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USE OF UNITED STATES SOYBEANS IN JAPAN

Increase in soybean acreage in the United States

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

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Note: Figures 14, 15, and 17 courtesy of Sugiyama Chemical Research Institute, Tokyo.

DEFINITIONS OF JAPANESE FOOD PRODUCTS

HAMANATTO: Whole soybeans cooked and fermented for several months with _Aspergillus oryzae_.

KINAKO: A form of full-fat soy flour made by grinding roasted soybeans.

MISO: A fermented food of paste-like consistency. Miso is made by fermenting various ratios of soybeans and rice or other cereals. _A. oryzae_ is the principal fermenting organism.

MONOSODIUM GLUTAMATE: A seasoning compound. Monosodium glutamate (MSG) is prepared by crystallizing the monosodium salt of glutamic acid. The glutamic acid is usually derived from soybean protein, wheat gluten, corn gluten, or Steffens waste. A new method is by fermentation of certain carbohydrates.

NATTO: Whole soybeans cooked and fermented for a few days with _Bacillus natto_.

SHOYU OR SOY SAUCE: A seasoning product.

FERMENTED SHOYU is made by fermenting whole soybeans and wheat or other cereal for several months primarily with _A. oryzae_. The soybeans are sometimes replaced or partly replaced by defatted soybean meal.

CHEMICAL SHOYU is made by acid hydrolysis of soybean or other vegetable protein. Shoyu contains about 18 percent salt.

TONYU OR SOYBEAN "MILK": The cooked water-extract of soybeans supplemented with oil, vitamins, and minerals.

SOYBEAN SPROUTS: Soybeans sprouted in the dark for 3 to 5 days.

TOFU: A nearly white curd, usually formed into small cakes. The soybean curd, called Teou fu by the Chinese, is made from the water extract of the whole bean by coagulating the protein. Tofu also contains emulsified oil.

FROZEN TOFU, KORI TOFU, OR KOYA DOFU; tofu which has been frozen for several weeks and dried.

ABURAGE; fresh tofu dried in deep fat.

NAMA-AGE; fresh tofu which has been surface dried.

SATSUMAGE; fresh tofu mixed with wild potatoes and fried.

YAKI DOFU; fresh tofu lightly roasted.

YUBA: Dried sheets of soybean protein containing emulsified oil. It is made by removing and drying the skin formed by heating soybean "milk."

USE OF UNITED STATES SOYBEANS IN JAPAN[1]

By Allan K. Smith[2]

INTRODUCTION

Japan imports soybeans to supplement her domestic food supplies with protein and oil. Total imports for 1956 were about 20 million bushels.

Surveys conducted by the Ministry of Health and Welfare, Japanese Government, show that the diet of the Japanese people is low in protein, and that the soybean is next in importance to fish as a source of this essential nutrient. The population of Japan, now about 91 million people, is increasing. Present population density per square mile of arable land is more than 4,300 or approximately double that of any other country. Japan needs more soybeans to meet her nutritional requirements.

Japan's imports of soybeans are far below the prewar level; it was reported that prior to the war Japan imported 36 million bushels of soybeans from Chinese and Manchurian sources. Present import requirements are estimated at 55 million bushels. These requirements are based upon Japan's 23 percent increase in population since 1942, the need for more protein in the diet of her people, and the present limited uses of soybeans in feed and industrial products in Japan. As her standard of living and population increase, her soybean requirements will increase further.

Table I shows Japanese imports of soybeans by country of origin for 1950-56. These data show a trend toward increasing imports from the U. S.

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1 An earlier study made by the author in 1948 "Oriental Methods of Using Soybeans as Food" (USDA Bur. Agr. and Ind. Chem. AIC-234, 40 pp., June 1949) contains valuable background information.

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Table 1.--Japanese imports of soybeans by country of origin for 1950-56 in metric tons (M.T.)

Year	United States	China	Brazil	Others	Total
	1,000 M.T.	1,000 M.T.	1,000 M.T.	1,000 M.T.	1,000 M.T.
1950	95	108	0	1	204
1951	293	6	0	11	310
1952	162	1	2	2	167
1953	409	24	14	1	448
1954	443	46	18	1	508
1955	572	204	31	1	808
1956	536	166	12	3	717

Source: Foreign Agriculture Report No. 104

Most United States soybeans imported by Japan are used by modern oil-mill processors for producing oil and meal. For this type of processing our soybeans are superior to Japanese soybeans except for the foreign material they contain. United States soybeans have an average higher oil content than beans from other sources, and for this reason they are the most profitable for oil-mill processing.

The traditional Japanese food products, which account for roughly 50 percent of soybean usage, are valued more for their protein than for oil. Actually, many of these products that use the whole bean intact or the water-soluble portion of the bean, contain a high percentage of oil as well as protein. Most of the traditional Japanese soybean foods are made from whole beans, and such processes present much different problems from those encountered in oil-mill processing. For the traditional foods some processors have stated that they prefer Japanese to U. S. soybeans; on the other hand there are a few others that use only U. S. soybeans. Thus, the amount of U. S. beans used in making Japanese foods varies among the processors from 0 to 100 percent, depending upon each processor's particular requirements and experience.

Some of the people engaged in promoting soybean exports to Japan have not been able to understand the various attitudes of the Japanese food processors toward U. S. soybeans. However, preliminary reports received in this country have shown clearly that the position taken by many Japanese food processors is restricting U. S. exports. A determined effort to clarify this problem was initiated in July 1956.

Under an agreement with the Foreign Agriculture Service of the U. S. Department of Agriculture, the American Soybean Association (ASA) was given the responsibility of conducting an extended soybean marketing

THRESHING MACHINES FOR SMALL GRAIN AND SOYBEANS

Figure 1.-- Drying soybeans before threshing.

Figure 2.-- Monually operated threshing machine

Figure 3.-- Power operated threshing machine.

program in Japan. To carry on the program the American Soybean Association organized the Japanese-American Soybean Institute in Tokyo with Mr. Shizuka Hayashi as managing director. The Japanese part of the Institute membership is made up from the various associations of oil-mill processors; tofu, miso, and shoyu processors; and the soybean importers-exporters. The technical investigation reported here is a part of this overall program. Mr. Hayashi and many members of the Institute gave generous assistance to the writer in obtaining the information contained in this report.

There is a wide difference between farming practices in Japan and in the United States. Farms in Japan are very small, averaging about 2.5 acres in size. Cultivation of the land is mostly with hand tools although power equipment comparable to that used by home gardeners in the U. S. is being developed.

For harvesting grain the farmer, kneeling on one knee, uses a small one-hand scythe. The grain is tied in bundles and dried on wooden racks before threshing. Drying soybeans for threshing is shown in Figure 1. Drying rice and the equipment used for threshing rice and soybeans are shown in Figures 2 and 3. The beans are stored and marketed in bags made of rice straw. (Figure 6 shows small-sized equipment for weaving straw.) This type of operation produces clean and very few broken soybeans.

As Japanese farmers supply only clean soybeans to the market, the Japanese grading standards are quite different from those used in the U. S. Most Japanese food processors are unfamiliar with farming and marketing practices in the U. S. and do not know why imported soybeans contain foreign material and split and broken beans. There is a similar lack of information among U. S. soybean people about Japanese requirements. This lack of information concerning each other's customs and practices may sometimes lead to gross misunderstanding and even to suspicion of the good intentions of the other party. The present program of the Japanese-American Soybean Institute has among its aims the exchange of information between the two countries and the clearing away of existing misconceptions. The promotion of mutual understanding of farming and marketing customs, processing requirements, and economic background is an important factor in the solution of existing problems.

Since Japan needs more soybeans to supply present and future requirements, the investigation reported here was undertaken to find out why Japanese food processors prefer domestic beans, in many of their processes, to United States soybeans. A further objective was to make recommendations for research and development work which will overcome major objections expressed about using U. S. soybeans. Specific research recommendations have been proposed in a separate report.

Because of the shortage of protein for food, feed, and industrial uses in Japan, as well as throughout much of the world, there is a good possibility of greatly extending our export market for soybeans. The market price of United States soybeans under most conditions is low enough to meet competition from other sources. Our beans, for example, are delivered to Japanese processors at a lower price than their own beans. However, even though all the requirements of the Japanese soybean processors are met, soybean exports fall within the plans of the Japanese government for imports and for the use of foreign exchange. This situation may limit Japan's imports.

The United States grows more than half of the total world supply of soybeans. Average annual production in the United States in bushels from 1940 to 1958 is shown in Figure 4. The total exports of soybeans from the United States in 1957 according to present estimates are expected to be about 95 million bushels or 20 percent of the 1956 crop. About 25 million bushels will be sent to Japan, which makes her our largest single customer.

Solving the food- and industrial-use problems in Japan may be expected to have a beneficial effect on our export program to other countries too. Furthermore, soybeans are a replacement for our surplus crops; agricultural statistics for 1956 show that soybeans have replaced more than 21 million acres of other harvested crops in soybean-growing areas. Thus, extension of the export market will be a substantial benefit to the U. S. economy, particularly to the American farmer.

PROBLEMS OF JAPANESE FOOD PROCESSORS IN USING UNITED STATES SOYBEANS

Food Production Problems

The information for making this report was obtained during a 2-month visit to Japan. Visited were soybean food-processing plants, government and independent research laboratories, and universities engaged in work on soybeans. Research investigations and industrial experiences in using soybeans as a source of food protein were discussed. Many food-processing plants were visited and details of their processing methods were observed. Definitions of the Japanese foods reviewed in this report appear on page iii.

The principal foods prepared from soybeans in Japan are miso, fresh tofu, frozen tofu, aburage, shoyu, monosodium glutamate, and natto. Somewhat less important foods are kinako, hamanatto, soybean sprouts, and yuba. There also is localized small-scale production of many different soy products which will not be considered in this report. At present, there is no commercial production of soybean "milk," but research on this product is in progress. Fresh tofu, frozen tofu, aburage, kinako, yuba, soybean sprouts, and hamanatto are products containing high oil, as well as protein. There is no report on shoyu

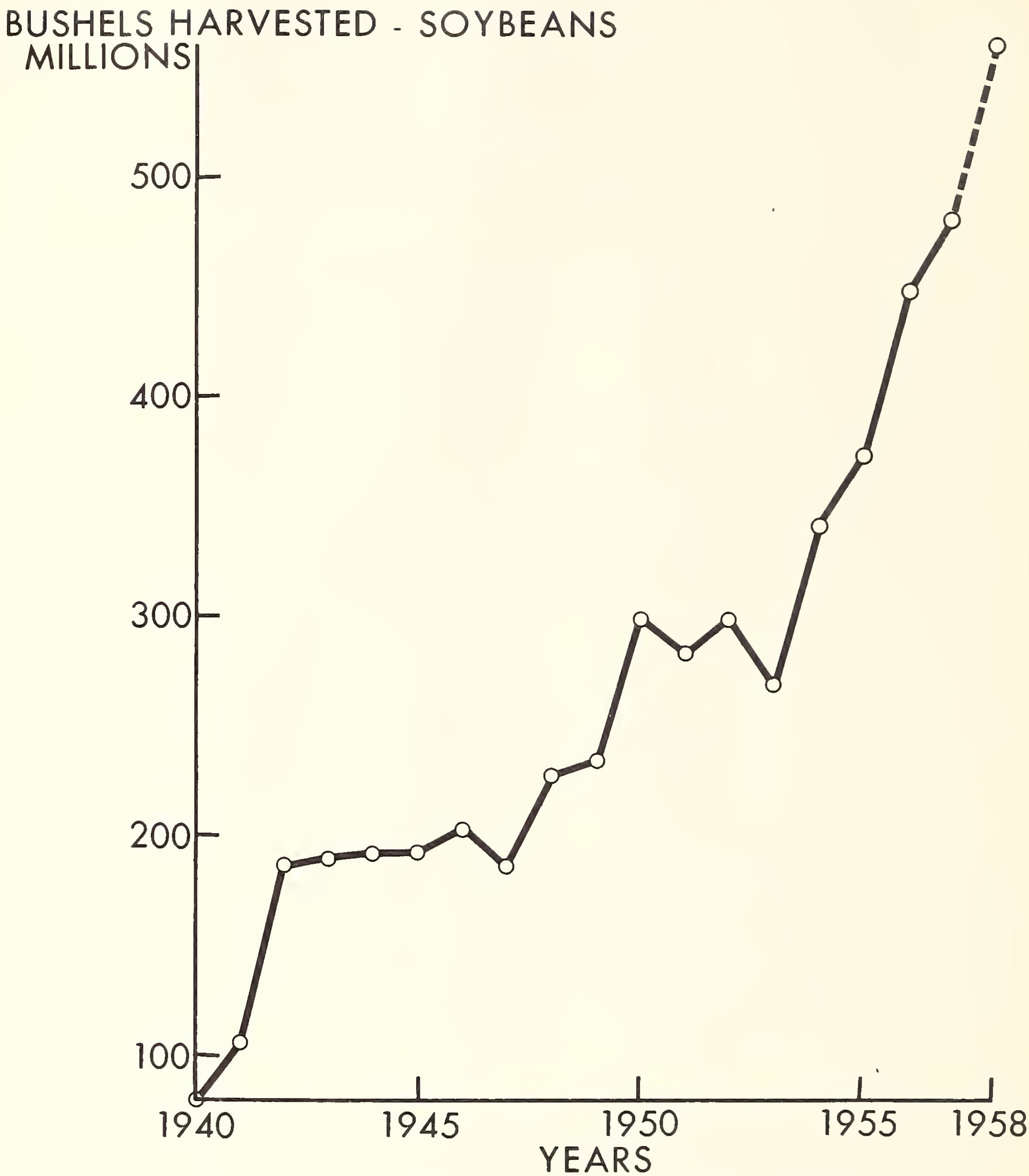


Figure 4.-- Soybean production in the U.S. in bushels from 1940 to 1958

and monosodium glutamate, as defatted soybean meal is used to a greater extent than the whole soybean in their production. U. S. soybeans are the principal source of the defatted meal.

The problems mentioned by some food processors in using United States soybeans in Japanese foods are not particularly unique. Omitting consideration of supply and cost factors, selection of foods by the consuming public depends largely on food habits and tastes. A processor tries to satisfy these habits and tastes and hopes to do a better job than his competitors. The practical soybean food problems in Japan are essentially the same as food problems in other advanced countries, that is to say, food processors are concerned with adjusting appearance, flavor, consistency, and texture of their products to satisfy the customers at the lowest possible cost.

In addition to problems which have to do with the quality of the finished food products, there are other problems that may be referred to as processing problems. These are concerned with removal of foreign matter, split and broken beans, rate of water absorption, rate of cooking, rate of fermentation, uniformity in size of beans, and age of beans.

All of these are recognized as valid problems in the present investigation, but they vary widely in significance in processing of soybeans into food products. However, they all require serious consideration in a project designed to increase the use of U. S. soybeans in Japan.

Foreign Material, Broken and Dark-Colored Soybeans in Exports

According to Official U. S. Grain Standards, soybeans (and other grains) are permitted to contain a limited amount of foreign material and broken and dark-colored beans. These standards appear reasonably satisfactory for U. S. grain handlers and processors but they have not been as satisfactory in the export market to Japan. For some years the Japanese have been criticizing U. S. grading standards for soybeans as they apply to Japanese requirements. Thus, incidental to the investigation of food utilization and processing problems described above, a review of the problem of foreign matter in U. S. soybeans was made, and a brief report of the results is included here.

Foreign matter by its nature is objectionable to all soybean users. It is most objectionable to the soybean food processor because it must be entirely removed from food. Foreign matter is unrelated to the natural quality of soybeans, but it plays an important role in marketing.

Broken and dark-colored soybeans are not particularly objectionable to oil-mill processors who sell their meal for animal feeds, but such material must be removed from foods. Even edible grain such as corn, oats, and black soybeans are objectionable to food processors because these appear as foreign bodies and detract from the appearance of their food products.

In the U. S., soybeans for export are usually sold on the basis of No. 2 grade. Official grain standards of the United States for No. 2 allow a minimum test weight of 54 pounds per bushel, a maximum of 14 percent moisture, 20 percent splits, 3 percent total damaged kernels including 0.5 percent heat damaged, 2 percent foreign matter, and 2 percent brown, black, or bicolored soybeans. Foreign matter is defined to include broken soybeans which pass readily through an 8/64-inch sieve and all matter other than soybeans which passes through or remains on the 8/64 sieve.

Foreign matter in U. S. soybeans, which includes other grain, results from mechanical harvesting. Split and broken beans result mostly from mechanical methods of handling; the extra handling for export further increases the splits and broken-bean fractions. U. S. soybeans have a lower moisture content than Japanese soybeans and the brittleness resulting from loss of water increases the tendency to split and break.

U. S. soybeans are severely criticized by all Japanese processors for the undesirable material they contain and are at a serious disadvantage in this respect. Weed seed, especially morning-glory seed, corn, small stones, and pieces of metal were cited as specially objectionable. In food processes where the whole soybean is soaked in water and cooked with steam, as in the preliminary treatment for fermentation of miso, the split and broken beans absorb water and cook more rapidly than whole beans; and a nonuniform product is obtained. Processes that ferment intact whole beans are natto and hamanatto, where in addition to water absorption and cooking problems the appearance of splits and broken beans in the final product is not favorably received; also the split and broken beans do not ferment at the same rate as whole beans. The small food processor does not have mechanical seed-cleaning equipment and claims that he cannot afford to buy it, although such equipment is available on the Japanese market. A small-scale commercial seed cleaner and grader is shown in Figure 5.

It was reported that in bulk handling of beans in export, the foreign matter tends to sift to the bottom of the ship's hold. Since a shipment of soybeans may be divided among a number of soybean processors, those receiving beans from the bottom of the hold may receive more than their share of foreign matter. Although the buyers always attempt to divide each shipment in a fair manner, this added problem of concentration of foreign matter, split and broken beans during shipment, needs correction. Perhaps the best solution to this problem would be a further overall reduction of foreign materials.

The oil-mill operators object to foreign matter, splits, and broken beans also, but these are not so serious for them as for the small food processors. The large operators have rather elaborate seed-cleaning equipment and they do a good job of cleaning, which is necessary as most of their meal as well as their oil goes into food industries. The low moisture in U. S. soybeans is a decided economic advantage to the oil processor, since he is buying less water; and splits process as well as whole beans.

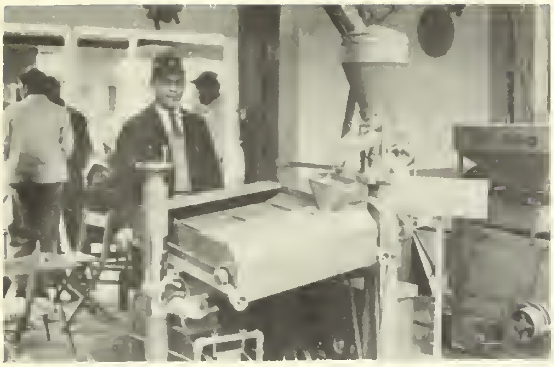


Figure 5.-- Modern small-scale equipment for cleaning soybeans and grading for size.

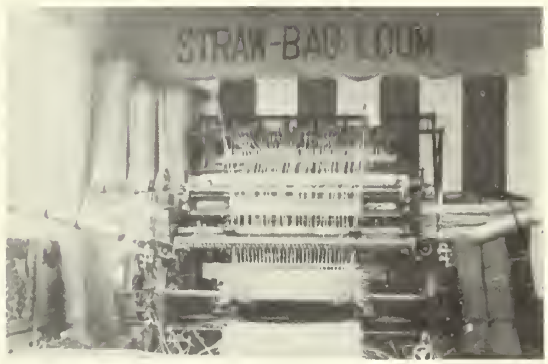


Figure 6.-- Straw weaving equipment; straw bags are used for soybeans, rice, and other farm products.

Figure 7.-- Cooling roasted soybeans and hand cleaning for making kinaka.

Since the problem of foreign matter, splits, and dark-colored beans is a complaint made by all Japanese processors, and since this type of problem is always a contention between seller and buyer, there needs to be a complete investigation which will follow the beans from the combine on the farm to unloading docks in Japan, or perhaps even to the food processor. This investigation should determine in detail:

1. The factors which permit foreign matter and splits to get into soybeans.

2. Where and how foreign matter and splits can be reduced to a minimum most economically in the movement of beans from farms of the United States to markets in Japan.

The factors affecting the reduction of foreign matter and splits, the possibility of introducing a special grade for export, or of shipping soybeans as "identity preserved," need more exact evaluation before recommendations can be made for further improvements. Many soybeans on arrival in Japan are unloaded from ships to barges for transfer to oil mills located along the rivers and harbors. This system does not appear to be very efficient and a study of the unloading and distribution system should be made. These studies may lead to a relatively inexpensive system of cleaning and grading United States soybeans at the Japanese docks prior to distribution to food processors.

ANALYSIS OF THE PROBLEMS

Problems reported by some Japanese food processors for U. S. soybeans are given in the preceding section. Although there are not available many research data that bear directly on solving these problems, the accumulation of information from other areas of research on soybeans suggests a partial explanation of these difficulties and indicates the type of research that might be expected to improve the use of United States soybeans in Japanese foods.

From the information available it was tentatively concluded that the differences in processing behavior of Japanese and United States soybeans in Japanese foods can be attributed to three possible causes: (1) Differences in character of the seedcoats of soybeans, (2) differences in hardness and density of soybeans, and (3) differences in oil content (to some degree). There is no reason for believing there is any significant difference in nutritional value of food products which can be attributed to the source of the beans. The manufacturing or processing methods may be expected to modify nutritional value more than the origin of the soybeans.

Japan and the United States grow many varieties of soybeans in different soils and in a wide range of climatic conditions; these factors are known to influence composition and properties of soybeans. Hence, it should not be expected that all soybean varieties, either Japanese or American, would process in exactly the same manner or give identical food products. To cite a well-known example in another field, wheat varieties are famous for differences in their milling characteristics and baking properties of their flours. Although there are no indications that varietal differences of soybeans are of the same order of magnitude or are as important in food processing as in wheat utilization, nevertheless, small differences are apparent. In this report varietal differences between American and Japanese soybeans are credited with many of the problems encountered in the use of American beans in Japanese foods.

An ideal soybean for making Japanese foods such as miso, tofu, natto, and other products would have (1) a seedcoat with a very light yellow color and preferably white if such were possible, (2) a very light yellow or white hilum, (3) a very thin and glossy seedcoat, (4) a high percentage of protein, (5) the property to absorb water and cook very rapidly, and (6) uniform size. The first three of these desirable properties reside in the seedcoat; the fourth is a compositional factor; the fifth appears to reside in the physical structure of the bean and perhaps is influenced by loss of moisture after harvest. The first five of these properties may be modified to a certain degree through breeding; the problem of uniform size, however, will depend partly on climatic conditions during the period when the pods are filling. Uniformity in size may be improved by grading and selecting uniform seed for planting.

In contrast to Japanese soybeans some U. S. varieties are reported to have a thick seedcoat. This thickness is an advantage in mechanical harvesting because it protects the seed from splitting and shattering. Seedcoats of U. S. soybeans are often rather rough and the hilum may be black, brown, or yellow. The differences between soybeans with dark- and light-colored hila are shown in Figure 8. This photograph shows two U. S. soybean varieties with black hila and one Japanese with a white hilum; beans having extreme differences were selected for making this illustration. The seedcoats of U. S. varieties vary somewhat in color, and those with dark-colored pigments have the most effect on the color of the products in which they are used. It was reported by some processors that United States beans are slower to absorb water, to soften in cooking kettles, and to ferment than Japanese beans. If cooking time is increased to obtain the desired softness, the color of the final product is darkened and the rate of fermentation is reduced. It is believed that the rate of cooking and fermentation may be closely related to physical structure of the soybean. U. S. soybeans usually contain less moisture than Japanese beans; the lower moisture content along with a higher oil content may result in the formation of a harder and more compact structure of the embryo, which would have slower water-absorbing and cooking properties. The size of the bean also has a marked influence on the rate of water absorption; large beans absorb water at an overall slower rate than small beans.

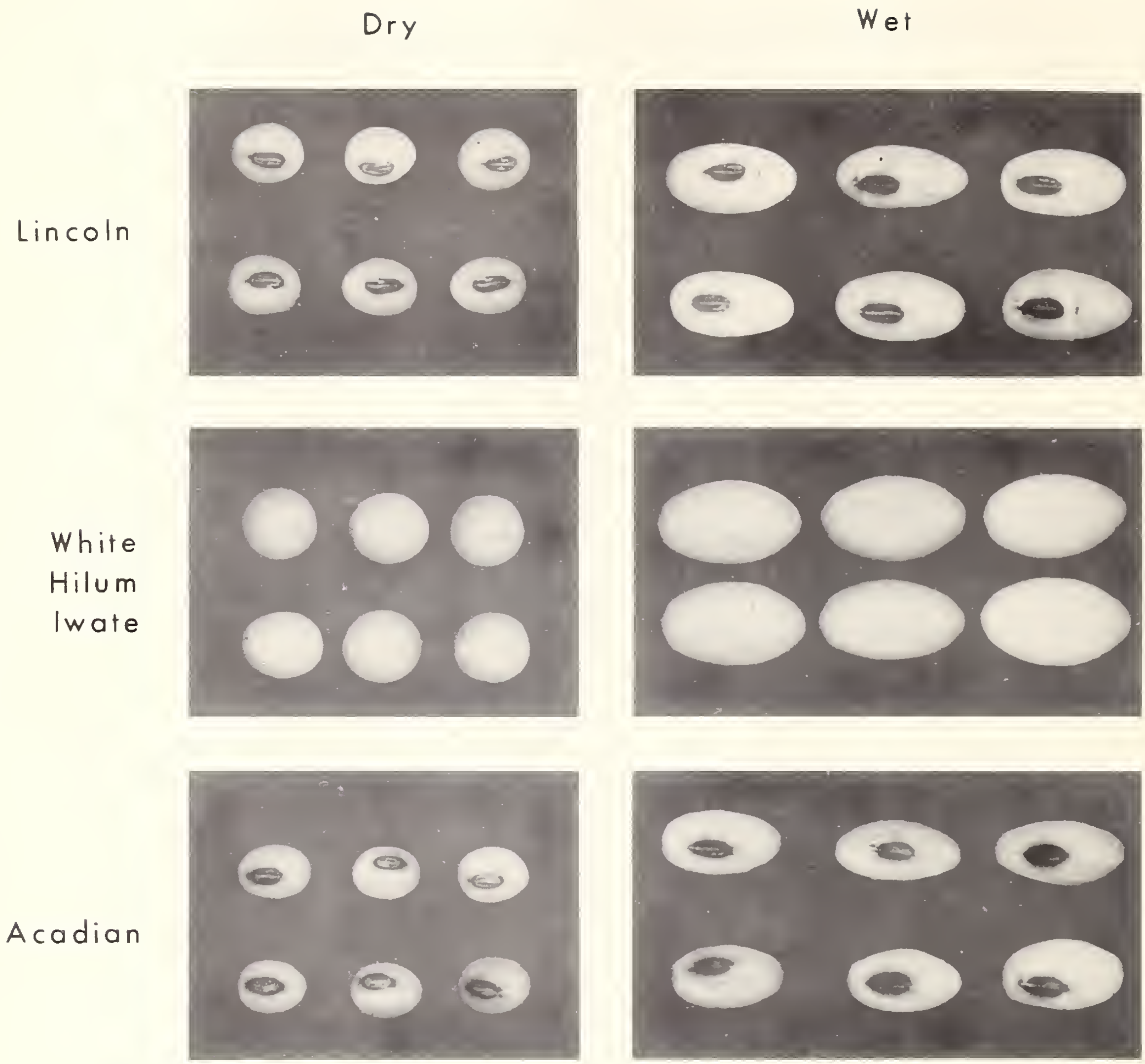


Figure 8.--Soybean varieties. Lincoln and Acadian with black hila and White Hilum Iwate with white hilum.

As is well known, soybeans were originally introduced to America from the Orient. For the past 25 years the U. S. soybean breeding and improvement program has been planned and developed partly to satisfy the needs of the U. S. soybean processors' desire for oil and in this respect the program has been highly successful. The development of soybean varieties suitable for food uses has not been included in the breeding program. Now we are finding that other countries want and need our soybeans for food and that it is to our advantage to supply this market; thus new problems have been created.

The farmers of the United States grow approximately 35 different types of soybeans which have rather wide differences in size and appearance and have some differences in composition. Because of the extensive, plant-breeding program, the varieties selected for production are constantly changing. Plant breeders are developing new types for (1) higher yields, (2) higher oil content, (3) greater resistance to shattering when harvested with a combine, (4) minimum lodging, and (5) greater disease resistance. In contrast, Japanese soybean breeders are reported as developing new types for (1) higher yields, (2) increased bean size, (3) obtaining a white hilum and a light-colored, smooth seedcoat, and (4) greater disease resistance.

Soybean utilization in the United States is considerably different from that in the Orient. Essentially all soybeans (excepting those reserved for seed) are processed for oil and meal. The oil goes into food and industrial uses in the approximate ratio of 85 to 15 percent. More than 93 percent of the meal goes into animal feeds. There has been only limited interest in the use of soybean protein for human food. However, even with this limited effort, U. S. soybeans and soybean protein are used successfully in many foods in Japan as well as in the United States and other countries.

A research and development program on food problems would be expected to lead to new and improved processing methods which would overcome existing problems and aid in extending utilization of U. S. soybeans in food products.

RESEARCH PROPOSALS

From this survey two different approaches are suggested for increasing the use of United States soybeans in Japanese food products: (1) To supply a selected variety or varieties of U. S. soybeans comparable in food uses to their own beans, and (2) to modify Japanese food processing methods so that soybeans from the United States can be used to give equally as good products as beans grown in Japan.

Under present methods of marketing and exporting soybeans, solution of Japanese problems by selecting a particular variety for export would be difficult. Such a procedure would certainly make a substantial increase in the export price; but the increased cost of effort would be reduced as the number of soybean varieties suitable for food and industrial utilization is increased by our plant-breeding program. The selection method then would not be difficult. This proposal is not inconsistent with our own changing domestic needs.

Food and industrial uses of soybeans in the United States are increasing each year and our own interest, coupled with an expanding export market for food protein, suggests that our breeding program should give serious consideration to properties of soybeans which make them better adapted for foods and industrial utilization.

Such a program would also be consistent with the present trend in processing soybeans for feed use. At present more than 60 percent of domestic soybeans processed for meal are consumed by the poultry industry. This market requires a high protein meal (50 percent), which is obtained by removing the hulls and which eliminates also half or possibly more than half of the fiber. Because swine feeders also prefer dehulled meal, most processors believe that eventually all soybean meal will be dehulled. Hulls do not make a known contribution to the feed or food value of meal used for poultry, swine, or humans. Since there is no practical use for a possible 500,000 tons or more of unwanted hulls, development of new varieties of soybeans with a lower proportion of hulls would be favored by soybean processors both at home and abroad.

A plant-breeding program aimed at modifying the hull and other properties of soybeans will require considerable time; for this reason it is believed that the other approach, which is to modify the methods used in food processing, holds more immediate and perhaps greater promise for increasing the use of U. S. soybeans in Japan. Modification and improvement of processing methods would be expected not only to eliminate the differences between United States and Japanese soybeans, but also to improve the quality of the final product and to reduce production costs.

Proposed changes in processing methods for miso and for fresh and frozen tofu would start with removing the most objectional feature of the soybeans, namely the hulls. Methods for cracking soybeans into grits and removing the hulls by aspiration and screening are well established. Grits would be ground directly to make tofu, but to make miso they would be converted into coarse flakes for cooking and subsequent mixing with rice koji for fermentation. Flaking the grits between smooth rolls will crush the cell structure and permit a rapid diffusion of water through the meal. It is believed that crushing the seed should overcome any structural differences that may occur between variety or source of beans. With a thinner and more porous system it is anticipated that the cooking time will be shortened and that even an increase in rate of enzyme activity can be expected.

This procedure of removing hulls eliminates the soaking of the whole beans in water as in present procedures. It also eliminates any benefits which may arise from soaking, but there are no known benefits except the diffusion of water into the beans preparatory for cooking, thereby reducing the cooking time. It should be possible to cook soybean flakes with steam without preliminary soaking.

It is recommended that studies be conducted on factors which determine the rate of miso fermentation. These studies would include time of cooking, moisture level, optimum pH and temperature, salt concentration, selection of the most suitable organism for koji preparation (*Aspergillus oryzae*), and any other factors known to influence the rate of activity of fermenting organisms. Miso is produced in relatively large plants; many of them have an output of 10 tons or more per day capacity. There is a trend toward modernization in these plants, and many processors appear to be receptive to adoption of more modern methods.

Removal of the seedcoat will increase the protein content of the paste and eliminate a fraction of the soybean that is probably without significant nutritional value as a human food; further, it should improve the texture, color, and possibly the flavor of food products. These possibilities of improving the use of United States soybeans for making Japanese foods, as well as improving their quality and lowering the cost of production, are justification for a substantial research program. Removing the seedcoat is a rather drastic modification in processing both tofu and miso and will require research on cooking, some modification of equipment, and other additional steps in these processes.

Five of the important Japanese soybean food products are described in further detail, including manner used, conventional processing methods, and compositional data. This information should further assist in visualizing the state of the soybean food industry in Japan and in evaluating the proposed research program.

MISO

Miso, said to have been eaten in Japan for about two thousand years, is a fermented product made from soybeans and rice or some other cereal grain. The importance of miso in the Japanese diet may depend as much on flavor qualities as on nutritional value. Its nutritional value is dependent mostly on its nitrogen content of about 12 percent. The counterpart of miso in China is known as soybean paste, although miso has a greater importance for the Japanese than soybean paste has for the Chinese people.

Miso is produced in various colors from nearly white to a very dark shade; they commonly are known as white, red, and black miso. The flavor resembles soy sauce but, because of a lower salt concentration, miso can be eaten in larger quantities. Average per capita consumption in Japan is estimated at 35 grams per day.

The variety of flavors and colors of miso are derived by varying the proportion of soybeans with other cereals and by varying the time and temperature of fermentation. Miso production is usually on a local basis and there is only limited transportation of miso from one part

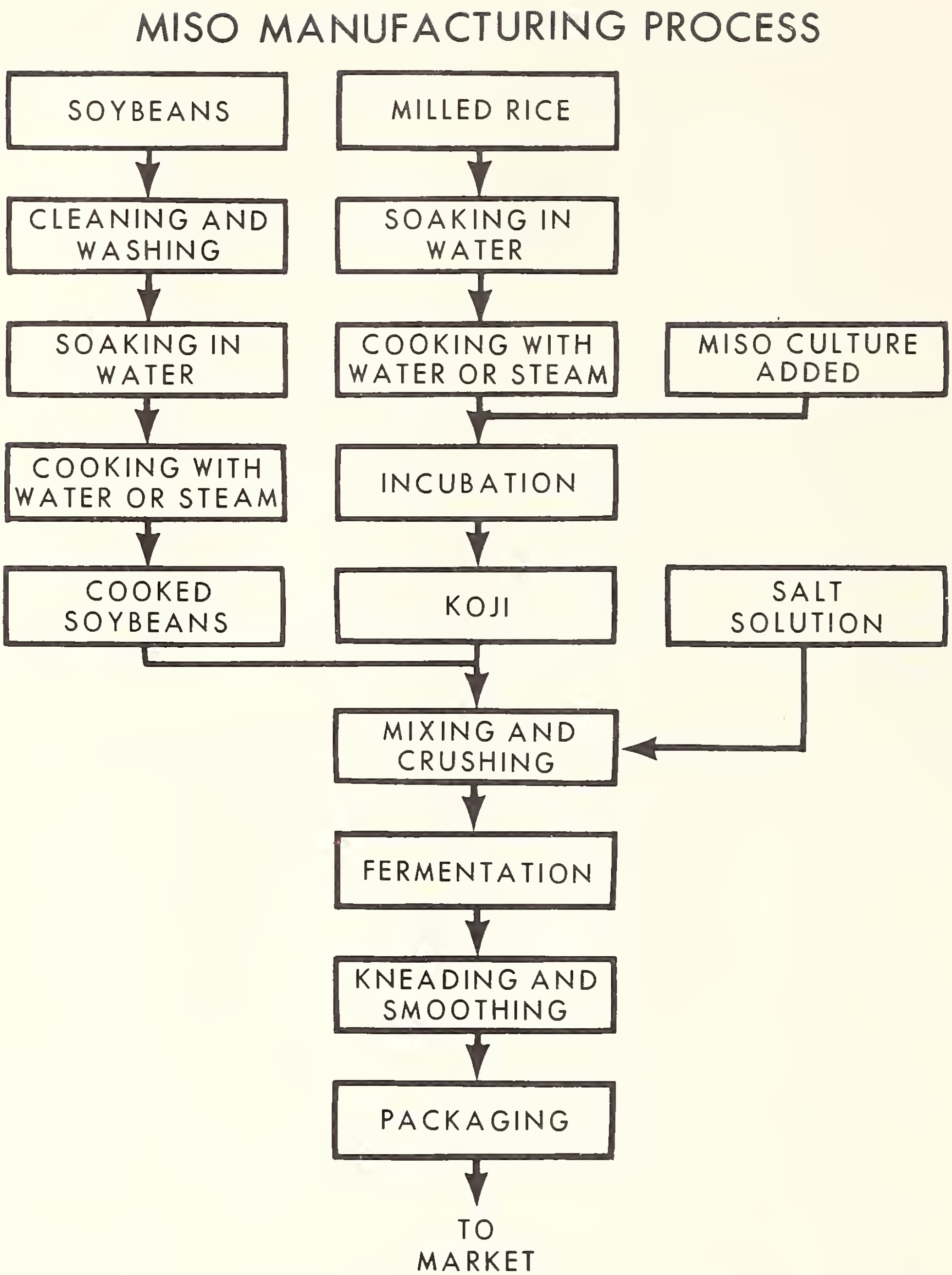


Figure 9.-- Flow diagram for miso production.

of Japan to another. This probably explains the many variations in color and flavor. Each processor claims to process miso to the taste of his customers.

White miso contains more rice than soybeans whereas the darker brands contain 50 percent to 90 percent soybeans. Cheaper grades of miso are made by replacing various amounts of whole soybeans with defatted meal. The true miso flavor is thought to be contributed entirely by the soybeans whereas the rice contributes sweetness. White miso is made with a low concentration of salt to permit rapid fermentation, and the process is completed in about 2 weeks. However, white miso has a serious handicap because it keeps sweet only a short time.

The darker grades of miso, containing a high concentration of salt, require fermentation periods from 3 to 12 months; they can then be preserved without refrigeration for several months. Salt stops the growth and development of undesirable microorganisms. Fermentation in most factories is at a controlled temperature of 38° to 40° C. Miso fermented at the prevailing temperature of the locality in which it is made is called "natural miso." Production of natural miso requires at least one complete summer season since little fermentation occurs during the winter.

Processing

Miso is still produced to a considerable extent in farm homes where the farmer uses his own bean supply. However, throughout Japan the manufacture of miso in factories having a capacity up to 10 tons per day has become an important industry. According to the All Japan Miso Industrial Association, there are approximately 5,000 miso plants in Japan. Figure 9 is a flow diagram of the miso manufacturing process.

Most miso processors are very particular about removing all foreign matter from their beans; the larger factories have mechanical equipment, but frequently this is supplemented by some hand cleaning. Some plants have seed polishing equipment to remove the rough surface of the seedcoat. After cleaning, the beans are washed and soaked in water. The soaking period varies with the temperature but is usually about 8 hours during summer months. The beans are cooked, usually with live steam, and then mixed with rice koji.

Koji is made from polished rice, which is washed, soaked in water, and cooked with steam. This cooked rice is inoculated with seed spores of *Aspergillus oryzae* and placed in small wooden trays about 30 x 15 x 2 inches. The trays are placed in a warm humid room for 48 hours or longer; most processors mix the rice koji once or twice during its preparation.

The finished koji and cooked soybeans are mixed together with considerable crushing of the beans, and a salt solution is added. This mixture is placed in large wooden tubs shown in Figure 10 for fermentation. When fermentation is completed, miso is packaged for market in smaller wooden tubs (Figure 11). Hand assembly of the market-size tubs is shown in Figure 12.

Yield data were difficult to obtain, but one processor claimed to make 45 tons of miso from 10 tons of soybeans, 5 tons of rice, and an estimated 4.5 tons of salt. The shortest fermentation period disclosed, except for white miso, was 45 days.

The writer made a brief visit, while in Nagano, to a miso exhibit, where the various brewers of Nagano Prefecture compared their products. The contest judge explained that he graded miso on three factors--60 percent taste, 20 percent color, and 20 percent odor.

Uses

More than 20 percent of all soybeans used in Japan are consumed in miso. Miso does not require much cooking. It is sold in the range of 9 to 13 cents per pound. It is said to be the most commonly used food in Japan, next to rice. In most Japanese families, whether they are rich or poor, breakfast consists of rice and miso soup containing vegetables or seaweed, or both. Breakfast for the more wealthy families may include other types of food. Miso is also used in other meals, where it appears again as soup with varied ingredients such as tofu, shellfish, fish, or meat.

Miso is combined with other flavors such as vinegar and/or sugar to serve as a dressing for fish, vegetables, tofu, beef, pork, and poultry. Radishes and other vegetables are pickled for preservation in miso. Miso soup is used sometimes as a weaning food for babies. In the cities which are influenced by Occidental tastes miso producers have attempted to introduce new recipes such as miso salad dressings, miso stew, and miso-mixed griddlecakes. So far these new foods have not attained much popularity.

Production

Production of homemade miso was reported by the All Japan Miso Industrial Association to be about 391,000 metric tons and factory-made miso 583,000 metric tons. The amount of various materials used in factory miso production and production of the various types as reported by the Japanese Association are shown in the following tabulation in metric tons (M.T.).

Figure 10.-- Wooden vats used for fermenting miso.

Figure 11.--- Miso ready for market

Figure 12.-- Hand assembly of wooden tubs for shipping miso and shoyu.

Type of miso	Annual production	Amount used of- Soybeans	Rice	Barley	Salt
	M.T.	M.T.	M.T.	M.T.	M.T.
Factory-made					
Rice miso	379,000	134,000	72,000	-	58,000
Barley miso	146,000	52,000	-	30,000	22,000
Soybean miso	58,000	32,000	-	-	9,000
Total	583,000	218,000	72,000	30,000	89,000
Homemade					
Miso of all types	391,000	143,000	43,000	28,000	70,000
GRAND TOTAL	974,000	361,000	115,000	58,000	159,000

According to these data a total of 13 million bushels of soybeans are used in making miso, of which 8 million bushels are used in factory production.

Composition

The composition of miso varies with the ratio of soybeans and cereals used for its production. An analysis of various types of miso has been taken from literature published by the All Japan Miso Industrial Association.

Type of miso	Composition: Water	Total nitrogen	Crude protein	Crude fat	Carbo-hydrate	Crude fiber
	%	%	%	%	%	%
Rice	50.80	2.016	12.60	4.46	16.70	1.80
Barley	51.34	1.360	8.50	4.24	18.74	2.10
Soybean (90%)	47.02	3.710	23.19	10.63	4.10	2.93

Other data comparing the composition of sweet, salty, and enriched miso were obtained from the same literature source.

Food Composition of Miso

Item	Sweet miso	Salty miso	Enriched miso
Calories (cal.)	179	155	
Water (gm.)	49.0	51.0	
Protein (gm.)	10.0	12.0	
Fat (gm.)	1.7	3.4	
Sugar (gm.)	30.8	18.4	
Fiber (gm.)	1.0	1.8	
Ash (gm.)	7.5	12.8	
Calcium as Ca (mg.)	81	110	+200 ~ 400
Phosphorus as P (mg.)	180	200	
Iron as Fe (mg.)	3.6	6.6	
Vitamins			
A (I. U.)	0	0	+1,800~2,000
B_1 (mg.)	0.05	0.03	1.3 ~ 2.0
B_2 (mg.)	0.10	0.10	1.3 ~ 2.5
Niacin (mg.)	1.5	1.5	
C (mg.)	0	0	
Common salt (NaCl) (gm.)	7	12	

TOFU AND ITS MODIFICATIONS

Tofu, also known as soybean curd, is made from the water-soluble protein of the soybean; tofu also contains oil in proportion to the amount of protein extracted. A typical analysis of tofu is 88 percent water, 6.0 percent protein, and 3.5 percent fat.

Tofu is produced in many forms, although so-called "fresh tofu" is used in the largest amount and is also the starting point for all other types. Fresh tofu is usually made in very small plants which process from 100 to 300 pounds of beans daily. The Japan Tofu Association reports a membership of around 40,000 with another 10,000 known nonmembers. Since fresh tofu can be preserved only a few days without refrigeration, it is sold the same day it is manufactured, as the common people do not have refrigeration. Work in a tofu factory may start as early as 3 a. m. in order to complete the day's operation early enough in the afternoon to provide time for distribution the same day it is made.

The small-scale methods used in making fresh tofu require a tremendous amount of hand labor per unit of product, and the manufacture of tofu does not appear to be a highly remunerative occupation.

Fresh tofu is further processed into frozen tofu, aburage, nama-age, satsumage, yaki dofu, and other foods. Fresh and frozen tofu and aburage, the most important foods on this list, are the only ones discussed in this report.

Processing Fresh Tofu

Problems in making fresh tofu are: (1) Foreign matter, (2) color, (3) cohesiveness of the tofu cake, (4) flavor, (5) coagulation of the curd into a gelatinous state with calcium salts, (6) handling of the curd to prevent destruction of its gelatinous condition, and (7) mechanical and engineering improvements to reduce labor costs.

A layout of a present-day tofu factory is shown in Figure 13. Figures 14 and 15 show the grinding, heating, and filtering equipment used in a tofu factory. In this process, clean whole soybeans are soaked in water for several hours and ground while wet. The mill is usually of a rotating stone type, shown in Figure 14. The wet mash is transferred to a cooking vessel where it is cooked for a few minutes with live steam. Water is added in the desired ratio and the resulting "milk" separated from the residue with cloth filters. The first filter is a coarsely woven bag (Figure 13, No. 4); the second filtration (No. 5) is also through coarse cloth as the "milk" passes into the coagulating tank. After the second filtration and while the "milk" is at about 60° C., the curd is precipitated by adding a predetermined amount of calcium salts. The curd is permitted to settle for several minutes and about half of the supernatant solution is removed with a dipper. The curd is then poured into rectangular filter boxes which are lined with filter cloth (No. 6). The curd is pressed with weights adjusted by hand. After pressing of the curd, the boxes containing the tofu are lowered by hand into a washing tank (No. 7) and the cakes of tofu are removed by inverting the boxes. After a period of soaking in water, the tofu is removed from the tanks and sliced into cubes of a standard size for the market.

The heat applied in removing the beany flavor from the soybean "milk" must be carefully controlled because it modifies the protein in respect to cohesiveness, water-holding capacity, and other properties. Coagulated tofu has a very delicate structure and must be handled carefully until it has been filtered and pressed.

The color problem in using United States soybeans appears mainly to derive from the seedcoat. This may not be the only source of the color difficulty, as pigments in the embryo including the oil may contribute to color. Here, as in the processing of miso, research needs to be undertaken to develop a process using dehulled soybeans. Removing hulls will eliminate presoaking of the whole bean. The grits obtained in dehulling can be ground wet or converted into flakes for extraction of the soybean "milk." The use of a centrifuge for removing insoluble residues would permit withholding the steam

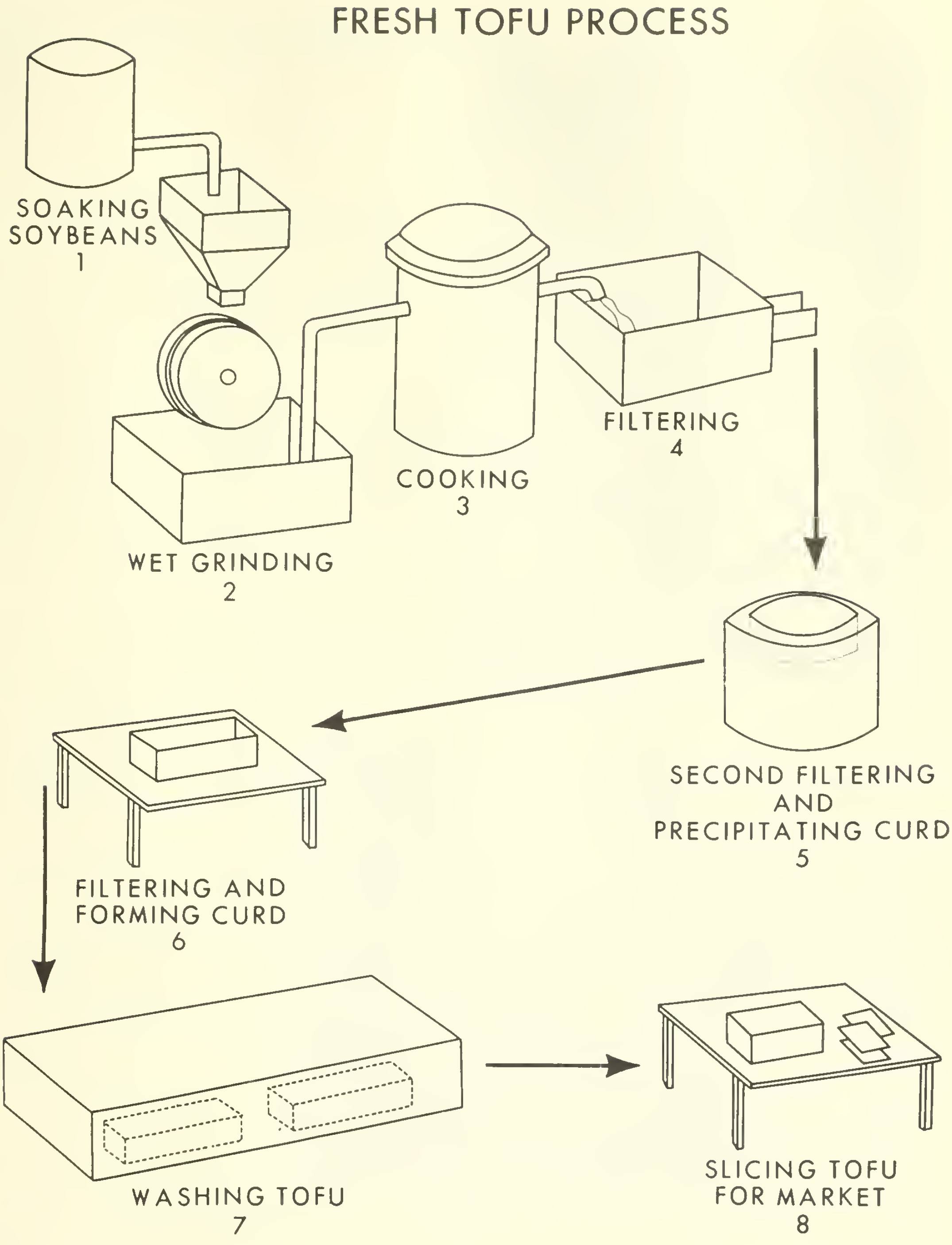


Figure 13 -- Diagrammatic sketch of equipment far making fresh tafu.

EQUIPMENT USED IN MAKING TOFU

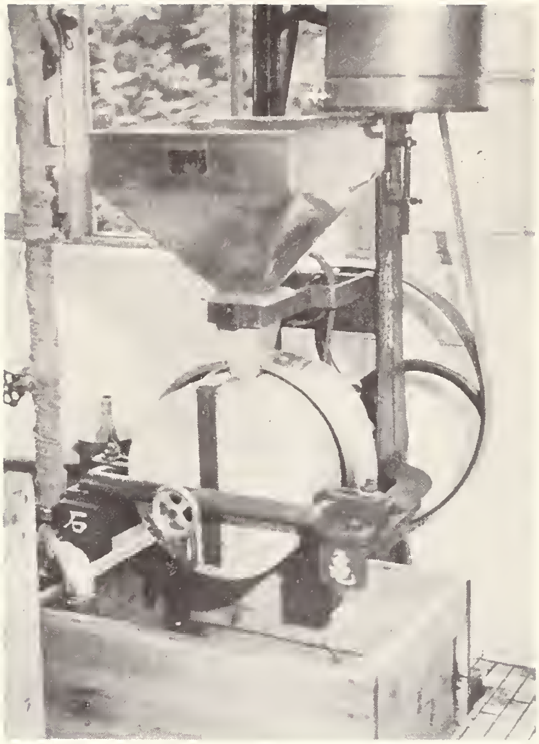
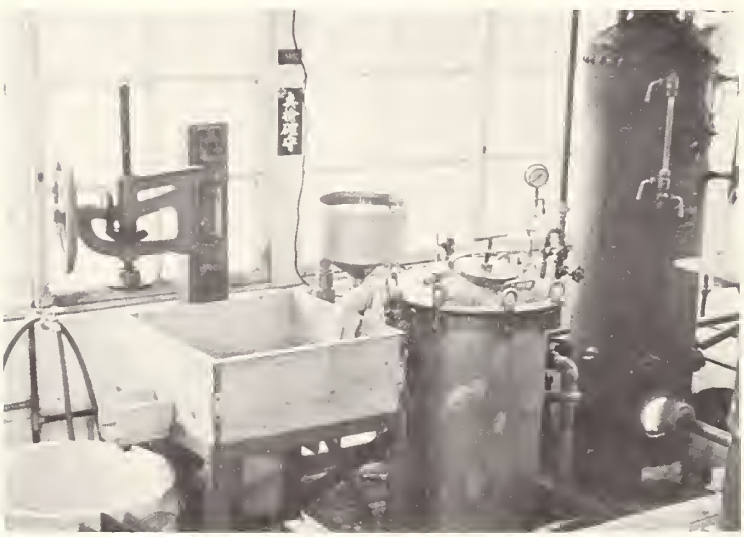


Figure 14.--Stone mill far wet grinding of soybeans.

Figure 15.--Boiler, cooker, filter, and precipitatian vat used in making tafu.



Photagraphs courtsey af Sugiyama chemical Research Institute, Takya

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treatment until after clarification of the "milk." Results of these suggested changes on the nature of tofu need investigation and the overall operation must be adjusted to produce the desired end product.

Processing Frozen Tofu

The name "frozen tofu" is misleading to Americans. It suggests a fresh frozen product, which it is not. Frozen tofu is a dry product that has had its protein modified in processing by heating the "milk," freezing the curd for 3 weeks, drying the curd in a hot-air oven, and finally treating with ammonia. An examination of the diagram (Figure 16) shows that the process starts out by the making of fresh tofu, although frozen tofu does not require a highly gelatinous curd as does fresh tofu. Small cakes of fresh tofu are frozen at about minus 20° C., then are stored for 3 weeks at a higher temperature that maintains the curd in the frozen state at about minus 5° C. At the end of the freezing period the cakes are soaked in water. At this stage they have a very spongy character. The cakes are then partially dewatered in a centrifuge and the remaining water removed in a tunnel drier. The cakes are given a final treatment with gaseous ammonia to increase their water absorbing and swelling properties. The product can be preserved a long time.

There are only a relatively few plants making frozen tofu, but they have large capacities. They are far more advanced mechanically and are otherwise more progressive than the fresh tofu manufacturer as well as many of the other soybean food processors. However, they use a maximum of 20 percent United States soybeans, usually less. These processors claim that U. S. beans reduce the color and luster in frozen tofu and produce an undesirable flavor.

Since frozen tofu can be produced in large-scale operation and since it keeps indefinitely, domestic markets can be expected to increase and another export product perhaps will develop for Japan. The problems of color, luster, and flavor resulting from the use of United States soybeans appear to be solvable. The color and luster problems, and perhaps some of the undesirable flavors, are partly derived from the soybean seedcoat. The present method of separating the extract from the pulp by means of a coarse filter cloth may permit hull fragments and other insoluble parts of the bean to go into the curd. This could be expected to cause the unfavorable effects noted. The proper use of centrifuges in this process would reduce the labor required and at the same time improve the properties of the final product. Improvements in flavor seem possible through better methods of cooking and aerating the extract. There are good reasons for anticipating that the processing of frozen tofu can be modified so as to satisfactorily use 100 percent of United States soybeans.

FROZEN TOFU PROCESS

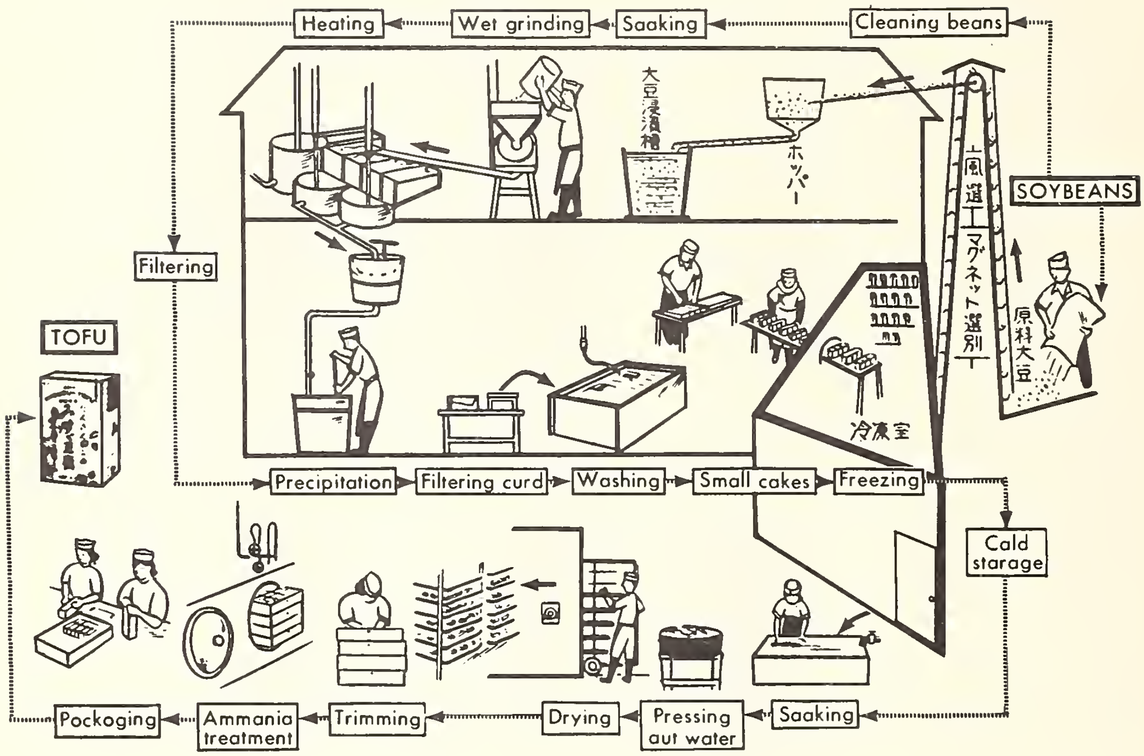

Figure 16.-- Flow diogrom of o frozen tofu factory.

Aburage

Aburage is fresh tofu fried in deep fat. Either rapeseed or soybean oil is used. The operation is shown in Figure 17. Two oil kettles at different temperatures give the best product. The first kettle is at 100° to 110° C. where the tofu is held for 2 to 3 minutes. Then the tofu is removed to the second kettle at 200° to 220° C., where it is held until a golden-brown-colored aburage has developed. Fresh tofu made from whole soybeans contains on a dry basis about 25 to 30 percent oil and double that amount of protein. In deep fat frying, the water content is reduced and the oil content is increased, thus aburage is very rich in oil and protein.

A piece of aburage is about 8 inches long, 3 or 4 inches wide, and three-quarters of an inch thick; it has a rather bland taste and oily feel. The outside has a skinlike formation, and when the cake is cut in two in the middle the cut end of each half is the opening of a sack about 4 inches deep. One way of eating aburage is to fill these sacks with rice.

Aburage is often made from United States soybeans; however, small operators making fresh tofu from other beans may not bother to convert to United States beans when they make aburage. The use of a substantial amount of defatted meal can be used without detriment to aburage, since the deep fat frying determines the color of the product and frying in fat re-adds some of the oil removed in making defatted meal. Also deep fat frying is an excellent method for improving the flavor.

NATTO

Natto is made by fermenting whole soybeans, a process which is said to have originated with the Buddhist monks. Making natto is a simple operation; selected soybeans are cleaned and soaked in water 12 to 20 hours, depending on the temperature, until they have approximately doubled in weight. The beans are cooked at 5 pounds' steam pressure for 12 to 15 minutes or until they can be crushed easily between the fingertips. The beans are then inoculated with *Bacillus subtilis* (*Bacillus natto*) by adding the inoculating culture and tumbling in a barrel until the organisms are well distributed. The beans are wrapped in a paper-thin sheet of pine wood and placed in the fermenting room at 40° to 43° C. for 18 to 20 hours. Each package of natto before fermentation contains about one-third of a pound of beans; during fermentation they lose weight to one quarter of a pound. The fermenting room is heated with charcoal at the start of fermentation, but after a few hours the heat of fermentation may be more than sufficient, and aeration may be required to prevent overheating.

A recent modification of the natto process is to soak the cooked beans for about 1 minute in the steam condensate recovered from cooking. The condensate contains nutritional components for the *B. natto* organism, and a more rapid and superior type of fermentation is obtained. After fermentation is complete some operators circulate air through the natto at room temperature for a day. This treatment retards spoiling. However, without refrigeration natto has a shelf life of only about 1 week. Fresh natto has a noticeable odor of ammonia.

Before pine veneer came into use the cooked beans were wrapped in straw and inoculation with B. natto was unnecessary, as the straw contained the fermenting organism.

Japanese soybeans are favored for making natto and only a very small amount is made from U. S. soybeans. Soybeans for making natto must be exceptionally free of foreign matter; small beans of a uniform size and smooth seedcoat are preferred, as they cook and ferment more uniformly than mixed sizes and they give the finished product a better appearance. Some natto operators claim that U. S. soybeans lack flavor and that a longer fermentation time is required. They claim that removal of foreign matter costs ¥200 per bale of 60 kg., or 6 percent of the cost of the beans.

During fermentation the beans become covered with a viscous, sticky fluid which appears to determine to a large extent the quality of the natto. The fluid has the property of forming long stringy threads when touched with the fingers; the longer the strings the better the quality of the natto.

Natto has a grey color, does not have much odor, but has a strong and rather persistent and somewhat musty flavor. Its flavor would not be acceptable to most Occidental tastes; in fact, many Japanese do not care for natto. Some localities in Japan favor natto more than others. Natto is often used for breakfast and dinner along with rice. Natto may be used as a side dish dressed with mustard. However, natto is a low-cost and highly nutritious food that has an important place among the soybean foods of Japan. Each one-quarter pound package sells for about ¥10. It is a rather well-accepted rule in natto factories to produce 1,000 packages from a 60-kg. bag of soybeans or the equivalent of 2.2 U. S. bushels. Natto holds a high percentage of water, so the yield is nearly double the original weight of the beans.

Various reports show a rather wide variation in the composition of natto, but an approximate analysis is 60 percent water, 19 percent protein, 9 percent fat, 10 percent carbohydrates, 2.3 percent fiber, and 2.6 percent ash. Vitamins B_1, B_2, and niacin are reported in milligram percent as 0.07, 0.50, and 1.1, respectively.

Present Japanese research work on natto is concerned with the amount and character of the mucus coating. In some operations there appears to be a contaminating organism which tends to reduce the production of mucus. It also appears possible that the permeability of the seedcoat to the soybean nutrients which feed the B. natto, or that the solubility of the bean components which occur next to the seedcoat, may have a substantial effect on the rate of mucus growth. It has been reported that germinated soybeans do not produce mucus, a discovery that may help in clarifying the mechanism of mucus formation during natto manufacture.

Removing the seedcoat as recommended for some of the other types of Japanese soybean foods does not fit into the conventional natto process. Research on removing foreign material from U. S. soybeans and on increasing the production of mucus, coupled with an educational program on the food value of natto, would be expected to increase the use of United States soybeans for making this food product. There are about 80 natto factories in Tokyo and 800 throughout Japan.

HAMANATTO

Hamanatto, sometimes spelled hamananatto, is made by fermenting whole soybeans. Hamanatto is produced in a limited area in Japan in the vicinity of Hamanatsu. Hamanatto should not be confused in any way with natto. The only resemblance between the two products is that both are made by fermenting whole soybeans. Hamanatto has a pleasant flavor resembling miso or shoya but is sweeter. Factors unfavorable to the popularity of hamanatto appear to be its very dark color (black) and its rather high cost. Hamanatto is said to cost four times as much as miso.

Hamanatto is reported to have come to Japan by way of Korea about 350 years ago at the time of the Japanese invasion of that country. Natto means "contributed beans" and hamanatto was contributed to the Japanese warriors. The process is reported to have originated in Buddhist temples where it was developed as a source of protein. The ancestors of the people owning the Yamaya Brewery and the Saito Mido Plant of Hamanatsu are said to have inherited the process from the Buddhist monks.

In making hamanatto the beans are soaked in water for 4 hours and steamed without pressure for 10 hours. The cooked beans are spread on the floor for cooling to 30° C. Koji prepared from roasted wheat or barley is sprinkled over the beans to cover their surface. The Japanese are very particular to cover the entire bean surface. The inoculated beans are placed in trays in a fermenting room for about 20 hours; during fermentation the beans acquire a good coating of green mold. When taken from the fermenting room they are covered with a sticky material and must be separated and dried in the sun to about 12 percent moisture. This can be accomplished in 1 day if the weather is warm and sunny. At one factory the beans are carried to the roof for drying.

The dry beans are placed in wooden buckets that have a capacity of about 15 gallons. Strips of ginger are placed in the bottom of the buckets before adding the beans and the salt water to cover them. A cover that fits inside the bucket is placed over the beans and a

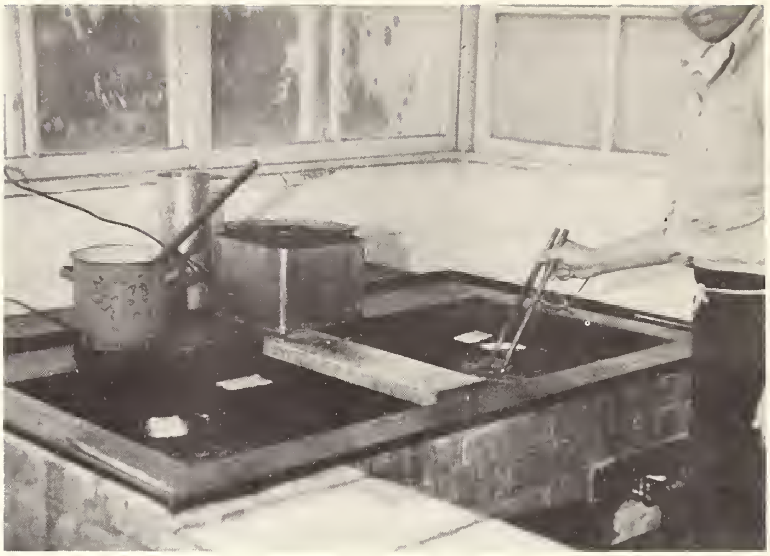

Figure 17.--Deep fat frying of tofu for making aburage.

Figure 18.--Wooden buckets used for fermenting hamanatto. Stone weights are used to compact the beans during fermentation.

very heavy weight placed on the cover. Rough stones estimated to weigh about 100 pounds are used for weights. Figure 18 shows the buckets with the stone weights used during fermentation, which requires 6 to 12 months and must include one full summer. During fermentation the beans acquire a dark reddish color that is not unpleasing. After fermentation is completed and the beans are dried again in the sun, they turn black. Hamanatto contains about 11 percent salt, said to be the cause of their turning black. Hamanatto will keep at room temperature for 1 year or longer.

The makers of hamanatto, now using only Japanese soybeans, prefer a very select grade grown only in Hokkaido because they are large, are uniform in size, and are free of foreign matter. They claim to pay ¥4,500 for 60 kg. of specially selected beans; an equal quantity of U. S. beans would cost them ¥3,000. On this basis the relative cost per 60-pound bushel of Hokkaido and U. S. soybeans is $5.65 and $3.80, respectively.

An analysis supplied by the Yamaya Brewery is as follows: Water 38 percent, total nitrogen 3.8 percent, water-soluble nitrogen 2.6 percent, reducing sugars 7.0 percent, total sugars 10 percent, crude fiber 12.5 percent, ash (including 11 percent sodium chloride) 12 percent, volatile acids 0.015 percent, total acids 1.2 percent, and pH of water suspension 5.1. The composition of hamanatto probably varies considerably.

If hamanatto could be produced in a dark red rather than a black color and the process modernized to bring the cost more nearly in line with other fermented soybean products, it should have much wider acceptance and use.

KINAKO

Kinako is a Japanese product that corresponds more nearly to full-fat soy flour of the United States than any other product. Making kinako is a very simple process. Soybeans are roasted for one-half hour or longer in a gas-fired rotating drum to remove the bean flavor; roasting is continued until the characteristic toasted flavor so well known to soybean processors is acquired. The beans are then cooled by spreading on a straw mat in the open as shown in Figure 7. Foreign matter is removed by hand, the beans are ground to a moderately fine flour, and the kinako is packaged by hand in plastic bags.

The Kinako Association has 16 members in Tokyo and about 50 in all of Japan. Maximum production capacity of any of these plants is probably not more than 5 tons per day. Production of kinako is seasonal; December is the month of highest production. Production originated in farm homes as a small family industry; later, mechanization of the process was improved, and it became established as a commercial process.

One of the principal ways of using kinako is to sprinkle it on rice or rice cake. Rice cake is made by pounding cooked rice, and the kinako is sprinkled on the macerated product. The poor people of Japan are the principal users of kinako; it should be an excellent protein supplement for their rice. However, it is not known whether the nutritional value of kinako has ever been determined. It could be greatly improved by dehulling the soybeans. Dehulling would increase the protein content about 6 percent and remove undesirable fiber.

There is not much known about the relative improvement in nutritional value obtained by roasting whole soybeans and steaming the grits. It is possible that if the beans selected for roasting happen to have a low moisture content, they would fail in gaining their best nutritional value. Comparative nutritional values should be made on roasted and properly heated soybeans. If the roasting treatment is inadequate, a conditioning or steam treatment should be installed in the process. The new procedure suggested would be to clean soybeans mechanically, crack the beans into grits, remove the hulls, condition the grits with steam, then roast and grind. Modernizing kinako factories would reduce labor cost, improve quality, nutritional value, and color, and further extend its usefulness to other foods as in the fortification of bread, noodles, and other cereals.

NEW PRODUCTS RESEARCH

In addition to increasing use of United States soybeans in traditional Japanese foods, an excellent opportunity exists for a further increase by developing new products or improving foods now having only limited markets in the Orient. Examples in the food area are soybean "milk"; soy flour in noodles, bread, and other wheat products; soybean cheese, yogurt, and isolated protein, to mention only the more important. Also, developing industrial uses for soybean meal and for soy protein is another opportunity to increase exportation of U. S. soybeans to Japan.

Research and development of new uses of soybeans in the United States have followed a different pattern and are more advanced than in Japan. Thus certain soybean uses could be introduced into Japan with very little additional research. It would be mostly a problem of adjusting known processes to Japanese industries.

Soybean "Milk"

Nutrition investigators for the United Nations International Children's Emergency Fund (UNICEF), for the World Health Organization, and for the Foreign Agricultural Organization have repeatedly called attention to the great need in overpopulated and underdeveloped countries for a food for weaning babies and for young children. Soybean "milk" would fill such a need for Japan and should make a valuable addition to her food economy. In Japan and many other densely populated and underdeveloped countries babies are breast fed up to 2 years or even longer because there is not available readily and cheaply an easily digestible and nutritious weaning food. The period following weaning is critical for

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the development of malnutrition, as exemplified by the prevalence of Kwashiorkor in many countries that have short food supplies; however, there is probably no malnutrition of this severity in Japan.

Soybean "milk" has been produced in Japan at various times but is not now a commercial product. Other countries are using soy "milk" successfully; UNICEF has built a plant in Indonesia which is expected to be in operation soon. A plant at Hong Kong has been reported as operating very successfully. China has used some soy "milk" for many years. Soy "milk" is also successfully produced and marketed in the United States where its most important use is to feed babies allergic to cow's milk.

The analysis of soybean "milk" shows it to have protein, fat, and carbohydrates at about the same concentration as in cow's milk. If desired these components as well as vitamins and minerals can be adjusted to simulate mother's milk. However, because the protein, fat, and carbohydrates as well as other components differ in kind from those in mother's or cow's milk, it is not recommended for feeding babies until after they are several months old. Despite its present utilization and limited success, further research is required to increase its range of acceptability and usefulness, particularly for Oriental people.

Improvements should be made in methods of production and in composition, flavor, stability, and nutritional value to give soy "milk" proper recognition. There is very little doubt in the minds of people that have studied and had experience with soybean "milk" that its nutritional values can be made equal to or perhaps better than cow's milk.

Expanding the use of soybean "milk" for feeding children in Japan and also in some of the underdeveloped countries of the world that cannot support a dairy industry would consume many million bushels of soybeans. It is estimated that 3 million bushels of soybeans with some added oil, minerals, and vitamins to balance composition would supply enough milk to feed 1 million children 1 quart of vegetable milk per day for 1 year. This is a program that deserves serious consideration. A product developed successfully for Japan would be useful in many other countries.

Fermented Cheese

The name "cheese" has been given to a wide variety of fermented and nonfermented products in the Orient as well as in the Occident. Most cheeses are fermented products, containing varying ratios of protein and fat and ranging in flavor from bland to exceedingly strong; most, but not all, cheeses are distinguished by strong flavors. Enzymatic breakdown products of the protein contribute most to the flavor of cheese.

For many years China has had a variety of "cheeses" made from soybeans, but Japan has not adopted any of these or developed one of her own. The soybean curd, or tofu, is a suitable base product for making a fermented "cheese" and is, in fact, used for this purpose in China. Fermented "cheese" usually has a moderately long shelf life, high food value, and makes an excellent contribution to variety in the diet. The probability of developing a successful "cheese" or "cheeses" for consumption in Japan is considered to be very good and research on this type of product is recommended.

Soybean Flour and Isolated Protein for Foods

Soybean flour and isolated protein are American products; the flour has been used to some extent in Europe but not in the Orient. In recent years Japan has produced a product resembling full-fat soy flour, called kinako. Kinako is made by roasting whole soybeans and grinding; however, it is not used as soy flour is used in the United States.

Cereals such as rice, wheat, and barley are the most abundant foods in the world because they supply more calories per acre than any other crop. However, the cereals are low in protein and the protein they do contain has a poor balance of essential amino acids, which is to say their proteins are inadequate for good nutrition. Cereals are noted for their low lysine content and soybean protein supplies this deficiency. The most economical method of improving the nutritional status of people with high cereal diets is by fortification with soybean protein. The addition of only 4 or 5 percent of soy protein to wheat flour makes a remarkable improvement in its protein quality. Methods for the successful use of soy flour and isolated soybean protein for the fortification of wheat bread, spaghetti, and doughnuts have been developed in the United States.

Japan consumes large quantities of noodles and is expanding her consumption of wheat in the form of American-type bread and other bakery products. There is now available in the United States sufficient technical information for using soy flour and protein in noodles and bread. The present need, therefore, is not so much for new research to develop these uses but rather of U. S. technical assistance to teach these new techniques to the Japanese bakers and noodle makers. This work could very profitably be supplemented by nutritional research demonstrating the advantages of fortifying the cereal products of Japan with soybean protein; the Ministry of Health and Welfare would thus be assisted in demonstrating to the Japanese people an economical method of improving their diet.

Isolated Soybean Protein

More than 50 million pounds of isolated soybean protein are produced in the United States each year. Present construction will increase this capacity an estimated 30 percent. Current outlets in the U. S. for isolated soybean protein are mostly industrial, such as for paper coating, sizing, lamination, latex paints, fire-extinguisher foam, and others. However, with the increasing interest in its use in foods, it is anticipated that such uses will soon catch up to and even surpass industrial uses. Japanese processors have had an interest in isolated protein for several years, but none is produced. Technical assistance to establish factories for isolating soybean protein would appear to be another means of increasing the export of U. S. soybeans.

Japanese oil processors use U. S. soybeans almost entirely. Because defatted meal is the base material for isolated protein, there will probably be no competition for U. S. soybeans in this area of utilization. Japan has industries where uses for the protein would be very similar to those in the United States.

Textile fibers have been produced on an experimental scale from isolated protein in the United States, but further research is required to develop them into a commercial product. Because textile fibers are a large and expanding market throughout the world and because Japan has practically no domestic wool, fiber production from soybean protein is of interest to Japanese processors. Successful production of soybean fibers in Japan would be an entirely new outlet for U. S. soybeans.

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