

THE SOY BEAN AS HUMAN FOOD¹

FRANCES L. DITTES

NASHVILLE AGRICULTURAL AND NORMAL INSTITUTE, MADISON

The soy bean is a plant of early cultivation in China. Its use dates back to the beginning of China's agricultural age under the Emperor Chen Nung. The soy bean is mentioned in the Ben Tsao Gang Mu, the ancient "Materia Medica," written in the year 2838 B. C. This bean is remarkable for its richness in oil, averaging 20 per cent; the almost complete absence of starch; high protein, averaging 40 per cent; and high ash, averaging 5.5 per cent.²

For centuries the soy bean has been the most universal article in the Chinese dietary. It is also extensively used for food in Korea, Japan, Indo-China, the Philippine Islands, the Dutch Indies, Siam, and India. The Chinese make practically no use of dairy products. The majority of the people consume a meager amount of meat, and

TABLE 1

*Composition of Soy Bean Seed compared with that of other Legumes**

VARIETY	MOIS- TURE	PRO- TEIN	FAT	N-FREE EXTRACT	FIBER	ASH
	%	%	%	%	%	%
Soy bean	9.9	36.5	17.5	26.5	4.3	5.3
Cowpea.....	11.6	23.6	1.5	55.8	4.1	3.4
Field pea.....	9.2	22.9	1.1	57.8	5.6	3.4
Navy bean.....	13.4	22.7	1.5	53.0	5.8	3.6
Velvet bean.....	11.7	20.8	6.4	51.0	7.5	2.6
Garden pea.....	11.8	25.6	1.6	53.6	4.4	3.0

*From Henry and Morrison, in "Feeds and Feeding."

yet, in spite of this, they have lived for centuries on what appears to be a remarkably well-balanced diet by the use of the soy bean.

This bean is known also as soja bean, or soya bean. Botanically, it has been referred to in literature usually as *Glycine hispida*. Recently its classification has been re-examined, with the result that the botanical name of the plant became *Glycine Max* under the International Rules of Botanical Nomenclature, or *Soja Max* under the American Rules.³

¹Read before the Tennessee Academy of Science at the Nashville meeting, November 27, 1931. Miss Dittes prefers to use "soybean, vitamin," and "vitamine." The use of "soy bean, vitamine," and "vitamines" in this paper is one the Editor is responsible for.

²Horvath, A. A., *The Soy Bean as Human Food*. Reprinted from News Edition, Vol. 9, No. 9, p. 136, May 10, 1931. Health Section, Bureau of Mines, Pa.

³Piper, Chas., and William, Morse, *The Soy Bean*. 1923, McGraw-Hill Book Co., New York, Chap. III, p. 27-32.

The celebrated dictionary of Su Shan describes the plant under the name of *Tzhouan*. It seems very probable that the names *soi*, *soy*, *soya* and *soja*, are all derived from the ancient Chinese name *soi*. The soy bean is mentioned in many of the ancient Chinese poems, as for example in the rhymes of the great poet Sou, of the second century: "The tender jade gets perfumed by it in the kettle," and "to boil the pea to milk and the seed to butter."

There are as many as five hundred different varieties of soy beans now grown in Manchuria, which is the principal country producing this legume. In 1921, Manchuria produced approximately 4,500,000 tons of soy beans on eight million acres, covering approximately 25% of the total cultivated area.

The soy bean was introduced into the United States from the Orient as early as 1804. Until 1917, it was used largely as stock food and as a forage crop. In 1917, during the World War, a special committee appointed by the Department of Agriculture, while searching for a cheaper source of protein for human consumption,

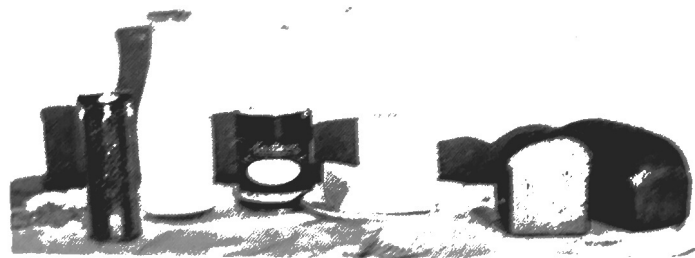


Fig. 1. Products of the soy bean. Reading from left to right, soy beans, soy milk, soy cheese, and soy bread.

discovered the soy bean. The government has urged the use of this food in the United States. As a result of these investigations made during the World War, an increasing demand for soy bean seed has led to the development of a very profitable industry in certain sections of the country, particularly in the South. Because of this, American factories are now making from the soy bean valuable food products, besides such articles as glycerine, enamels, varnish, waterproof goods, explosives, linoleum, paints, celluloid, rubber substitutes, printing inks, lubricants, etc.⁴

The protein of the soy bean is similar to that of cow's milk. The chief protein of the soy bean, according to Osborne and Clapp, is glycinin (a globulin), and is very similar in its amino acids to beef. Rose and MacLeod demonstrated that the human organism is able to store 3.3 per cent of the nitrogen taken in the form of soy bean curd but only one per cent of meat nitrogen. These investigators

⁴Horvath, A. A. *Op. cit.*, p. 1.

point out that the proportion of amino acids in glycinin is thus not very different from that found in animal flesh and approaches it more closely than does that of the amino acids in the proteins of wheat and other cereals. Merial and Becker refer to the glycinin as "vegetable casein" and call attention to the points it has in common with animal casein. It is acted upon by strong acids and ferments and gives the same products as animal casein with these agents.⁵

Crude soy bean oil is digested by man to the extent of 95.16% as shown by Zimmerman. The presence of certain fatty acids as linolic and linolenic, in the soy bean oil, makes it exceptionally valuable for the building up of fats in the various cells of the body. Keel, Yamaguchi, Anderson, and Mendel discovered the striking amount of activity exhibited by rats on a 37 per cent soy bean oil diet: "At periods of great activity several of these rats must have run constantly at a rate of 20 revolutions per minute for 15-hour periods."⁶

TABLE 2
Comparison of Soy Milk with other Milks⁷

KIND OF MILK	WATER	PROTEIN	FAT	NITROGEN-FIXING FACTIVES	
	%	%	%	%	%
Soy Bean (Tsinanfu, China)	90.71	4.22	1.87	2.80	0.40
Soy Bean (Peking, China)		2.85-3.35	3.01		
Soy Bean (Japan)		2.79	1.24	1.13	0.33
Woman		11.25	2.50	6.0	0.25
Cow	87.0	3.8	4.0	5.0	0.70
Goat		4.0	4.50	4.0	0.50

⁵From *The Soy Bean as Human Food*, by Dr. A. A. Horvath. Booklet Series No. 3.

The soy bean is also very rich in *lecithin*, an important constituent of all organs of the human body, and especially of the nervous tissue, the heart, and liver. Hesse found that the lecithin of vegetable origin does not produce obesity. One pound of soy beans is equivalent in protein and fat to two pounds of beef.⁷

The ash of the soy bean seed is physiologically alkaline, and is rich in potassium and phosphorus. Nuzum, Osborne, and Sansum found that in rabbits fed on a soy bean diet the urine was kept alkaline, and the carbon dioxide combining power of the blood serum was high. Horvath showed that there is an increase in the blood inorganic phosphorus of rabbits fed on raw soaked soy beans. The alkalinity of the soy bean ash may account for the high retention figures for soy bean protein by the human organism by saving the nitrogen re-

⁶Horvath, A. A. *Op. cit.*, p. 1.

⁷Horvath, A. A. *The Soy Bean as Human Food*. Health Section, Bureau of Mines, Pittsburgh, Pa.

⁸Horvath, A. A. *Soya Flour as a National Food*. Reprinted from *Scientific Monthly*, Sept., 1931, Vol. 33, p. 251-260.

quired for the neutralization of the body acids. Hindhede explains in a similar way the unusually high physiological value of the nitrogenous substances of potatoes.⁸

Horvath found the calcium content of soy beans to be 0.26 per cent while that of cow's milk varied around 0.16 per cent. These beans contain an excess of fat in regard to the ratio, calcium: fat, required for optimal absorption and metabolism of calcium salts. If supplemented by wheat flour or rice, to reduce the percentage of fat in the mixture, a soy bean diet keeps the blood calcium at a normal level. Hence the rice and soy bean diet in the Orient.

According to Osborne and Mendel the soy bean is the only seed, known, which contains both the water-soluble and fat-soluble vitamins. The presence of vitamins A and D was demonstrated particularly by Hornimann. Horvath in the September, 1931, issue of the Scientific Monthly, calls attention to the two factors of vitamin B, B₁ and B₂ having been found in the soy bean. Vitamin E is also present.

TABLE 3

Composition of Soy Bean Milk compared with Cow's Milk
Compiled from Various Sources

KIND OF MILK	WATER	PROTEIN	FAT	CARBOHYDRATES	OTHER SUBSTANCES	ASH
	%	%	%	%	%	%
Soy Bean.....	92.00	3.70	2.00	1.80	0.50
Soy Bean.....	80.00	4.95	2.97	1.34	0.44
Soy Bean.....	89.25	3.15	3.10	3.02	1.02	0.45
Soy Bean.....	92.50	3.02	2.13	0.03	1.88	0.41
Cow.....	86.06	3.05	4.00	5.00	1.19	0.70

It can be seen that, from the point of view of its chemical constituents, its physiological value and its richness in vitamins, that the soy bean occupies an outstanding place among the foodstuffs.

Since the soy bean is rich in protein and oil, a soy bean milk can be prepared from the seed in the same way as almond milk. The value of this milk for infants has been known for many centuries in China. Many tests have been made in the pediatric departments of various universities in the United States, showing that the soy bean can be used as the only source of protein in the nutrition of young infants. Recently forty babies were successfully fed—by Doctors Hill and Stuart at the Department of Pediatrics, Harvard University Medical School, for a period of two months or more—a diet with soy bean flour as the sole source of protein. According to Fisher, soy bean milk gives a much finer flocculent curd in the stomach than cow's milk. Its period of stay in the stomach is shorter. Its ingestion results in a feebler and shorter secretion of gastric juice. The

⁸Horvath, A. A. *Op. cit.*, p. 2.

peristaltic motion of the stomach is less after the ingestion of soy bean milk than in the case of cow's milk. These qualities make the soy bean milk more desirable as a food for delicate infants than cow's milk.⁹

If soy bean milk is boiled with a solution containing magnesium chloride or calcium sulphate, its proteins are precipitated. The cheese-like product obtained by pressing this precipitate is generally known as bean curd and is called in China "tofu." This "tofu," if fresh, contains approximately 8 per cent of protein and 3 per cent of fat, and according to Oshima, is digested to an extent of over 95 per cent. Fried "tofu" resembles beef in its content of protein and fat, and is called in China "the meat without the bones."¹⁰ In the Orient, "tofu" forms a very popular and almost indispensable dietary article. This "tofu" can be used in many different dishes. It is delightful as a constituent of roasts, omelets, etc.

While for centuries, as stated above, the soy bean prepared in various ways has been an article in the Oriental dietary, not until late years has any appreciable interest been shown on the part of America or Europe. W. J. Morse, of the United States Department of Agriculture, is a leading figure in arousing interest in the soy bean as an article in the American dietary. Morse, returning recently from an extended visit to the Orient, brought back four hundred different and distinct food products manufactured from the soy bean. In all the vegetable kingdom there is no plant so versatile for human food as this.

In Europe and the United States, soy bean preparations are chiefly used in the form of salad oil, lard substitutes, Worcestershire sauce, and bouillon extract. Soy bean flour was not very popular until recently on account of its *beany* taste and its capacity for rapidly turning rancid. Berczeller, a leading food physiologist, of the University of Vienna, succeeded in eliminating from the bean the disagreeable flavor and odor, and now in several countries manufacturers are producing soy bean flour under the Berczeller patents. This flour has a nutty, agreeable taste, and does not turn rancid on keeping.

The University of Padova, Italy, has done extensive work in the soy bean food field. In Russia the soy bean is taking a prominent place in the dietary of the people. A soy institute was recently organized in Moscow, as well as a special exhibition of soy foods, at which 130 varieties of soy dishes, including cutlets, pastry, salads, candy, and roasts were shown.

In the United States at the present time soy bean flour is being used by large bakeries as a constituent of bread, rolls, pastry for pies, cakes, etc. Baby foods are coming on the market containing certain percentages of soy bean milk. Chocolate malted milk containing a

⁹Horvath, A. A. *The Soy Bean as Human Food*. Health Section, Bureau of Mines, Pittsburgh, Pa.

¹⁰Horvath, A. A. *Op. cit.*, p. 2.

good per cent of soy bean products is now manufactured and sold by several companies. For some time, manufacturers of diabetic foods have been placing on the market products made largely from the soy bean. The soy sauce, otherwise known as Oriental "Shoyu," has been popularized by the Chinese chop suey restaurants, and is now being canned and manufactured in various other ways. Powdered soy bean milk has become a commercial product.

Kufemann recommends soy bean flour as a food in cases of chlorosis, anemia, and hyperthyroidism, and especially in heart neurosis, as it is very rich in phosphorus. Phosphorus was found to be more effective in hyperthyroidism than the iodine medication. The same author recommends also the use of soy beans for the treatment of alcoholism.¹¹

One of the most striking points about soy beans is the fact that they contain no starch, or a very small quantity, which is strange when one considers that other varieties of beans are extremely rich in starchy materials. Because of this fact, the soy bean takes a prominent place in the diet of the diabetic.

Thus, there are significant reasons for expecting that the soy bean will become one of our most stable and prominent sources of fat and protein. There are reasons to expect also that the United States will become the leader in introducing the soy bean in the daily diet of the white race.

BIBLIOGRAPHY

1. Adolph, W. H. How China uses the soy bean as food. *Jour. Home Economics*, vol. 14: 63-69; 1923.
2. Bowers, W. G. Some studies on the nutritive value of the soy bean in the human diet, North Dakota Agri. Col., Agri. Exp. Sta. Bull., Vol. 5, No. 13; 1919.
3. Burleson, D. J. Soy Beans, Ark. Exp. Sta. Circ. 230; 1927.
4. Child, Alice M. Soy Beans, and Soy Bean Foods, Forecast, Vol. 37, No. 2: 103, 132; Feb., 1929.
5. Soy Beans as human food. Mass. Agri. Exp. Sta. Bull., 162; 1918.
6. Kiescelbach, T. A. Soy Beans. Nebr. Agr. Exp. Sta. Bull., 166; 1918.
7. Langworthy, G. F. Soy Beans as food for man. U. S. Dept. Agr. Farmers Bull., 58; 1899.
8. Magee, C. R. Soy Beans. Mich. Agr. Exp. Sta. Special Bull. 100; 1920.
9. The nutritive value of the proteins of coconut meal, soy beans, rice, bran and corn. *Jour. Dairy Sci.*, Vol. 6, No. 3; 222-236; May, 1923.
10. Parsons, T. R. The use of the soy bean in human nutrition. *Lancet*, Vol. 212: 267-268; 1927.
11. Roberts, Lydia J. and Miller, E. W. A cheap homemade soy bean meal for diabetics. *Jour. Home Econ.* Vol. 10: 64-70; 1918.
12. Webb, Louis and Stuart, Harold C. A soy bean food preparation for feeding infants with idiosyncrasy. *Amer. Med. Asso. Jour.*, Vol. 93, No. 13: 958-987; 1929.

¹¹Horvath, A. A. *The Soy Bean as Human Food*. The Bureau of Industrial and Commercial Information, Hankow Road, Shanghai.