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## SOY BEANS AND SOY BEAN OIL.*

BY E. V. HOWELL.

This bean is a native of southeastern Asia. It is at present the most important legume grown in Japan, China and Manchuria, where it is grown almost exclusively for human food. It has been cultivated from a remote period, each district having its own distinctive variety, some two hundred kinds in all. It was brought to Europe in comparatively recent times and there cultivated in botanic gardens for more than a hundred years without attracting any particular attention. The bean was introduced into England in 1790. Apparently the first mention of soy beans in American literature, was in the *New England Farmer*, October 23, 1829, in an article by Thomas Nuttall. He grew a variety with red flowers and chocolate-

* Scientific Section, A. Ph. A., Indianapolis meeting, 1917.

brown seed in the botanic garden at Cambridge, Mass. From his observations he wrote a brief account of it: "Its principal recommendation at present is only a luxury, affording the well-known brown sauce 'Soy,' which at this time is prepared only in China and Japan." Just two years later, November 23, 1831, an article appeared in the same journal regarding the culture of the plant at Milton, Mass., the seed having been obtained from Nuttall. Further mention of the plant appeared in a brief account under the name "Japan Pea," by A. Ernst, Cincinnati, Ohio.

In 1854, the Perry Expedition to Japan brought back two varieties of "soja beans," one with white seeds, the other with red seeds. They were distributed by the Commissioner of Patents in 1854, and from then on frequent references to the plant occur in agricultural literature under the names Japan pea, Japan bean, and Japanese fodder plant. The name soy or soja bean followed. Prof. Henry Trimble, in June 1896 and in November 1897, in the *American Journal of Pharmacy* published excellent papers on the soy bean.

It is not adapted to sections with a short growing season; however, from the large number of varieties to choose from, there is little difficulty in growing it over an extensive section of the United States, particularly in the South. Scarcely more than a dozen varieties have as yet been grown in large quantities.

IMPORTANCE.

I think the soy bean is the most important plant introduced into the South within a hundred years. This opinion is based on the range of the plant, the value as a soil improver, and the numerous uses of the seed and oil, together with the fact that the present cottonseed oil mills can produce the oil with practically no change in machinery and thus double their mill season. The beans can be stored, as they are practically immune to insects. Especial emphasis is placed on this statement in the present demand for food on account of the war. In Japan the bean forms one of the most important articles of food, by nature a meat, to go with the starch of rice. The Chinese make from the beans a cheese resembling our own cheese, while the Japanese make the well-known sauce for rice or fish, soy or suey sauce. It is one of the principal ingredients in "Tofu" (bean curd), natto (steamed beans), and white and brown miso, which is like our molasses brown bread.

The beans are eaten as a vegetable, or in soup, or picked green, boiled and served cold with soy sauce, and sometimes as a salad. A "vegetable milk" is also produced from the bean, and this milk is the basis for the manufacture of the different vegetable cheeses. This milk is used fresh, and also a condensed milk is made from it. All of these foods are in daily use in Japanese homes, and for the poorer classes form the principal protein diet.

A factory for the production of this milk has been recently established in America. This can be used in cooking, by bakers, confectioners, and chocolate manufacturers. I have before me the following food articles in which soy bean meal is the principal ingredient: Egg substitute No. 1, egg substitute No. 2, colored cocoanuts, coffee substitute, cocoa substitute, roasted malted nuts, coloring curry powder, cutlet powder, soy and navy beans with pork, the equal of any pork and beans.

The use of the soy meal for soups, for proportional use in muffins, cookies, fritters, croquettes, biscuit, and loaf bread is unlimited. Its use is checked only

by our prejudice for certain customary flavors, just as northern people and Europeans do not use corn meal. In other words, North Carolina, if forced to by war conditions, could largely exist on the soy beans crushed in the State this year, including the imported and native beans crushed, the oil from which I estimate to yield this year 400,000 gallons. This oil can be used for frying, and for a salad oil in French dressing or in mayonnaise. I fried a partridge in the crude unrefined oil, and found it delicious.

While the chief use, so far, of the oil has been for soaps and paints, the particular object of this paper has been to call attention to the use of soy oil in pharmaceutical preparations. In brief, these experiments show first the necessity of a distinctive test for soy oil. It does not respond to the Halphen test for cottonseed oil, nor the hydrochloric acid-sugar test for sesame oil. It was substituted for cottonseed oil in Camphor Liniment, for linseed oil in Compound Solution of Cresol, for olive oil in Compound Brown Plaster, N. F., and Brown Ointment, N. F., for sesame oil in Ammonia Liniment, with satisfactory results. In Phenolated Oil, N. F., the soy oil used for olive oil became darker after standing several weeks. A Manchurian oil purchased in New York gave these results:[1]

| | Specific gravity. | Saponification value. | Iodine value. |
|---|---|---|---|
| Sample No. 1 | 0.9240 | 194.4 | 131.1 |
| Sample No. 2 | 0.9244 | 194.9 | 130.9 |
| Sample No. 3 | 0.9241 | 194.6 | 131.3 |

An ordinary pycnometer was used at 20° Centigrade. The iodine number represents the percentage of iodine monobromide, in terms of iodine, absorbed by the oil. From a sample of mammoth yellow beans we found ash 3.6 percent, oil 21 percent by ether solvent and Soxhlet extraction. No evidence of alkaloids was discovered.

CONSTITUENTS OF SOY BEANS.

The Government and certain state agricultural departments have so extensively treated this subject, in the bibliography cited in this paper, that merely typical analyses will be given.

SOY BEAN MEAL.

| | Moisture. | Protein. | Fat. | Nitrogen-Free Extract. | Ash. | Fiber. |
|---|---|---|---|---|---|---|
| Soy bean | 7.59 | 44.65 | 8.77 | 27.12 | 5.89 | 5.96 |
| Cottonseed | 6.62 | 40.29 | 7.41 | 28.63 | 6.21 | 10.84 |
| Linseed, old process | 8.98 | 33.23 | 7.20 | 36.51 | 5.40 | 8.68 |
| Linseed, new process | 9.63 | 37.51 | 2.49 | 36.09 | 5.54 | 8.74 |
| Peanut, decorticated | 10.73 | 46.84 | 7.91 | 24.34 | 4.89 | 5.29 |
| Sunflower seed | 7.68 | 23.80 | 7.94 | 27.49 | 5.03 | 28.06 |

The average oil content of soy beans is 19 percent. While some varieties will uniformly run a little higher, two lots of the same variety will vary from 18 to 21 percent, while occasionally a lot may run a little below 18 percent.

During the past six or seven months there has been produced in this country in the neighborhood of one hundred thousand gallons of soy oil. The largest part of this quantity has been produced in North Carolina by the Elizabeth City

[1] "Investigation of Soy Bean Oil," George W. Byrd, Chapel Hill, N. C.

Oil & Fertilizer Co., Winterville Cotton Oil Co., and the New Bern Cotton Oil & Fertilizer Mills. Samples from the different crushings have been examined in comparison with the imported oils. It was found that the chemical constants of the domestic oils compared very closely with those of the imported oils. A comparison of the chemical constants is here shown from a report of L. P. Nemzek, to Bureau of Paint Manufacturers:

| Identification No. | Specific gravity. | Iodine number. | Acid number. | Saponification value. |
|---|---|---|---|---|
| FI, No. 9355 (Domestic) | 0.929 | 124.3 | 0.8 | 194 |
| Lab. No. 383 (Domestic) | 0.921 | 129 | 0.6 | 193.8 |
| Lab. No. 411 (Domestic) | 0.924 | 126 | 1.3 | 201 |
| Lab. No. 409 (Domestic) | 0.925 | 123.5 | 2.0 | 196.1 |
| Lab. No. 335 (Domestic) | 0.924 | 126.3 | 1.2 | 190.4 |
| Imported Oil, FI, No. 8940 | 0.925 | 123.8 | 1.9 | 190 |
| Imported Oil, FI, No. 9029 | 0.925 | 133.8 | 3.1 | 190 |

## THE UNITED STATES GOVERNMENT'S ESTIMATE OF THE VALUE OF THE SOY BEAN AS A FOOD FOR MANKIND.

In *Farmers Bulletin* No. 121, issued Nov. 19, 1906, prepared under the supervision of the Office of Experiment Stations, on pages 12 and 13, an account of soy beans is given, and the statement made that "In the Orient this bean, and the various food products made from it, are so largely consumed that it is, perhaps, the most important food plant next to rice."

On page 19 of this *Bulletin* we find a comparison of the food values of various food materials, in which we find these analyses:

| Material. | Water. Percent. | Protein. Percent. | Fat. Percent. | Ash. Percent. | Carbohydrates. Percent. | Fuel value per pound calories. |
|---|---|---|---|---|---|---|
| Navy beans | 12.6 | 22.5 | 1.8 | 3.5 | 59.6 | 1,605 |
| Soy beans | 10.8 | 34.0 | 16.8 | 4.7 | 33.7 | 1,970 |
| Potatoes | 78.3 | 2.2 | 0.1 | 1.0 | 18.4 | 385 |
| Wheat flour | 11.9 | 10.7 | 1.0 | 0.6 | 75.8 | 1,650 |
| Lean beef | 70.0 | 21.3 | 7.9 | 1.1 | .. | 730 |
| Milk | 87.0 | 3.3 | 4.4 | 0.7 | 5.0 | 325 |
| Eggs | 73.7 | 14.8 | 10.5 | 1.0 | .. | 720 |

## MEDICINAL USE.

In England a diabetic biscuit is manufactured. In this country an infant's food from the soy bean is on the market. The enzyme in the bean is also attracting attention and opening a field for investigation. In conclusion, I want to call attention to the necessity of examining the imported seed for plant diseases as the cake is entering into commercial fertilizers and the danger from spreading the meal over land is obvious to those who know the cost of the imported boll-weevil, or the San José scale.

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## AMERICAN SULPHUR.—HERMAN FRASCH.*

BY M. A. MANSBACH.

To start with, I am neither a scientist nor a chemist, and the excuse which I have for appearing before you consists mainly of the facts, first, that at the present time there is an extraordinary famine in sulphur; second, the revolution brought about in the winning of sulphur by that wonderful chemical and mechanical genius, Herman Frasch, is yet far too little known; and third, the Government states in the *United States Geological Survey Bulletin* No. 666B, that, as a preparedness measure, the sulphur deposits that are now idle should be thoroughly developed, search should be made for new deposits in areas where the geological conditions are similar to those in the vicinity of known deposits, and that other deposits of sulphite ores should be intensely developed.

Sulphuric acid, a government specialist has said, is probably used for a greater variety of purposes in the chemical arts than any other substance. It is made largely from sulphur. This acid and sulphur itself are employed in the manufacture of fertilizers, nitroglycerin, celluloid, powder, matches, fireworks, soap, paper, glass, starch, sugar, molasses, copper, galvanized iron, tin plate, artificial ice, effervescent drinks, shoe blacking, iron, steel, coke and medicine, for vulcanizing rubber, for bleaching wool and silk, for printing calico and tanning and for refining gold, silver and petroleum. It is surprising that no mention at all is made of the use of sulphur as a base for dyestuffs.

Previous to 1895 the method of producing sulphur consisted of digging for it in the same orthodox manner in which we are now digging for coal. This old method was found to be impracticable in this country owing to the great depth of the sulphur deposit, underlying a strata of oil-bearing quicksand. Losses of plants and hundreds of lives occurred until the Government intervened. Sicily at that time had quite a domineering position in the sulphur market. Sulphur is found in and near craters of volcanoes in Japan and Sicily. In Sicily, 35,000 men are employed in the winning of sulphur and this industry is of the greatest local importance. In 1833 sulphur was almost the cause of a war between England and Italy when an English fleet demonstrated in the Bay of Naples to compel Italy to rescind the sulphur monopoly granted to France. Sulphur is also found in Spain and Scandinavia, but not in sufficient quantities to compete with the Sicilian sulphur.

*An address before Scientific Section, A. Ph. A., Indianapolis meeting, 1917. The author was delayed and therefore it was impossible to illustrate the lecture; however pictures of the interior of the plant, sulphur deposits and pumps were shown; also samples of sulphur from the Louisiana, Texas and Nevada deposits.