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Black Soybean: An Ignored Nutritious and Medicinal Food Crop from the Kumaon Region of India

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Abstract

Black bean, a variety of soybean (Glycine max), *is cultivated as a food crop in the Kumaon region (Uttaranchal state, northern India), and in the bordering states and countries in the Himalayas. The yellow variety, cultivated throughout the world for the soya oil, is a genetically improved variety obtained from USA. There is not much difference in the chemical constituents of the black and yellow varieties, except that the latter contains more oil. The article deals with the origin, distribution, and introduction of* Glycine max, *the ethno-dietary recipes, the proverbs and sayings on black bean in Kumaon, its chemoprofile, pharmacology, and clinical uses, and the status of the bean in the world and in India. In the Kumaon region, the black bean is an important crop because of its high nutritional and medicinal value. The seeds are a rich source of vegetable protein and oil. They are cholesterol-free, but contain linolenic acid, which has been found to prevent heart disease. Soybean contains isoflavones such as genistein and daidzein that have been found to have antioxidant, antitumor, and estrogenic activity. These isoflavones have also been found to be potential therapeutic agents for benign prostrate hypertrophy, and for prostrate and ovarian cancers. The compounds are also believed to have pharmacological effects on osteoporosis, with additional hepato-protective and antilipid properties. In India, the seed meal obtained after oil extraction is available in plenty, and is commonly marketed as 'Nutri-Nuggets'. It is a good source of vegetable protein, and people need to be educated about its nutritional and medicinal value. Adding some soya flour to wheat flour helps prevent a number of ailments and diseases. In Kumaon, the cultivation of the crop is dwindling by the day, which is matter of great concern. Efforts must be made to conserve this important crop.*

Black soybean or black bean (*Glycine max*) is cultivated as a staple food crop in the Kumaon region of northern India (situated in Uttaranchal, the new state created from Uttar Pradesh). It is locally known as *bhat* or *bhatmas* and is used in the preparation of different types of dhals. The seeds are either black or brown. White or yellow soybean (Fig. 1), grown in the terai region of Uttaranchal, and in other parts of India

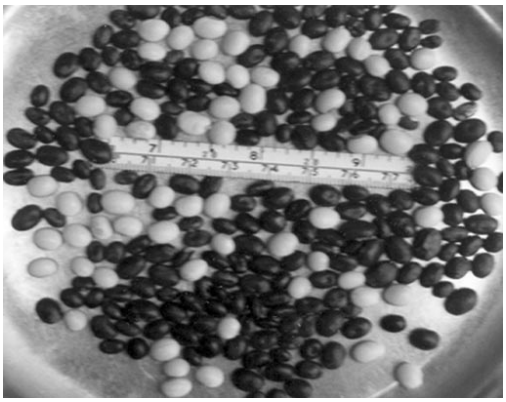

Figure 1. Black and yellow soybean seeds.

and in the world mainly for oil, are genetically improved varieties obtained from USA (Hymowitz and Newell, 1981). In the Kumaon hills, the black or brown variety is grown throughout the region (1500–2500 m above sea level) for edible purposes, and whatever surplus remains after consumption is sold in the larger towns. The seeds are sown in June; the plants flower in August to September, and are harvested in mid or late October. Black soybean is a twining, sub-erect or erect, annual herb that reaches a height of 0.3–2.0 m. It is pubescent, with reddish-brown hair on all parts of the plant. The leaves are trifoliate, with 3.0–15 cm long elliptic-ovate leaflets. The inflorescence is a 5- to 8-flowered raceme, with violet, pink, or white flowers. The seeds are black or dark brown.

A total of 10 species of *Glycine* are found in the world; three species have been reported from India. The black or brown variety of *G. max* is cultivated in Kumaon, Nepal, and Bhutan for edible purposes, while the yellow variety is usually cultivated for commercial purposes in Myanmar, eastern Asia, China, USA, etc.

The origin of *G. max* is stated to be in China (although some now believe that it originated in Australia where wild soybean was first cultivated). The wild soybean (*Glycine soja*) is found only in China, Taiwan, Tibet, Japan, the Korean peninsula and USSR (Juvik *et al*., 1985).

The pioneer horticulturist Norman Gill introduced eight varieties of soybean in Kumaon for experimental purpose during 1910–20. He concluded that the best varieties of soybean (the yellow variety) can only be grown in very rich soil; the hilly nature, poor soil, and the cost of transport had prevented the profitable cultivation of this crop. He further suggested that in the Kumaon region, soybeans are best used for green manuring, and that the most useful varieties for this purpose are the black-seeded, *bhat* and Nagpur varieties, which can grow freely in comparatively poor lands, where the large-seeded and oil-producing varieties fail entirely (Shah, 1996).

Hymowitz (1969) conducted a survey for the collection of soybean germplasm in the Kumaon Hills. According to him, it was a recent introduction into India and was probably brought into the country from

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Burma (Myanmar) via the Naga Hills and Manipur, and cultivated by farmers for over 100 years. He also found that the protein deficiency disease kwashiorkor, which is so prevalent in India, was rarely seen among children in the Kumaon Hills, who frequently take soybeans in their daily meals in one form or the other. A detailed account of the taxonomic treatment, domestication, and uses of soybeans has been given by Hymowitz and Newell (1981).

Ethno-dietary recipes in Kumaon

Soybean is one of the staple foods of the people of Kumaon. It is cooked in several ways: *churkani*, *rasa* or *thatwani*, *dubka*, *bhat-jaula*, *bhuti-bhat* (roasted soybean), etc. All these preparations are invariably "hard-cooked" in a *karahi* (iron bowl). The recipes, as described by Shah (1987), are given below.

Churkani

Soybean seeds are fried in a little mustard (*Brassica campestris*) oil until they turn semi-brown. Wheat (*Triticum aestivum*) or rice (*Oryza sativa*) flour is mixed with the seeds and again fried until the flour turns light brown. Water is added to this, and the soup is continuously stirred and allowed to cook for about 3 min. A separately ground paste of various condiments [cumin (*Cuminum cyminum*), dried chili (*Capsicum annuum*), etc.] is added to the soup, which is then left to boil for about 15 minutes. Salt is added to taste, and the soup served without seasoning.

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Rasa or *thatwani*

Bhat (soybean), *gahut* (horse gram; *Dolichos uniflorus*), and *chana* (chickpea; *Cicer arietinum*) seeds are mixed together in equal parts and soaked overnight [*rajma* (cowpea; *Vigna unguiculata*) and *mas* or *urd* (black gram; *Phaseolus mungo*) seeds could also be used]. The next day, the soaked seeds are boiled for about half an hour, until the water turns a dark color. When the seeds are completely softened, the dark liquid (extract) is decanted and the seeds removed. Rice is soaked separately for about an hour, and then ground into a paste with cumin seed and dried chilies. The paste is added to the decanted seed extract in a *karahi* and boiled again for some time. Salt is added to taste. When the dark brew is well-boiled, half-teaspoon of *garam masala* (finely ground mixture of condiments) is added to it.The *karahi* is then taken off the fire and the brew is seasoned with the hand-mashed inflorescence and leaves of either *jambu* (rose-apple; *Syzygium jambos*) or wild *Allium consanguineum* (*A. stracheyi*) or *A. wallichii* or root of *gandrayan* (*Angelica glauca*). For the seasoning, various spices are light-fried in ghee in a small bowl and then added to the brew. This type of seasoning is locally known as *chhonk* or *tarka*. The dish is then garnished with green coriander leaves before serving. *Rasa* or *thatwani* is mostly prepared on Sundays, when the entire family is at home.

Dubka

Black soybean seeds are soaked overnight with a little rice. The next morning, these are ground, in the traditional *sil-batta* or in a blender, into a fine paste, which is then mixed with water and boiled in a *karahi* for about half an hour.

Bhat-jaula

Soybean seeds are soaked overnight in an iron *karahi*, and then coarsely ground and mixed with half the quantity of water-soaked rice. After adding water, the mixture is boiled and allowed to cook for half an hour or more, until the seeds become well cooked and softened. No spice, condiments, or salt is added. The preparation is served hot, with a paste of fresh *dhaniya* (coriander; *Coriandrum sativum*) and *khusani* (chili) leaves ground with salt. This is supposed to be the most nutritious preparation of black bean seeds, and is often advised in diet management for patients recovering from jaundice.

Bhuti-bhat (roasted soybean)

Roasted soybean is a snack prepared by frying soybean seeds in a little mustard oil, in a *tawa* or in a *karahi*, and salted to taste.

Chemoprofile, pharmacology, and clinical uses

Soybean seeds contain a number of well-known chemical constituents, and important nutritional and medicinal compounds such as protein, fat (oil), phosphorus, etc. The nutritional analysis of black and yellow seeds is given in Table 1. The black and yellow varieties differ in the fat (oil) percentage of the seeds, but not much in their chemical constituents.

Besides nutritious chemical compounds, soybean oil contains medicinal compounds such as poly-unsaturated and mono-unsaturated fat, and linolenic acid. The seeds contain isoflavones, the naturally occurring diphenolic compounds such as genistein and daidzein. They also contain lectins.

Medicinal compounds in soybean oil

Soybean oil is the most widely used edible oil in the world. USA alone consumes about 80% of the total world production. Soybean oil contains 61% poly-unsaturated fat and 24% mono-unsaturated fat. Saturated fats in the diet can raise blood cholesterol levels and increase the risk of heart disease. Therefore, healthcare professionals recommend diets that replace saturated fats with unsaturated fats as much as possible. Further, like other vegetable oils, soybean oil contains no cholesterol. Soybean oil is also one of the few non-fish oils containing linolenic acid, an omega-3 fatty acid that has been shown to help prevent heart disease (website <www.talksoy.com>).

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Table 1. Nutritional analysis of black and yellow seeds.

Parameter	Black seeds[1] (at zero moisture per 100 g)	Yellow seeds[1] (at zero moisture per 100 g)	Soybean seeds[2] (at 8.1 g moisture per 100 g)
Energy (kcal)	439	444	432
Protein (g)	38.0	39.0	43.2
Fat (g)	17.1	19.6	19.5
Carbohydrate (g)	40.3	35.5	20.9
Fiber (g)	4.9	4.7	3.7
Ash (g)	4.6	5.5	
Calcium (mg)	243	251	240
Phosphorus (mg)	580	606	690
Iron (mg)	10.8	9.4	10.4
Potassium (mg)	467	999	
β-carotene (μg)	11	11	426
Thiamine (mg)	0.74	0.73	0.73
Riboflavin (mg)	0.26	0.24	0.39
Niacin (mg)	3.19	2.44	3.2
Folic acid (μg)			8.65 (free) 100 (total)
Minerals (g)			4.6

1. J.A. Duke, USDA, Beltsville, Maryland, USA (personal communication).
2. Not specified as black or yellow.
   Source: Gopalan *et al*. (1996).

Isoflavones in soybean seed

Soybean isoflavones are important from the therapeutic point of view and these are present in high concentrations (up to 3 mg g^{-1}) in soybean seeds. Genistein and daidzein are sugar-containing isoflavone molecules that are important for digestion; intestinal bacteria cleave or cut off the sugar molecules, creating even more genistein and daidzein.

Kawamura *et al*. (2000) note that cultivars of black and brown soybeans contained high levels of the isoflavonoids genistein and daidzein. Genistein is a natural product of plant origin and is the most potent antioxidant among the isoflavones, followed by daidzein. It is characterized by antioxidant, antitumor, and estrogenic activity. Takahata *et al*. (2001) has shown that the brown soybean variety has a much higher scavenging (antioxidant) activity than the reddish varieties but lower than the black varieties.

Genistein has potential as a therapeutic agent for benign prostatic hypertrophy (BPH) and prostate cancer, as it is protective and lowers the risk of prostate cancer during the promotional phase of the disease. Apart from this, it inhibits the growth of colon cancer and ovarian cancer cells. It has the ability to check the growth of a wide range of cancer cells, including those that are not

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hormone dependent, such as melanoma (skin cancer), leukemia, lymphoma, and cancer of the bladder and lungs (Eun *et al*., 2000).

Further, genistein works in several ways to reduce various types of cancer risk (incidence, latency, or tumor cell number). Its anti-estrogen activity is similar to that of Tamoxifen®, a synthetic anti-estrogen drug widely used in the treatment and prevention of breast cancer (Grynkiewicz *et al*., 2000). In USA, a number of products specifically targeting women's health have recently been released commercially, containing isoflavones or isoflavone-enriched soya protein. A number of isoflavone-based drugs are available in India – Bilem® (Lemery), Cytofen® (BDH), Mamofen® (Khandelwal), Tamodex® (Biochem), and Tamoxifen® (Dabur).

Recently, a semi-synthetic isoflavonoid that is structurally similar to soya isoflavonoids has been synthesized under the name Ipriflavone, as a medicine for increasing bone density in post-menopausal women. Ipriflavone is being used in Italy, Hungary, and Japan under different brand names and recently became available in USA (White, 1999).

The pharmacological and clinical aspects of genistein and daidzein have been reviewed in detail for health and nutrition (Suthar *et al*., 2001).

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Lectins in soybean seed

Apart from a high protein content, soybean seeds also contain several hemagglutinating isolectins. Lectin in the duodenal lumen stimulates pancreatic secretion. Parenteral administration of soya lectin modulates the host's immune response and inhibits tumor growth. In clinical treatment of acute lymphoblastic leukemia, soya agglutinin is used in purging the marrow of T. cells and thus reducing the risk of graft virus host diseases (Van Damme *et al*., 1997).

Other pharmacological activities of soybean

Prevention of osteoporosis. The effect of a soybean ethanol extract was examined on the activity of osteoblast MC3T3-EI cells. The soya extract has a direct stimulatory effect on bone formation in cultured osteoblastic cell in vitro. Presumably, dietary soya products are useful in the prevention of osteoporosis (Choi *et al*., 2001).

Hepatoprotective effect. Soya extract was tested for hepatoprotective effect on liver injury. The effect was found to be improved by the treatment with black bean

extract, which was compared to silymarin as a standardized drug (Wu *et al*., 2001).

Antilipid activity. Hot water extracts of black bean were tested and evaluated with those of other leguminous seeds. All legume extracts showed antisuperoxide formation activity in which the black bean extracts exhibited the most powerful antioxidant activity (Lin *et al*., 2001).

Discussion

Status of soybean in the world

Soybean is cultivated throughout the world for seed, which is ultimately used for extraction of soya oil, the world's most widely used edible oil. According to Juvik *et al*. (1985) soybean was brought to North America some 200 years ago and even earlier to Europe. In USA, it has attained great success as an oil and forage crop. Its first great development as an industrial crop took place in the late 1800s in northeastern China (Manchuria), where the oil was extracted for edible purpose and the high-protein meal was used as human food, animal feed, and as a fertilizer.

During the last 50 years, soybean has become a major crop in North America (USA and Canada) and more recently in South America (Brazil, Argentina, and Paraguay), with large tonnages being shipped to Europe and eastern Asia. Over 90% of the world's soybeans are now grown in USA (56%), Brazil (17%), China (11%), and Argentina (7%). Most of the remaining production is in the following 11 countries (each with 1% or less of the world's total): Canada, India, Indonesia, Japan, North Korea, South Korea, Mexico, Paraguay, Romania, Thailand, and the former USSR.

Most of the production is processed, with the oil being extracted and made into food products (margarine, salad dressing, cooking oil, etc.), and the meal going into poultry and livestock feeding rations. The use of this high-protein meal has revolutionized poultry

Soybean and health

It is now widely recognized that soybean consumption is good for health. Soybean is often recommended for the prevention of a variety of ailments and diseases.

General health: Reduced weight loss; sturdier bones and joints; healthier hair, skin, and nails; improved energy and stamina; reduced cholesterol, blood pressure, and risk of heart disease; reduced risk of diabetes; improved memory and brain power; improved function of digestive tract, kidneys, and thyroid.

Women: Alleviation of menopause and perimenopause complications; healthier breasts; alleviation of PMS (post-menstrual syndrome) and menstrual disorders; improved sex drive and reduced vaginal dryness; improved endometrial (uterine) health.

Men: Improved prostate function.

and livestock production greatly by increasing the efficiency of egg and meat production.

Status of soybean in India

In India, the yellow variety is cultivated in almost all the states for the production of oil. As such, a vast quantity of the seed meal is left after the extraction of oil, and is commonly marketed as 'Nutri-Nuggets'. Soybean seed meal is a good source of vegetable protein, and people need to be educated about its nutritional and medicinal value. Using a 1:10 mixture of soya flour and wheat flour in culinary preparations helps prevent a number of ailments and diseases.

Status of soybean in Kumaon

The traditional cultivation of black soybean is dwindling in Uttaranchal day by day. Although the yellow variety is being cultivated in the terai region and in the valleys of Uttaranchal as it has good market for production of oil, it cannot replace the black variety. It cannot be used in the popular Kumaoni recipes discussed earlier because it gives an acrid taste. In the late 1950s/early 1960s, when the government persuaded the Kumaoni people to adopt the new variety for cultivation and for their local dietary use, the Kumaonis rejected it outright. Firstly, the variety did not grow well in the hilly soil; secondly, the taste and flavor was not akin to that of the black soybean, which was part of their cultural diet and being cultivated in the region for years.

The fact that cultivars of black and brown soybean contain high levels of isoflavonoids (Kawamura *et al*., 2000), and that they have a high antioxidant activity (Takahata *et al*., 2001), underlines the importance of these soybean varieties in Uttaranchal and other regions where they are being traditionally cultivated and consumed.

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"Hard cooking" and dietary management

As mentioned earlier, traditional Kumaoni food with black beans require "hard cooking" (thorough and prolonged cooking) during their preparation. Anybody eating a black bean based preparation that is not "hard cooked" is bound to get indigestion. This practice of thorough cooking clearly has a scientific basis, since Mollison (1993) found that soybeans have a 'trypsin inhibitor' enzyme that inhibits protein digestion in the body. Prolonged cooking therefore destroys the trypsin inhibitor. Further, the consumption of the preparation *bhat-jaula* as a diet management in jaundice by the people of Uttaranchal is possibly due to the stimulation of pancreatic secretion by the lectins present in the soybean.

Though the people of Kumaon cultivate black soybean as a food crop, with a cultural legacy of special dietary recipes, they seldom know about its nutritional benefits, and its cultivation is dwindling day by day.

Conclusion

Soybeans are highly nutritious and a great source of vegetable protein. People with high levels of soybean intake have lower rates of coronary heart disease, breast cancer, and osteoporosis than people with low levels of soybean intake. Soybean decreases LDL-cholesterol (low-density lipoprotein) levels and increases HDL-cholesterol (high-density lipoprotein) levels. Studies also show that the plant chemicals isoflavones are unique to soybeans, having antioxidant properties, which protect LDL from oxidation.

Though the people of Kumaon cultivate black soybean as a food crop, with a cultural legacy of special dietary recipes, they seldom know about its nutritional benefits, and its cultivation is dwindling day by day. It is therefore a matter of great concern that such a useful crop of nutritional and medicinal value is being neglected. It is high time that the government and NGOs make an effort to create wider awareness about the benefits of this crop, and its importance both in the Kumaoni culinary heritage and in the general health of the people.

The website <thesoydailyclub.com> gives a wealth of information on soybean – recipes, market, business, etc. It also offers an interesting *e*-newsletter dedicated to soybean.

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