	20.80	15.41	19.70	19.00	19.10	13.29
Lysine	8.10	9.83	9.50	6.90	6.30	6.80
Material cost ($/kg)	**6.00**	**7.00**	**10.00**	**3.50**	**3.50**	**6.50**

8. While soy protein supplementation and high calorie diet along with strength exercise increase the protein anabolism, the soy supplementation in calorie restricted diet works in a complete different manner. In a recent study (2002) five days soy protein supplementation of 1.5 g/ kg body weight (Diet + supplements) of professional Indian power athletes with low calorie low protein intake, shows that the extra protein that has been taken, gets utilized to fill in the energy deficiency instead of getting utilized for anabolic purpose as reflected in increased urinary urea excretion. This would reduce further body protein catabolism secondary to energy deficiency.

9. Proteins are the most efficient macronutrient in suppressing food intake. Obese and normal-weight people have been shown to significantly decrease their energy intake after consuming a high-protein (54%) diet

compared to a carbohydrate rich diet of similar calories. Protein is more slowly digested and therefore having a high satiety value. This may induce a better compliance with the dietary modification by the subjects intending to loose weight. Interestingly a high protein diet also stimulates fat oxidation. This might be due to increased glucagons levels in the blood on a high protein diet. This is one of the phenomenon, which is used for the obesity management diet with low calorie high protein diet.

10. Diets that are rich in protein, especially animal protein, are known to cause people to excrete more calcium than normal through their urine. Athletes, who need a stronger bone may get affected for this reason. Plant-based diets, which provide adequate protein in addition to calcium through the consumption of beans in presence of fruit juice can help to protect against Ca loss for this group. Vegetable estrogen, a derivative of isoflavone from soybean can strengthen bones and prevent osteoporosis in women by facilitating the formation of bone while inhibiting bone resorption.

ADVANTAGES AND DISADVANTAGES OF PROTEIN SOURCES

Whey proteins: Perceived as high quality protein; taste & mixability; rapid digestion and uptake of amino acids; familiar source. But cost is high.

Casein: Lower cost; Perception of high quality; range of grades; may provide delayed release of amino acid uptake compared with whey. But some of the grades do not mix well; perception as inferior to whey.

Egg protein: Perception as highest quality; familiar source; ease of mixing. But the taste and the cost are not impressive.

Soy protein isolates: Successful human research on athletes; good taste; ease of mixing; isoflavone content; complete protein for human.

Whey protein hydrolysates: Perception as high quality; fastest uptake of amino acids; hypothetical advantages unproven in athletes;

Free amino acid mixture: Customized formula; highest purity; non protein amino acids; tryptophane unavailable

GUIDELINES FOR PROTEIN SUPPLEMENTATION:

Aerobic exercise: Running, cycling, swimming, skiing, rowing, sports events or training lasting longer than 60 mins.	Protein intake (all sources) maintains 1.8-2.0 g protein/kg/day intake during strenuous training or competition and 1.0-1.4 g protein/kg/day intake during other periods of training. Protein supplements- one serving daily contains 20-60 g of protein, depending upon product serving size and body weight.
Anaerobic exercise: Weight lifting, body building, track and field, maximal intensity events (Short term repetitive, exhaustive exercise lasting less than 60 mins, e.g. football, hockey, wrestling, rowing, cycle sprints, volley ball)	1. Protein intake (all sources)-100-200-g/ day (2-3 gm protein/kg/day) during strenuous training or competition and 1.4-1.8 gm protein/kg/day during other periods of training.

	2. Protein supplements- one or two serving daily (contains 20-60 g of protein, depending upon product serving size and body weight.
	Weight gain powder one or two serving daily (should contain 25 g of protein per serving), CHO (>25 g/ serving) along with creatine, taurine and l-glutamine – preferably ingested just after workouts. May replace or augment protein powder supplements.

Therefore, soy protein seems to be promising source of protein supplement for atheletic and fitness world.

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SOY IN WOMEN'S HEALTH

DR. SANGEETA AGRAWAL

INTRODUCTION

SOY BEAN

The soybean is part of the pea family and is a legume — plants that can take nitrogen and convert it into protein. Legumes have a high protein content than other plant foods. The mature soybean is about 42% protein, 33% carbohydrate, 20% oil, and 5% hull.

Even among other legumes, the soybean stands apart. Both mature and green soybeans are considered protein powerhouses.

Plant foods	Grams of protein in one-half cup
Soybeans, mature	14.3
Soybeans, green	11.1
Pinto beans	7.0
Kidney beans	6.7
Lima beans	5.8
Blackeyed peas	5.7
English peas	3.8
Broccoli	2.9
Corn	2.1
Green beans	0.8

Values are from food composition tables from the U.S. Department of Agriculture (USDA).

The soybean contains not only more protein than other plants, but also the protein it contains is of higher quality. The soybean is the only plant source of protein considered a "complete protein", meaning that it provides all the essential amino acids in the right balance to meet human needs.

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SOY AND GLOBAL HEALTH

Epidemiological studies reveal lower mortality from CVD and certain cancers in Japan when compared with the United States and many other Western countries. Although there are many differences between East and West, a great deal of interest has focused on diet, and specifically soy protein consumption.

On average, Americans consume only 1-3 grams of soy protein a day. The average soy protein intake in Asia, on the other hand, ranges from about 10 grams a day in China to 30-50 grams a day in Japan and Taiwan. Asians on an average consume 20-50 times more soyfoods than Americans.

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However, when Asians migrate to the West, their diets change over time. In one survey, the soyfood intake of Chinese people living in China was 10 - 15 times higher than that of Chinese people in California and Hawaii.

Scientists have noted that the risk of many chronic diseases increases in Asians who move to the West. Breast cancer risk is about 50% lower in women born in Asia and 25% lower in American-born Asians as compared to American–born Caucasians. This same trend holds true for heart disease.

There's no direct evidence that the reduced intake of soyfoods in Japanese people who migrate to the West plays a role in their increased risk of chronic diseases. However, dietary changes in general-possibly including soyfood intake in particular-most certainly play a part.

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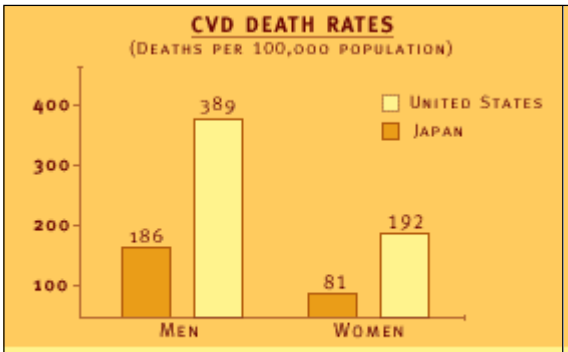

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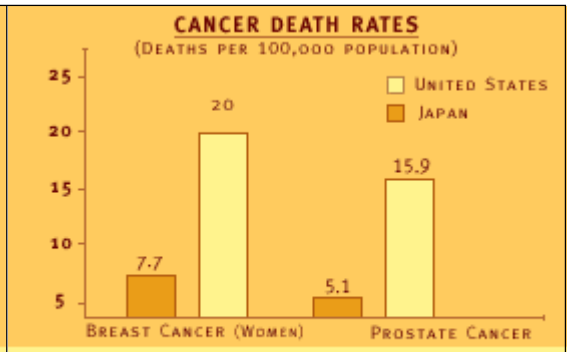

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Soy Phytoestrogens and Isoflavones

Soybeans have high concentration of compounds that possess a structure very similar to body's natural estrogens. These compounds are called phytoestrogens.

Phytoestrogens exert an estrogenic and antiestrogenic effect due to their similarity in structure to estrogens. The growing body of literature suggests that the health benefits of phytoestrogens may extend into several areas, especially cardiovascular disease, prevention of osteoporosis and decreasing the risk of cancer.

Soy Phytoestrogens have attracted the attention of the health professionals, in the recent years.

There are 5 major classes of Phytoestrogens

1. Isoflavones
2. Flavanols
3. Flavones
4. Flavanones
5. Lignans.

Each of these classes contains many categories.

Isoflavones have emerged as the most interesting class of phytoestrogens. Soybeans are the richest source of Isoflavones containing 2-4 mg of Isoflavones per gram of protein . The Isoflavones found in soy protein are genistein, daidzein, and glycitein.

They are found predominantly in legumes, soymilk, tofu and beans. Other sources are lentils, kidney beans, broad beans and chickpeas.

Isoflavones actually have several potential modes of action in the body. Depending on the circumstances, they may either act like a weak estrogen, act as an antiestrogen (blocking some effects of estrogen), or have effects not related to estrogen.

Lignans are found predominantly in whole grains, fruits, and vegetables. Flaxseed is the richest source of lignans.

Coumestans are found in clover seeds and alfalfa sprouts.

Soybeans are the richest source of Isoflavones, containing 2-4 mg of Isoflavones per gram of protein .

SOY IN WOMEN'S HEALTH

It is not surprising that given the high protein quality and the Phytoestrogen content, the soybean has valuable impact on the body functions and various disease processes. There is no doubt that they influence the quality of life. The role of soy beans in women's health specifically after menopause has been extensively studied.

MENOPAUSE

Advances in nutrition and health services have led to an increase in life expectancy in the present times. But the age of menopause has remained constant over many hundred years. With a life expectancy of about 81 years, a 50-year-old woman can expect to live more than one third of her life after menopause. Scientific research is just beginning to address some of the unanswered questions about these years and about the poorly understood biology of menopause.

Clinically, menopause is defined as the cessation of menstrual cycles and results from either follicular depletion ("natural" menopause) or surgical removal of the ovaries ("induced," or "surgical," menopause). The secretion of the ovarian hormones estrogen and progesterone ends with menopause. However, menstrual cycles seldom cease abruptly; there is an interval termed the "perimenopause" or "menopausal transition," during which there are considerable hormonal fluctuations. Natural menopause occurs at a median age of 51.4 years, with a Gaussian distribution ranging from 40-58 years.

The most significant findings are the marked reductions in Estradiol (E2) and Estrone (E1) levels. The serum E2 level is lower than the serum E1 level. There is an elevation in follicle stimulating hormone (FSH) and luteinizing hormone (LH). The remaining pituitary hormones are not affected. Both the postmenopausal ovary and the adrenal gland continue to produce androgen.

Estrogen deficiency can cause vasomotor symptoms and contributes to osteoporosis, cardiovascular disease, urogenital atrophy, cognitive decline, and Alzheimer's disease.

Estrogen has a number of benefits that can be lost when levels drop too low.

MENOPAUSAL SYMPTOMS

Some women experience few, if any, symptoms at menopause. However, the majority of Western women experience many symptoms as their estrogen levels decrease. These include hot flashes, night sweats, and insomnia; changes in vaginal tissues and a decrease in the ability to control urination; headaches; aching

and painful joints; and sore breasts. Psychological effects associated with menopause include sudden mood changes, irritability, problems with concentration and memory, anxiety, a feeling of being unable to cope, and even depression.

Hot Flashes

Hot flashes are an early and acute symptom of estrogen deficiency. They often begin in the perimenopausal age when estrogen levels fluctuate widely. Hot flashes typically last from 0.5 to 5 years after natural menopause but may persist as long as 15 years. The episodes result from a hypothalamic response (probably mediated by catecholamines) induced by a change in estrogen levels. The flush is described physiologically as heat dissipation occurring through an increase in peripheral temperature (eg, in the fingers and toes); a decrease in skin resistance, associated with diaphoresis; and a reduction in core body temperature. Hot flashes can cause insomnia, which contributes to fatigue, irritability, and a reduced ability to concentrate.

Urogenital Atrophy

It has been reported that as many as one third of women aged 50 years and older experience urogenital problems. Estrogen deficiency results in thin and pale vaginal mucosa; the moisture content is low, the pH increases (usually pH > 5), and it may exhibit inflammation and small petechiae.

Cytology reveals a loss in superficial cells and an increase of basal and parabasal cells.

Dry and atrophied vaginal mucosa can cause vaginal discomfort, itching, dyspareunia, and recurrent vaginitis.

The tissue lining the urinary tract also undergoes similar changes. Loss of collagen leads to a decrease in the muscle tone and hence urinary incontinence. Some women have stress incontinence, which is a sudden leaking of urine when they cough, sneeze, or exercise. Urge incontinence occurs when a trigger, such as laughter or a sudden movement, produces a urge to urinate, followed by leaking of urine.

Mood Changes and Cognitive Function

Estrogen receptors are abundant in the brain. Estrogen is known to have a role in many brain processes, and the absence of estrogen can result in physiologic and symptomatic changes. Estrogen is important for cerebral blood flow, cerebral glucose administration, synaptic activity, neuronal growth, the survival of cholinergic neurons, as well as such complex functions as cognition.

In general, estrogen has a positive effect on mood and contributes to a sense of well-being, which may be due to its stimulation of the adrenergic and serotoninergic systems. The role of estrogen deficiency in postmenopausal depression, declining cognitive function, dementia, and Alzheimer's disease is not clear and is an area of intensive debate and research.

Percent of Japanese, Canadian, and American Women with selected common menopausal symptoms

Symptoms	Japan (%)	Canada (%)	United States (%)	X^2 (2 df)
Diarrhoea/constipation	24.5	12.8	21.4	62.8*
Aches/joint stiffness	14.5	31.4	38.6	279.1*
Hot flashes	12.3	31.0	34.8	246.6*
Trouble sleeping	11.7	30.4	30.6	189.8*
Irritability	11.5	17.1	29.9	246.6*
Feeling blue/depressed	10.3	23.4	35.9	365.2*
Lack of energy	6.0	39.8	38.1	503.3*
Cold or night sweats	3.8	19.8	11.4	158.2*

* $P<0.01$

Adapted from Lock M. Menopause: lessons from anthropology. Psychosom Med 1998;60:410419.

SOY AND MENOPAUSAL SYMPTOMS

A survey of 8,000 women conducted in Scotland indicated that 57 percent of the women responding had experienced one or more of the menopausal symptoms mentioned above. This percent is actually lower than the estimates of 70 to 85 percent usually given for North American women.

The interesting fact is that Asian women had a much lower incidence of menopausal symptoms. For example, studies estimated that less than 25 percent of Japanese women and 18 percent of Chinese women complained of hot flashes. These observations led researchers to investigate the possible effects on menopausal symptoms of dietary factors in Asian cuisines, including soy food consumption.

Soy and Hot Flashes

The hot flash is the most common symptom of menopause; but there is a wide variation in its frequency among women in different parts of the world. In Europe and the United States, 70-80 percent of menopausal women experience hot flashes, in Malaysia 57 percent, in China 18 percent, and in Singapore 14 percent. One of the most striking dietary differences among women in these areas is their intake of dietary soy protein.

A number of clinical trials have been conducted on postmenopausal women to evaluate the effect of soy on hot flashes. Variability of dose and duration of treatment, and bias in subjective assessment of severity of flashes make the trials difficult to interpret and draw conclusions . Nevertheless, the results have been very promising.

In one study by Murkies and associates, postmenopausal women who were regularly experiencing hot flashes were given either soy flour or wheat flour over a three-month period. Although both groups had a decrease in the number of hot flashes they experienced and in their menopausal symptom score, the soy produced a more rapid response.

In a recent study by Albertazzi et al soy protein with naturally occurring isoflavones was compared with a

placebo (casein) in postmenopausal women. The researchers found that soy protein was significantly superior to the placebo in reducing the mean number of hot flashes experienced daily. The women taking soy protein had a 26-percent reduction in the mean number of hot flashes by the third week, increasing to a 33-percent reduction by the fourth week, and a 45-percent reduction by the end of the twelfth week.

This trial used daily intake of 35-75 mg of isoflavones and women had 7-15 hot flashes daily at baseline.

Similar, multi-center randomized placebo controlled study, of 75 patients with at least seven hot flashes per day, and given soy extract containing 70 mg of genistein and daidzein per day showed 61% reduction in hot flashes over 16 weeks as compared to 21% in the placebo group.

Management of hot flashes in post-menopausal breast cancer patient is any physician's dilemma. An alternative to HRT is sought for eagerly. A double blind, placebo-controlled trial evaluated effect of phytoestrogens in 149 breast cancer survivors, currently on tamoxifen or raloxifene and noticed that there was no difference in the frequency, duration or severity of hot flashes between the placebo and the phytoestrogen group. Further there was no difference in hot flashes in those receiving tamoxifen or raloxifene. Van Patten (2002) reported similar results on vasomotor symptoms, with phytoestrogens in postmenopausal breast cancer patients taking tamoxifen.

Soy protein ingestion can lead to 30 – 40 % reduction in the hot flashes.

Soy and vaginal dryness

Wilcox in 1990, showed a significant improvement in vaginal dryness and changes in vaginal cytology in women who had received dietary supplementation with soy flour.

An another double blind randomized, crossover study of 44 post-menopausal women showed that phytoestrogens alter the vaginal cytology maturation index to a more estrogenic epithelial pattern.

Chiechi et al recently studied the effect of a soy rich diet over a period of six months on the vaginal epithelium in postmenopausal women in a randomized double blind trial. 187 women were recruited for the study and divided into three groups: a phytoestrogen rich diet group; a hormonal replacement group, and a control group. Hormonal cytology was taken before and at the end of the study. The karyopicnotic index (KI) increased significantly in the diet group and in the HRT group but not in the control group. The maturation value (MV) had an identical trend to the KI. Thus soy may play a valuable role in preventive interventions for symptoms due to vaginal atrophy.

Effect of phytoestrogens on vaginal cytology and menopause symptoms: summary of studies

Investigator (yr)	Phytoestrogen	Numbers	Vaginal cytology	Hot flushes
Wilcox (1990)	45g SF	25	$p < 0.05$	
Murkies (1995)	45 g SF	58	NS	$P < 0.001$
Baird (1995)	TVP substitute	94	NS	
Dalars (1996)	45 G SG	52	$p < 0.03$	NS
	45 g linseed	NS	$P < 0.02$	
Harding (1996)	80 mg SP drink	20		$P < 0.03$
Brezezinski (1996)	80 g tofu, miso, 10 g linseed	165	$P < 0.007$	$P < 0.004$

Phytoestrogen SF-soy flour, SP-soy protein, SG-soy enriched bread, TVP-textured vegetable protein. NS. not significant.

Soy and Cognitive function.

There are very few studies that have evaluated the role of Soy Phytoestrogens on cognitive function, one of which is the SOPHIA Study (2003). They found insignificant but favorable effect on cognitive function particularly verbal memory. Duffy et al (2003) reported a randomized double blind placebo controlled trial in postmenopausal women who were given either 60 mg Isoflavone or placebo over twelve weeks. They received a battery of cognition tests and analogue rating scales of mood and sleepiness. They found that those receiving the Isoflavone supplement showed significantly greater improvements in recall of pictures, in sustained attention task and improvement in planning task. There was no effect in self-ratings of mood or sleepiness.

BONE HEALTH

CHANGES AFTER MENOPAUSE

Osteoporosis, is a disorder characterized by low bone mass. In women, peak bone mass is achieved by the second decade and begins to decrease thereafter. Estrogen deficiency is a dominant pathogenic factor in bone loss. The accelerated decline in bone mass that occurs with estrogen deficiency is mediated by a variety of mechanisms, but the primary event is increased resorption (osteoclastic activity), which becomes uncoupled from bone formation (osteoblastic activity). Menopause results in a 3% reduction in bone mass per year for the first 5 years; thereafter, the rate of loss of bone ranges from 1%-2% per year as compared with a premenopausal loss rate of 0.13% per year. Loss of trabecular bone (spine) with estrogen deficiency is greater than cortical bone (femoral neck) loss. Estrogen deficiency is also a risk factor for alveolar (oral) bone loss in postmenopausal women with a history of periodontitis. These changes result in an increase in the risk of fracture. For every standard deviation of reduction in bone mass, there is a 2-fold or greater risk of fracture. The rate at which a woman reaches the fracture threshold depends on many factors, such as genetics, nutrition, activity level, and lifestyle; also extremely important is the total amount of bone a woman has at the time of menopause. After menopause, the positive effects of estrogen on growth factors, calcitonin, vitamin D metabolism, and calcium absorption are diminished.

OSTEOPOROSIS - A PUBLIC HEALTH THREAT

Osteoporosis represents a growing public health threat to millions of people. Osteoporosis takes a great toll in pain, suffering, and disability, in addition to the actual monitory costs involved.

Symptoms of osteoporosis often don't appear until the bones become so weak that they either collapse or break. The first symptoms of collapsed vertebrae may be severe back pain, a loss of height, or deformities, such as the "dowager's hump" seen in some older women. A bone weakened by osteoporosis may break with a minor fall or even a bump.

In western countries, more than one third of women older than 65 years suffer from symptoms of osteopenia/ osteoporosis. About 24% of the people over age 50 who fracture a hip die within one year. In addition, one-fourth of the people who were ambulatory before fracturing a hip need long-term care afterward.

RISK FACTORS FOR OSTEOPOROSIS

There are a number of recognized risk factors for osteoporosis.

Gender - Women are at higher risk as they reach a lower peak bone mass compared to men.

Age - Everyone's risk increases with aging because bones become weaker and less dense.

Body size - Women with a thin and/or small body build are at greater risk.

Ethnic heritage - Caucasian and Asian women are at highest risk, although African American and Latino women are also at risk.

Family history - People with parents prone to fractures seem to have lower bone mass and higher fracture risk.

Sex hormones - Risk is greater in women at menopause as the production of estrogen by their body is greatly reduced or in the absence of menstrual periods during adolescence and adulthood; and in men with low testosterone levels.

Eating disorders - Anorexia nervosa and bulimia increase risk.

Diet - A diet low in calcium and vitamin D increases risk.

Activity level - People who are not physically active or who are bedridden for any length of time are at greater risk. It's best to perform both weight bearing and strength training exercise.

Medications - Use of certain medications, such as glucocorticoids or some anticonvulsants, increase risk.

Cigarette smoking - Cigarette smokers are at greater risk.

Alcohol use - Excessive use of alcohol increases risk.

SOY AND BONE HEALTH

Epidemiological evidence

The prevalence of osteoporosis isn't the same across cultures. It has been reported that the incidence of osteoporosis related fractures are lower in Asia than in most western communities. Surveys of women in Japan have revealed that although Japanese women consume less calcium than most women in Western countries and are unlikely to use Estrogen Replacement Therapy (ERT) or Hormone Replacement Therapy (HRT), they have a lower prevalence of fractures.

Some researchers believe that part of the answer to this puzzle may lie with the high intake of soy foods in the traditional Japanese diet.

Somekawa et al reported that the mean intake of isoflavones in 478 Japanese women was 54.3.mg per day, and that the bone densities, after adjustment for weight and menopause was significantly higher in the higher intake group than in the lower intake group.

Animal studies

Several studies in ovarectomized rats have shown that low doses of Genistein help maintain bone mass by inhibiting osteoclast activity and maintaining bone mineralization. In one study using ovarectomized rats, 1 mg/day of genistein was equivalent to 5 mcg/day of steroidal estrogens in maintaining bone density.

Case control studies

A large number of studies have evaluated the potential of isoflavones for prevention and treatment of osteoporosis. There are five randomized, double blind placebo controlled clinical trials in women that have reported on the effects of soy/Isoflavone supplementation on bone density in Non-Asian Population. They are all short-term intervention studies involving 3 to 12 months of treatment in perimenopausal and postmenopausal women. Of these, 3 authors, reported positive effects albeit at higher isoflavone concentrations of more than 60 mg/day. Atkinson et al (2000) reported benefits only for pre and perimenopausal women but not postmenopausal women with 40 mg isoflavone pills. The effects of these studies are generally seen only in lumbar spine as these studies are of short duration and bone turnover in the trabecular bone of the lumber spine is more rapid than in the cortical bone of the hip.

Ipriflavone

Ipriflavone is a synthetic isoflavone, with a chemical structure very similar to daidzein and genistein. Ipriflavone has resulted in significant improvements in BMD in postmenopausal women. Various double blind, placebo-controlled trials indicate that ipriflavone (200 mg, three times daily) may reduce the rate of vertebral and radial bone loss in postmenopausal women as compared with placebo over the course of 2 years. This also indicates that natural isoflavone found in soy may affect bone metabolism. Soy may affect bone remodeling by various mechanisms. Bones contain estrogen receptors β. Genistein has high affinity for these receptors. It may exert an estrogenic activity after binding to the receptors. Tyrosine kinase enzyme influences the growth factors and cytokines that play a role in regulating osteoclast activity.

Soy and Calcium

Calcium excretion increases as protein intake increases. Protein from animal sources causes much greater calcium loss than vegetable protein. This has been confirmed in a study of 755 Japanese men and women. However, they found no significant relationship between calcium excretion and the consumption of plant protein.

These findings become more meaningful when they are translated into the effect on bone fractures. As part of the large Nurses' Health Study, researchers looked at usual dietary intake and fracture rates in 85,900 women. First, they compared women averaging less than 68 grams of protein per day with those consuming more than 95 grams. The woman eating more protein had an increased risk of fracturing their forearm. Next, the researchers evaluated the type of protein being consumed. The increased risk of forearm fracture was seen in women consuming animal protein. Consumption of vegetable protein, however, was not associated with an increased risk.

In conclusion research on the bone effects of natural Soy phytoestrogens after menopause is at a relatively early stage. Published studies are few, difficult to compare and often inconclusive, due in part to design weaknesses. Currently, many questions remain to be answered including to what extent a safe daily intake may prevent postmenopausal bone loss. These questions can only be addressed by conducting well-planned, randomized clinical trials that take into consideration present knowledge about estrogen, Phytoestrogen and bone.

CARDIOVASCULAR HEALTH

CARDIOVASCULAR CHANGES AFTER MENOPAUSE

Estrogen deficiency increases the risk of cardiovascular disease (CVD) in women. The Framingham Heart Study found that 10-year incidence of CVD in postmenopausal women aged 50-59 was 4-fold higher than in premenopausal women of the same age range. The Nurse's Health Study also found a higher risk of CVD in postmenopausal women compared with premenopausal women.

Premature menopause, occurring before age 35, has been associated with a 2- to 3-fold increased risk of myocardial infarction; oophorectomy (before age 35) increases the risk 7-fold.

The total cholesterol rises at an accelerated rate after menopause. Whereas age-related changes in weight, blood pressure, and blood glucose levels are not thought to be substantially different in men and women, the rate of elevation in total cholesterol after menopause is significantly different. This increase in total cholesterol results from increases in levels of low-density lipoprotein cholesterol (LDL-C), with the more dense forms predominating, and increases in very-low-density lipoprotein (VLDL) and lipoprotein a (LP(a)).

The oxidation of LDL-C is also enhanced. High-density lipoprotein cholesterol (HDL-C) levels may decrease over time, but these changes are small and insignificant relative to the increases in LDL-C.

A European study reported the results of a cross-sectional analysis of 9309 women (never-users of hormone replacement therapy [HRT]) that quantified the effect of menopause on blood lipid and lipoprotein levels. After adjustment for covariates (age, educational level, study center, BMI, smoking, hypertension, diabetes, previous contraceptive use, and time since menopause), the increase in total cholesterol, LDL-C, and triglycerides from premenopause to postmenopause was 4.4%, 4.0%, and 3.2%, respectively; without adjustment, the increases are higher — 6.9%, 7.5%, and 9.0%, respectively.

Coagulation balance is not altered significantly with menopause because a counterbalance of changes occurs; some procoagulation factors increase (factor VII, fibrinogen), but so do certain fibrinolytic factors such as antithrombin III and plasminogen. Blood flow in all vascular beds decreases after menopause; prostacyclin production decreases, endothelin levels increase, and vasomotor responses to acetylcholine challenges are constrictive. Further, circulating plasma levels of nitric oxide increase, and levels of angiotensin-converting enzyme decrease. Estrogen and progesterone receptors have been found in vascular tissues, including coronary arteries. Overall, the direct vascular effects that occur after menopause are considered as important as, if not more important than, the changes in lipid and lipoproteins in terms of CVD risk.

SOY AND CARDIOVASCULAR HEALTH

Epidemiological evidence

Although CVD is a major cause of death in the United States and most developed countries, not all populations have the same degree of risk.

Worldwide statistics for CVD show that the death rate (number of deaths per 100,000 population) in the United States is 201 for women, but in Japan, the death rate is 99 for women. There are a number of factors that may contribute to such a significant difference. Diet is certainly one of them. This led scientists to investigate differences in dietary habits between East and West—one of these being dietary intake of soy foods.

Soy foods represent a major source of protein in the traditional cuisines of Japan and many other Asian countries. In a health check up study of 1242 men and 3596 women living in Japan, the average intake of soy protein calculated from dietary questionnaires was 8.0 gms for men and 6.88 gms for women. In this same study they found a strong inverse relationship ($P<0.0001$) between serum cholesterol and daily intake of soy protein. In the United States and other Western countries, however, soy foods are almost totally absent from the average diet.

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Net Change* in Blood lipids and lipoprotein concentrations in subjects ingesting the soy-containing diets, as compared with control diets.

Lipids/ Lipoproteins	Total Studies	Total Subjects	Change (mg/dl)	95% CI	Percent Change
Total Cholesterol	38	730	-23.2	-32.9 to -13.5	-9.3
LDL-Cholesterol	31	564	-21.7	-31.7 to -11.2	-12.9
HDL-Cholesterol	30	551	+1.2	-3.1 to +5.4	+2.4
VLDL-Cholesterol	20	255	-0.4	-4.6 to +3.9	-2.6
Triglycerides	30	628	-13.3	-25.7 to -0.3	-10.5

* Net change is expressed as the change during the soy-containing diet minus the change during the control diet. (To convert values for cholesterol to millimoles per liter, multiply by 0.02586; to convert values for triglycerides to mmol/l, multiply by 0.01129.)

Abbreviations: mg/dL = milligrams per deciliter; CI = confidence interval; LDL = low-density lipoprotein; HDL = high-density lipoprotein; VLDL = very low density lipoprotein

Adapted from Anderson JW, Johnstone BM. Cook-Newell ME. Meta-analysis of the effects of soy protein intake on blood lipids. N Engl J Med 1995; 333:276-282.

Mechanism of action

Epidemiological and animal studies provide enough evidence that soy consumption is cardio protective. There are various mechanisms by which soy may influence the risk of cardiovascular disease.

1) Effect on Lipid Metabolism

Studies in animals and in humans have shown that consuming soy protein with naturally occurring isoflavones (and other bioactive components) results in greater cholesterol lowering than consuming either soy protein with the isoflavones removed or a placebo, typically casein.

A meta-analysis of 38 clinical studies, was published in 1995. The effects of soy on plasma lipids and lipoproteins were reviewed. Both men and women experienced substantial reductions in plasma triglycerides, total cholesterol (TC), and low-density lipoprotein cholesterol (LDL-C), and modest, although not significant, increases in high-density lipoprotein cholesterol concentrations (HDL-C). Furthermore, the effects of dietary soy on TC and LDLC were related to baseline TC concentrations, higher the initial cholesterol values, greater reduction was seen. Reductions in cholesterol level were seen in the patients with normal cholesterol level. The authors concluded that an average dietary intake of 47 gms of soy protein could result in an absolute reduction in total cholesterol (9.3 per cent) low-density lipoprotein cholesterol (12.9 per cent) and triglycerides (10.5 per cent). Crouse et al (1999) evaluated the effects of a soy protein supplement containing various levels of isoflavones (3, 27, 37, or 62 mg) on plasma lipid and lipoprotein concentrations compared with a casein supplement. All supplements contained equivalent amounts of protein. Compared with casein,

the soy supplement containing 62 mg of isoflavones significantly reduced both TC and LDLC. In addition, concentration of isoflavones had a dose-response effect on lowering LDL-C.

However, isoflavones alone may not be responsible for the beneficial effects. The proteins present in soy may play an important contributory role.

There are studies which show that soy protein with naturally occurring isoflavones lowers blood cholesterol levels, that soy protein without isoflavones does not lower blood cholesterol.

These results indicate that in order to achieve a decrease in blood cholesterol, the type of soy protein consumed is important. Research indicates that soy protein with naturally occurring bioactives is needed. The specific amino acids found in soy protein may affect cholesterol levels. Animals achieved greater cholesterol lowering when they received intact soy protein than when they were given a mixture of amino acids identical to those in soy protein. This suggests that although the specific amino acids in soy protein may help lower cholesterol, something else is at least partially responsible for the beneficial effect.

Researchers have also shown that particular storage proteins found in soy protein can affect cholesterol levels. These proteins, called 11S and 7S globulins, have helped to lower cholesterol in animals.

A meta-analysis showed that an average dietary intake of 47 gms of soy protein could result in an absolute reduction in total cholesterol (9.3 per cent) low-density lipoprotein cholesterol (12.9 per cent) and triglycerides (10.5 per cent).

2) Antioxidant Effect of Soy

Antioxidants are substances that can delay or prevent oxidation. Research has shown that the isoflavone genistein inhibits the oxidation of LDL-cholesterol in the laboratory. LDL-cholesterol becomes atherogenic only when it undergoes oxidation.

This effect was studied in healthy volunteers who consumed three bars containing soy protein with naturally occurring bioactives every day for two weeks. LDL-cholesterol was isolated from blood samples taken both during soy intake and again while the participants weren't consuming soy. When the various LDL-cholesterol samples were exposed to an oxidizing agent, oxidation of the samples taken during soy intake was delayed by 20 minutes, indicating that this LDL-cholesterol was resistant to oxidation.

3) Effect of Soy on Blood Coagulation

One of the essential steps in the atherosclerotic process is the adherence of platelets to foam cells and the subsequent increase in growth factors released from the platelets. Laboratory studies suggest that soy isoflavones, especially genistein, have a favorable effect on blood clot formation. Several mechanisms appear to be involved in this process,

- Inhibition of platelet activation and aggregation
- Reduction of the platelet derived growth factors, which play an important role in the proliferation of smooth muscle cells in the atheroscelerotic plaque.
- Inhibition of the action of Thrombin , an enzyme that converts fibrinogen to fibrin to form a blood clot.

4) Effect of Soy on Vascular Reactivity

Normal, healthy arteries dilate when exposed to acetylcholine, a neurotransmitter naturally occurring in the body. Arteries damaged by atherosclerosis, on the other hand, constrict in response to acetylcholine. This reduction in vascular reactivity is highly associated with fatal cardiovascular disease.

Honore et al examined the effects of soy isoflavones on coronary reactivity. Male and female monkeys were given soy protein either containing isoflavones (Soy+) or with the isoflavones removed (Soy-). Their coronary arteries were then exposed to acetylcholine. The arteries of both groups of male monkeys constricted in response to acetylcholine although the monkeys in the Soy+ group had less constriction. The female monkeys in the Soy+ group experienced a dilation of their arteries in response to acetylcholine. The arteries of the female monkeys in the Soy- group constricted in response to acetylcholine. However, when these female monkeys were later given the isoflavone genistein in the purified form intravenously, their arteries dilated.

5) Effect of Soy on Atherosclerotic Plaque

In another study researchers actually measured the amount of atherosclerotic plaque present in the arteries of monkeys consuming either casein, soy protein with isoflavones (Soy+), or soy protein without the isoflavones (Soy-). They found that the monkeys in the Soy+ group had 90% less atherosclerosis than monkeys receiving casein and 50% less than monkeys in the Soy- group.

When the researchers measured the size of the atherosclerotic areas that were present, they found that monkeys in the Soy+ group had the smallest areas of atherosclerosis, monkeys receiving casein had the largest areas, and monkeys in the Soy- group fell somewhere in between. The researchers concluded that the beneficial effects of soy protein on atherosclerosis appeared to be due to the isoflavones that were present.

The Soy Health Claim

Cardio-vascular disease remains the number one killer of both men and women in the United States and many other Western countries. Fortunately, advances in diagnosing and treating this serious health condition hold great promise for lowering these statistics.

For decades, researchers have investigated foods and other elements in people's diets as possible causes of heart disease. Recently, the scientific and medical experts are shifting their emphasis to identifying foods and specific substances in foods that may play a role in preventing heart disease.

In October 1999, the US FDA (Food And Drug Administration) authorized a health claim for soy protein and heart disease. A health claim identifies the relationship between a food or nutrient and the risk of a disease or health-related condition.

The FDA made this claim after carefully reviewing the evidence from more than 50 studies in human-research spanning more than 20 years. Many of these studies also were included in a meta-analysis published in The New England Journal of Medicine in August, 1995. The U.S. FDA has authorized the following health claim for soy protein and heart disease:

'25 grams of soy protein a day, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease.

The U.S. FDA health claim for soy protein states that
25 grams of soy protein a day, as part of a diet low in saturated fat and cholesterol,
may reduce the risk of heart disease.

BREAST CANCER

EPIDEMIOLOGY

It is well known that breast cancer risk varies substantially throughout the world. The highest rates are found among whites in the United States and Western Europe, whereas native Asian (Japanese and Chinese in their homelands) appears to have the lowest rates. As much as a six-fold difference in breast cancer risk between these populations has been identified. Although genetic differences may play some role, lifestyles—and particularly dietary habits—probably have a more significant impact. The breast cancer rates increase substantially among Asian-American women after they immigrate to the United States as do the rates among Asians in other non-Asian countries. Within a few generations their breast cancer rates approach those of white U.S women. Asian women born in the United States or other Western countries have estimated breast cancer incidence rates similar to the rates of white women residing in the same geographical study areas.

A possible explanation for the significantly decreased breast cancer incidence in Asian populations is their traditionally soy-rich diet. When Asian women leave their native lands they tend to eat less soy and this behavior correlates with increased breast cancer rates.

Country	Breast cancer
Western Nations	
United States	21.1
United Kingdom	26.5
Germany	22.1
Eastern Nations	
Japan	6.8
China	5.0

SOY AND BREAST CANCER

Mechanism Of Action

There are a number of mechanisms by which soy protein, particularly soy isoflavones may act as anti-cancer agents.

1) Hormonal effects

The ability of soy Phytoestrogens to modulate normal estrogen secretion or normal estrogen activity in estrogen-responsive tissues such as the breast could account for soy's protective effects. Soy Phytoestrogens could reduce breast cancer risk by competing with endogenous estrogens for receptors in breast tissue and by being less-potent estrogenic agonists.

Numerous investigators have found lower urinary estrone and estradiol excretion during the follicular and luteal phases of the menstrual cycle in Asian women than in white women. Asian women have lower serum estradiol levels both pre- and postmenopausal than do white women, even after adjusting for differences in body size. Premenopausal women taking 45 to 200 mg per day of isoflavones in a soy protein isolate or soymilk experienced decreased midcycle luteinizing hormone and follicle stimulating

Risk of breast cancer was significantly inversely associated with soy intake during adolescence and adult life.

hormone concentrations, increased menstrual cycle length, and decreased urinary estrogens. Additionally, there was decreased accumulation of a number of proposed genotoxic estrogen metabolites. The highest level of mammary cell proliferation occurs during the luteal phase of the menstrual cycle, therefore prolongation of the follicular phase of the cycle would reduce the number of total cycles a woman would have in her lifetime and thereby reduce the risk of getting breast cancer. Further the lengthened menstrual cycle and decreased urinary estrogen excretion may result in decreased exposure to estrogen, and both have been associated with a lowered risk of breast cancer.

2) Inhibition of Tyrosine Kinase

Tyrosine kinase is an important enzyme that regulates cell growth It is implicated in the development of various cancers. Genistein is a potent and specific inhibitor of tyrosine kinase.

3) Effect on the sex hormone binding globulin (SHBG)

Isoflavones seem to stimulate the synthesis of SHBG. At higher levels, the SHBG lowers the percentage of free estradiol and testosterone. This reduces their bioavailability and therefore their action.

4) Anti-angiogenic effects

Angiogenesis is a process in which the body generates new capillaries to provide blood supply to areas of growth. In normal adults angiogenesis occurs only during wound healing and menstruation. Pathological angiogenesis is important feature of growing tumours . Genistein is a potent inhibitor of in vitro angiogenesis and endothelial cell proliferation.

5) Anti-promotional and anti-proliferative effects

Genistein has shown to augment transforming growth factor - β, an essential growth factor that inhibits the cell cycle and therefore progression of cell growth. Genistein has potent anti-proliferative effects in both estrogen receptor dependent and independent human breast cancer cells.

6) Effect on stress response

The stress response is a cellular level defense mechanism in response to stressful conditions such as infections inflammation and onset of carcinogenesis. This mechanism allows the stress cells to induce the synthesis of specific stress proteins that protect them from programmed cell death. Genistein inhibits the expression of these stress response proteins and thereby allows the death of a damaged cell.

7) Antioxidants

Genistein prevents free radical damage to deoxyribonucleic acid (DNA). Genistein may increase the production of superoxide dismutase (SOD), a powerful antioxidant that quenches superoxide radicals. It is the free radicals that damage cells and thus accelerate the aging process, initiate many cancers and exacerbate many diseases in general.

Supporting data

The existing data strongly support the concept that consumption of soy protein may reduce the risk of certain cancers in humans. Research is focused primarily on tumors that are affected by hormones and diet. Research on soy protein and breast cancer prevention is one of the most active research areas today.

Animal data

There is a volume of supportive evidence from in vitro and animal studies that soy intake may influence the risk of breast cancer.

Results from animal studies support epidemiological findings. Feeding female rats a diet that contained isolated soy protein inhibits experimentally induced mammary tumor development compared with rats fed a casein-based diet. Hakkak et al investigated the effect of long-term feeding animals a diet containing isolated soy protein on mammary tumor development. They fed rats a soy protein-containing diet or a casein-based diet for two generations before administering a chemical agent known to induce mammary tumor to the third generation. At the end of the study, there was a significant decrease in the number of mammary tumors and a significant increase in the latency period in rats maintained on the soy protein diet compared with those on the casein diet.

Constantinou et al examined the synergistic effect of isolated soy protein with Tamoxifen on chemically induced mammary tumor development in rats. Tamoxifen is a drug approved by the U.S. FDA for breast cancer prevention in humans. They found that dietary supplementation with isolated soy protein or Tamoxifen resulted in a 37% or a 29% reduction in the number of tumors developed in mammary glands compared with the controls. However, they found a 62% reduction in the number of tumors in the group fed a diet containing both soy protein and Tamoxifen compared with the controls. Results from this study showed that soy protein is synergistic with tamoxifen and resulted in a greater inhibition on chemically induced mammary tumor development in animals. It suggests that consumption of soy protein may be beneficial to women who use tamoxifen for breast cancer prevention. Yan et al investigated whether dietary supplementation with isolated soy protein reduced pulmonary metastasis of malignant cells from mammary tumors in mice. The spread of cancerous cells from a mammary tumor to the lungs and other organs in the body is a major cause of death in breast cancer patients. Mice were fed a casein-based control diet or a diet supplemented with different contents of isolated soy protein before receiving an injection of mammary tumor cells into mammary glands for primary tumor development.

At the end of the study, the numbers of tumors formed in the lungs were counted as a measurement of the cancer spread because the more malignant cells spread to the lungs, more tumors would develop. The researchers found that there was a significant reduction in the number of metastatic tumors formed in the lungs in mice fed the soy protein diets compared with those maintained on the control diet.

These results demonstrate that soy protein reduces the spread of mammary cancer in animals, suggesting that soy protein may be a useful nutritional adjuvant in reducing metastasis in breast cancer patients.

Many researchers have investigated the role of Genistein, major soy Isoflavone, in mammary tumor development in animals. Fritz et al examined the effect of dietary supplementation of Genistein on chemically induced mammary tumor genesis in rats. Female rats were fed a diet containing different levels of Genistein from conception to day 21 post-parturition. All offspring were weaned at the age of 21 days, maintained on a genistein-free diet, and treated with a cancer-causing agent to induce mammary tumors at the age of 50 days. At the end of the study, animals from mothers fed genistein-supplemented diets had fewer mammary tumors compared with those from mothers fed a genistein-free control diet.

Similar inhibitory effect on mammary tumor development has also been observed when genistein was subcutaneously injected into animals. Results from these studies suggest that genistein is, at least in part, responsible for the cancer-attenuating effect of soy protein products.

Human data

Two epidemiological studies published before 1990 provided some indirect evidence that soy intake may protect against breast cancer. In one study of Japanese American women in Hawaii, researchers found that

the spouses of women with breast cancer ate less tofu and miso (soybean paste) soup than spouses of control-group women.

In another study, researchers reported that Japanese women who ate a bowl of miso soup a day had half the risk of breast cancer mortality compared with those who didn't eat miso.

Lee et al in 1991 first reported a reduced risk of breast cancer in premenopausal women in relation to high soy intake in Singapore.

During the 1990, two prospective studies, and four case-control studies provided mixed results on dietary soy intake and breast cancer risk. These epidemiological studies were not well designed; the soy intake was not adequately assessed. In 2001 two large case control studies conducted in Shanghai, China and San Francisco, were published regarding risk of breast cancer and soy intake. These were well designed, carefully assessed the soy intake, and accounted for potential confounders. The Shanghai study concluded that the soy intake during adolescence conferred a strong protective benefit. There was a non-significant reduction in risk associated with adult soy intake. The risk of breast cancer was not associated with soy intake in the San Francisco study. However the daily median intake of soy was substantially lower (1.6 mg of Isoflavone) amongst San Francisco non-Asians than in the Chinese in Shanghai (33 mg of Isoflavone).

Wu et al (2000) conducted a population based case control study of breast cancer among Chinese Japanese and Filipinos women in Los Angeles County to quantify breast cancer risk associated with intake of soy during adolescence and adult life among Asian American women. The intake of tofu was found to be more than twice as high among Asian-American women born in Asia (62 times per year) compared to those born in the U.S. (30 times per year). Among the migrants, intake of tofu decreased with increased years of residence in the U.S. They reported that risk of breast cancer was significantly inversely associated with soy intake during adolescence and adult life. The relative risk of breast cancer decreased with increased frequency of tofu consumption. This protective effect of high tofu intake was observed in both pre- and postmenopausal women. After adjusting for age, specific Asian ethnicity, education, migration history, and menstrual and reproductive factors, women who reported soy intake atleast once per week during adolescence showed a statistically significantly reduced risk of breast cancer. There was a significant trend of decreasing risk with increasing soy intake during adult life. However, even with these findings, the authors stated that "We cannot discount the possibility that soy intake is a marker of other protective aspects of Asian diet and/or Asian lifestyle."

In contrary to these results Peeters (2003) reviewed 13 studies on effect of phytoestrogens on breast cancer and concluded that none of the studies found statistically significant breast cancer reduction. At the same time, there is no negative effect of soy on breast cancer.

Increased mammographic breast density is associated with an elevated risk of breast cancer. Estrogens increase and antiestrogens decrease breast density. Breast density may therefore serve as a biomarker of effects of a treatment on breast tissue. Effects of isoflavones on breast density are being investigated. It has been recently shown by Jakes (2002), in a cross sectional study of four hundred Chinese women that dietary soy protein intake was inversely related to breast tissue density on mammography. But Maskarinee (2003) conducted a double blind randomized trial in premenopausal women who received a daily 100 mg Isoflavone supplement or a placebo over 12 months. Baseline and follow-up mammogram showed no significant changes in either the size of the dense areas or in the percent densities.

In conclusion experimental and physiologic studies provide much of the evidence on the inverse association between breast cancer risk and phytoestrogen intake. Research in humans has been limited to observational (case-control) epidemiologic studies and is far from conclusive. A critical evaluation through controlled

trials of phytoestrogens' breast cancer-protective role needs to be performed before they are adopted as chemopreventive agents.

ENDOMETRIAL CANCER

The development of endometrial cancer is largely related to prolonged exposure to the female hormone estrogen without cyclic exposure to the hormone progesterone. Dietary Phytoestrogens may reduce a woman's risk of endometrial cancer through their antiestrogenic effects, inhibiting the growth and proliferation of estrogen-dependent cancer cells.

The available data is very limited. A study of nearly 1,000 women in the San Francisco Bay Area published by the Northern California Cancer Center (NCCC), in August 2003 reported that women can reduce their risk of developing endometrial cancer by 40 – 50 % if they consume a diet rich in Phytoestrogens, which are found in soy-based foods. Further this risk reduction was strongest for postmenopausal women. In the NCCC study, the research team interviewed 970 African-American, Latina and white women ages 35 to 79 residing in the Bay Area. Five hundred had been diagnosed with endometrial cancer between 1996 and 1999 and 470 had never had the disease. Dr. Horn-Ross and her colleagues then evaluated the differences between the two groups in their dietary intake of seven specific compounds representing three classes of Phytoestrogens — Isoflavone, Lignans and Coumestans — and the risk of endometrial cancer. The study determined that consumption of the Isoflavone Genistein and daidzein, primarily found in soybeans, and the lignans, found in some whole grains, seeds and dried fruit, was associated with a reduced risk of endometrial cancer, particularly among postmenopausal women. The NCCC study emphasized that the results were based on the consumption of soy foods and not pills.

The NCCC study is only the second to directly examine the effects of phytoestrogen-rich foods on endometrial cancer risk and the first to examine the specific compounds in these foods.

A previous study of women in Hawaii by Dr. Marc Goodman and colleagues found that greater consumption of tofu and other soy products was associated with a 50 percent reduction in the risk of developing endometrial cancer. 322 multi-ethnic Hawaiian women diagnosed with endometrial cancer between 1985-1993, and 511 matched controls were evaluated using diet history questionnaires. The study found a positive relationship of fat intake to risk of endometrial cancer after adjustment for energy intake. Sources of fiber (but not starch), including cereal and vegetable and fruit fiber, were associated with a 29-46% reduction in risk for women in the highest quartiles (the upper 25%-50%) of consumption. High consumption of soy products and other legumes was associated with a decreased risk of endometrial cancer. Similar reductions in risk were found for increased consumption of other sources of Phytoestrogens, such as whole grains, vegetables, fruits and seaweeds. These results suggest that plant-based diets, low in calories from fat, high in fiber, and rich in legumes (especially soybeans), whole grain foods, vegetables and fruits reduce the risk of endometrial cancer. These, as well as other dietary differences, may help explain the reduced rates of uterine cancer in Asian countries compared with those in the United States.

Obesity may double a woman's risk of endometrial cancer. Among women consuming low amounts of Phytoestrogens, obesity may triple a woman's chances of being diagnosed with endometrial cancer. Thus, consumption of Phytoestrogens may be particularly important for heavier women. The reports are very encouraging, but further research is required before any recommendation can be made.

Women can reduce their risk of developing endometrial cancer by 40 – 50 % if they consume a diet rich in Phytoestrogens.

SOY IN PREGNANCY AND LACTATION

During pregnancy and lactation women require tissue building and protective foods.

Soy is a source of complete protein that provides all the essential amino acids that are required during pregnancy and lactation.

It is well known that diets containing high levels of animal protein greatly increase the excretion of calcium from the body. This loss of calcium is not observed with soy protein. Thus soy protein helps to retain the calcium, which is essential for the development of the fetus.

HOW MUCH SOY SHOULD BE CONSUMED?

Opinions vary as to how much is enough? 20-30 grams of soy protein per day is a good estimate. One can consume this amount if one eats 1 cup of cooked soybeans, 10 ounces of soft tofu, or 4 to 7 cups of soymilk per day. Alternatively, regular soy protein powders and those developed to be specifically rich in genistein are widely available. Depending on the brand, one serving of soy powder provides about 20-30 grams of soy protein and about 40 mg of isoflavones. Less processed soy foods are best for obtaining Isoflavone in the diet. For example, one half cup of tofu has an average of 40 mgs of Isoflavone, whereas one cup of soymilk provides only about 20 mg. Lower fat products have lesser Isoflavone. Although heat treatment does not significantly affect Isoflavone content, processing often does. Therefore, soy sauce and soybean oil have negligible amounts of Isoflavone, but isolated soy protein and textured vegetable protein (TVP) are still considered good sources of Isoflavone.

SAFETY ISSUES

There is some speculation that isoflavones cause thyroid disease on the basis of studies, which have shown that Genistein, can inhibit thyroid peroxidase (TPO), a key enzyme in the production of thyroid hormones. But this has not been conclusively proven. Some studies have compared growth and development of infants fed soy formulas with those who were breast fed and found no significant difference. A recent study of a cohort of 952 adults who had been fed either soy formula or cow-milk formula as infants found no significant difference between the groups, either males or females, with regard to height, weight, BMI, indices of pubertal maturation and numerous other reproductive outcomes, including fertility and cancer.

CONCLUSION

Soy is a complete protein and provides a good balance of essential amino acids. Soy is a useful addition to diet. It is associated with few risks, and is low in saturated fat, low in cholesterol, and provides high-quality protein.

Its high Phytoestrogen content, which has weak estrogenic activity, plays a very valuable role in women's health issues. There is a volume of evidence to show that high intake of soy in the eastern population is partly responsible for the low incidence of certain chronic disorders that are more commonly seen in the western population.

Soy protein and the Phytoestrogens appear to have a promising role in the management of menopausal symptoms. The hot flashes can be reduced by atleast 40 percent with soy supplements. It can be particularly useful in women with history of breast cancer where there would be apprehension in the use of HRT.

From the existing data, isoflavones ingested as part of soy protein seem to be an effective dietary intervention

in reducing high cholesterol and US-FDA recommends at least 25 gms daily intake of soy protein. Reduction in cholesterol can go a long way in reducing the high incidence of cardiovascular disease, the number one killer of present times.

The evidence for the role of soy in the prevention of osteoporosis is also promising; and can be a useful adjuvant to the more conventional methods (calcium supplementation and bisphosphonates) for prevention and treatment of osteoporosis.

More research is needed to better understand the role of soy especially as it relates to cancer especially breast cancer and other hormone-dependent diseases. Current literature suggests that soy-containing diet started even before puberty and continued through adolescence and adulthood would provide protection against breast cancer.

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