October, 1944

WAR FOOD ADMINISTRATION
Office of Distribution

FOOD USES FOR SOYBEANS AND SOYBEAN PRODUCTS

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To be presented at the Wartime Public Health Conference of the American Public Health Association, New York City, October 3, 4, and 5, 1944.

With the entrance of the United States into World War II, the Government decided that it was strategically essential to hedge the supply situation on proteins of high nutritional quality against possible shortages of animal protein. This could be most economically and conveniently accomplished by providing increased facilities for the manufacture of edible soya products. Ample scientific evidence was available to show that soybean proteins had excellent nutritional quality and crude soybean proteins were available in large quantities as a result of the expansion on production to meet wartime demands for fats and oils.

Government representatives urged soybean processors to expand facilities for grading, cleaning, dehulling, disembittering, and otherwise to alter their processing facilities so as to be able to produce a large volume of products of low fiber content under controlled sanitary conditions for human consumption in the event that they were needed.

Processors responded promptly to this request although the Government gave them no specific guarantees on the use of their expanded facilities, and even though they were fully aware that they were being brought into the food protein supply picture on the basis of underwriters. An annual capacity of about 1 billion 400 million pounds was speedily provided. This was judged to be sufficient to guarantee an adequate high quality protein reserve in the face of even a major catastrophe on the "Food Front."

Naturally the industry was hopeful that a part of the facilities which they provided would be used and that experience gained in their use and in merchandising products produced during the war emergency would help to develop a substantial post war market. They are, therefore, working toward this goal.

The public announcement of a large expansion of facilities for manufacturing soya products was immediately viewed with alarm by many old and established food industries. This alarm has, in turn, given rise to many weird rumors, expressions of doubt and prophesies of dire consequences. To soybean growers and processors, these developments were not unexpected for only yesterday their best present day customers for oil and meal were viewing the introduction of these products into the domestic market with melancholy predictions of gloom. To the general public, however, they were not expected and they have consequently given rise to considerable apprehension and uncertainty. It would appear, therefore, to be an opportune time to review briefly why the use of soya products was encouraged by the War Food Administration and the progress that has been made in developing new uses for these products in foods.

In general, the thinking of nutritionists has become so intently directed toward the well-known specific nutritional diseases and the accessory growth factors associated therewith that the importance of proteins and protein quality is frequently assigned a secondary role. Thus, we find that information on the protein content of American diets is usually arrived at by a secondary analysis of data collected primarily for the purpose of demonstrating adequacy or inadequacy on consumption of the so-called "Protective Food Groups."

It is not surprising, therefore, to find data compiled on this point often inadequate and frequently quite contradictory. From a recent report of the National Research Council /1 which sums up the results of 6 local surveys on the adequacies of various dietary elements, it would appear that protein deficiencies may be quite common and widespread, locally.

Data from this report showing the percentage of persons with protein intakes lower than recommended levels is reproduced in Table I.

The figures given in Table I cannot be considered as representing an adequate statistical sampling of the entire population of the United States. They do indicate, however, that serious protein deficiencies may be the rule rather than the exception in certain urban and industrial areas of Pennsylvania, in New York City and in rural districts of Tennessee and North Carolina. These figures are all the more startling when the fundamental role of dietary protein is taken into consideration.

To those interested primarily in proteins, it appears facetious to emphasize the importance of accessory food factors, which are mobilizers of digestion, to population groups such as those shown in Table I,

Table I. Extent of Protein Inadequacies in Diets as Shown by Studies of the National Research Council.

Identity of Survey	Percentage of persons with protein intake: less than recommended levels	less than 75 percent of recommended levels	less than 50 percent of recommended levels	less than 25 percent of recommended levels
Wilkes Barre, Pa. (1937)				
748 white children, 1-12 yrs.	81	35	6	0
39 white school adolescents 13-20 yrs.	100	87	36	0
14 colored children, 1-12 yrs.	92	54	8	0
Lancaster Co., Pa. (1938-40)				
42 white children, 1-12 yrs.	21	0	0	0
20 white adolescents, 13-20 yrs.	20	0	0	0
38 white adults	8	0	0	0
Philadelphia, Pa., (1941-1942)				
562 white children, 1-12 yrs.	58	6	1	0
38 white school adolescents 13-20 yrs.	71	21	0	0
New York, N. Y., (1939-1940)				
2037 public high school pupils	44	11	1	0
293 private high school pupils	26	7	0	0
Chatham Co., N. C. (1940-41)				
110 white adults	83	42	10	1
Wayne Co., N. C. (1942)				
51 white children, 15 yrs. & over	55	14	2	0
39 colored children, 15 " " "	59	21	10	0
Wilson Co., Tenn. (1941)				
457 white adults	51	24	7	0
194 colored adults	74	45	18	4
113 white adolescents	78	42	13	1
76 colored adolescents	94	74	33	4
206 white infants and children	61	39	12	3
115 colored infants and children	87	66	35	13
Burbank, California (1941-1942)				
250 aircraft workers	15	3	0	0
Total Number of Individuals - 5,360	55 ≠	21 ≠	5. ≠	0.6 ≠

without at the same time emphasizing the necessity for providing sufficient food of the proper kind and quality to be mobilized. There is evidence then of a real nutritional need for consumption of greater amounts and a more equitable distribution of food proteins which possess high nutritional quality.

Emphasis is placed on need for greater consumption and a more equitable distribution since production of animal proteins of high nutritional quality now exceeds 5 billion 250 million pounds annually. This would be adequate to supply basic nutritional needs if distribution was carried out in such a manner as to take full advantage of the supplementation effect of these proteins for available but incomplete cereal proteins. Now, estimates show that even the poorer American families spend more than one-third of their food money on animal protein foods. Since these constitute only about eight percent of the total diet, it can be seen that they are relatively the most expensive part of the diet. Thus, it seems reasonable to assume that the principal cause for maldistribution and underconsumption with these foods is economic. The basic remedy for this condition is, therefore, the provision of an adequate supply of low-cost, high-quality, protein foods.

The nutritional values of proteins of vegetable origin are usually inferior to those of animal origin but those of the soybean, corn germ, wheat germ, peanut, chick pea, and oat possess relatively complete assortments of the essential amino acids and have high nutritional quality either when fed as the sole source of protein or as supplements for other incomplete proteins.

The American soybean crop is the largest single available reservoir of vegetable protein possessing high nutritional quality. In 1944, /2 179,024,000 bushels of soybeans will be produced in the United States. This represents about 4 billion 300 million pounds of pure protein. This protein can be processed for human consumption at an average cost of one-tenth that of animal proteins. Thus, in this available reservoir of soybean protein, we can find the basic remedy for maldistribution and underconsumption of proteins; namely, an inexpensive protein of high nutritional quality.

Soya products which are available in quantity today include full-fat, low-fat (expeller process), and fat-free (extraction process) flours, grits, and flakes. These contain from 40 to 50 percent of protein. They are, strictly speaking, food ingredients and should be so used.

Tomorrow the list of products available will be larger and more diversified both as to composition and physical properties. They will still be offered, however, as ingredients for the improvement of the nutritional and culinary qualities of foods. For, the soybean processor is fully aware that future success in the food field will depend upon his ability to provide, at low cost, products that will fulfill these requirements.

The largest single use of soya products developed to date is in bakery products. It has been repeatedly demonstrated that soybean proteins combine with wheat proteins to yield products of superior nutritional quality.

Johns and Finks /3 were the first to study mixtures of patent wheat flour and soybean flour in bread and reported a marked supplementation effect. Kon and Markuse /4 then showed that the protein of wheat flour breads containing 10 and 20 percent soya flour possessed a nutritional efficiency greater than either wheat protein or soybean protein fed alone. Jones and Divine /5 showed that the addition of soya flour to patent wheat flour at levels of 5, 10, and 15 percent increased the nutritional efficiency of the protein contained therein by 84, 189, and 203 percent respectively. Hove and Harrel /6 found that at a 20 percent level the supplementation effect with soya proteins was even greater with whole wheat flour than with patent wheat flour. In a very recent study, Harris, Clark, and Lockhart /7 showed that the addition of as little as 3.0 percent soya flour to white bread improved the nutritional quality of the protein and that the addition of a combination of 3 percent soya flour with 3 percent nonfat dry milk solids brought about a supplementation which was superior to either 5.0 percent soya flour alone or 6 percent nonfat dry milk solids alone. Thus, it appears that soybean proteins not only supplement wheat proteins in bakery goods but may also supplement milk protein as well.

Soya flour is used in a wide variety of bakery goods. The concentration which can be used in any bakery product depends primarily on the quantity and quality of the gluten contained in the wheat flour used. Soybean protein contributes nothing to dough strength although it may impart other desirable physical properties to bakery doughs. In white bread, it is usually used at levels ranging from 2.5 to 5.0 percent on the weight of the flour used. In doughnuts and sweet doughs, it may be used at levels ranging from 6 to 10 percent. In specialty breads and cakes the concentration may vary from as little as 10 to as much as 25 percent.

Bakers have ascribed definite physical advantages to the use of soya flours. For example, in white bread, use at 3 to 5 percent levels has been reported as retarding loss of moisture, inhibiting staling of the resulting loaf and prolonging mixing time tolerance. In sweet dough, use at levels of 6 to 10 percent has been reported as producing a richer, more uniform appearance, a browner crust color and an improved crumb structure. In doughnuts, the use of 6 to 7 percent of full-fat soya flour inhibits absorption of excessive amounts of fat during deep-fat frying.

With any given flour, the baker must determine for himself the amount which he can use to obtain these desirable physical properties and at the same time not affect adversely the volumes, crumb color, and taste appeal of his products.

Possibly soya products have received more adverse publicity from the standpoint of the effect that they may have on the flavor of foods than on any other score. Thus, it seems appropriate to discuss at this point the results of a recent study /8 to determine the influence of soya flour on the flavor and consumer acceptance of white bread. In this study, the soya flours used were composite samples made, according to type, from regular production runs of 5 large soya flour companies. Thus, the final results cannot be attributed to any special flour or disembittering process. All 3 types of flour were tested in white bread at levels ranging from 5 to 7 percent. Tests were made on bread containing the individual types of flour in 3 separate, consecutive 30 day periods during which no other white bread was served. In all, 715,999 pounds of bread were served at 3,787,498 meals. Flavor acceptability and taste fatigue were judged solely on the quantity of bread consumed. The test groups were made up of inmates from State institutions and were not informed of any changes made in bread formularies or even that the tests were being conducted.

Results showed a progressive consumption of slightly increased quantities of bread during the 90-day period required to conduct the 3 consecutive tests. Per capita consumption was as good or better than for standard white bread served during the 30-day period immediately preceding the test or for the corresponding 90-day period of the previous year.

From these studies, it would appear then that the use of soya flour in white bread at levels of 5 to 7 percent did not adversely affect flavor acceptability or induce taste fatigue.

Soya products have been used rather extensively in prepared pancake and muffin pre-mixes at levels ranging from 10 to 25 percent. Here the nutritional story is much the same as with bakery products: Since it is possible to use soya flour at slightly higher levels in these products than in bakery goods, the supplemental effect of soya proteins for wheat proteins is usually more pronounced.

Similar nutritional advantages can be gained from the use of soya flour in paste goods. The limiting feature on use here is, as with bakery products, the quality and quantity of protein in the wheat flour employed. Strong doughs are absolutely essential to the practical production of paste goods. When wheat flours of very high gluten content are used, soya flour may be added to the extent of 15 percent of the weight of the wheat flour. However, 12.5 percent soya flour seems to be the maximum practical load for products made from average wheat flours and 10.0 percent may be as much as can be used with wheat flours of low protein content.

Some paste goods producers report definite improvements in color when they use soya flour.

The excellent nutritional quality of oat proteins has been firmly established. Recent tests show, however, that the addition of soya products to such a cereal as rolled oats results in an improvement in protein quality. The results of these tests are reproduced here in Table II because they provide an excellent example of the supplementary action of soya proteins for other dietary proteins.

From Table II, it can be seen that the inclusion of 20 percent soya flakes to a ready-to-eat rolled oat cereal formula increased the amount of protein available by 7.16 percent and the relative nutritive efficiency of the protein by 14.3 percent. The additional inclusion of 14 percent nonfat dry milk solids further increased the amount of available protein to 10.13 percent above that of the original cereal and the nutritive efficiency of the protein to 98.5 percent of that found for nonfat dry milk solids.

The third cereal concentrate formula shown in Table II is that of a prepared cereal concentrate, large quantities of which were purchased under Lend-Lease and shipped to Russia and other claimant agencies. The nutritional advantages to be gained from such a cereal preparation are plainly evident from the figures shown. It is to be hoped that soya products can eventually be used in a similar manner in various ready-to-eat breakfast cereals manufactured for domestic distribution.

Second in importance only to the baking industry as a consumer of soya products is the meat packing industry. The extension of use in this field will depend upon a number of factors. The principal ones being the development of:

Table II. Supplemental effect of soya flake proteins for rolled oat proteins .*

Product Tested Formula		Protein Content Percent: Ingredient	Protein Content Percent: Mixture	Protein Increase Over Base Product	Nutritional Efficiency: gms. gained / gms. protein consumed: index found	Nutritional Efficiency: gms. gained / gms. protein consumed: Increase over Base Product	Nutritional Efficiency: Percent of that found for milk protein **: found	Nutritional Efficiency: Percent of that found for milk protein **: Increase over Base product
1. Base Product - %								
a. rolled oats -	90	16.2	14.58					
b. sugar	8	0.0	0.0	0	1.61	0	83.5	0
c. salt	2	0.0	0.0					
			14.58					
2. Base Product + soya								
a. rolled oats	70	16.2	11.34					
b. soya flakes	20	30.0	10.0					
c. sugar	8	0.0	0.0	7.16	1.88	0.74	97.8	14.3
d. salt	2	0.0	0.0					
			21.34					
3. Base Product + soya + milk								
a. rolled oats	56	16.2	9.07					
b. soya flakes	20	50.0	10.00					
c. nonfat dry milk solids	14	35.4	4.96	10.13	1.90	0.79	98.5	15.0
d. sugar	8	00.0	0.0					
e. salt	2	0.0	0.0					
			24.03					

* ad libitum feeding at 10 percent protein level for an 8-week period.
**Based on nutritional value of 1.93 equaling 100 percent.

Based upon data received from the research laboratories of the Archer-Daniels-Midland Company.

1. An understanding as to the nutritional and economic advantages to be gained by both producers and consumers, and

2. Adequate methods of controlling use to prevent unfair competition among packers and the misrepresentation of products to consumers.

While it can be stated that animal proteins are usually more complete from the nutritional standpoint than vegetable proteins, this does not mean that the proteins of all packing house tissues used in prepared meats are perfect or complete nutritionally. The work of Hoagland and Snider /9 /10/11 /12 shows quite conclusively that the proteins in such tissues as tripe, sweetbreads, beef cheek, ox lips, ox palates, hog snouts, and pork cracklings have distinctly lower nutritional values than those of the muscles, hearts, tongues, livers, and brains of the ox, veal and hog. It is important, therefore, in using tissues containing proteins of low nutritional quality in prepared meat products that they be blended with other animal or vegetable proteins in such a manner as to provide protein supplementation effects. This is one way to provide consumers with a large volume of low-cost protein food possessing the highest nutritional value.

Soya products can be used to increase the protein content of many prepared meat products such as scrapple without lowering the nutritional quality of the meat protein, and the soya protein may even have a definite supplemental effect.

There are a few quite sound reasons for considering the use of such a product as low-fat soya grits in certain of the higher grade prepared meat products.

Possibly the most carefully prepared and most standardized product which is universally distributed by the meat packing industry is pork sausage. It has been demonstrated repeatedly that the inclusion therein of soya grits in quantities up to 10 percent increases the protein content of the resulting product. It also conserves calorie values through the prevention of excessive fat separation during a canning process or the frying away of large quantities of edible fat during preparation for serving. Repeated small scale tests indicate that these advantages can be gained without adversely affecting palatability or consumer acceptance.

In England the addition of 7 percent soya to all prepared meat products has been required by law during the war period. In the United States, its use is at present restricted to pork scrapple.

Large volumes of soya products have been used in dry pea-soya soup mixes and dry vegetable stew mixes for sale under Lend-Lease and for relief feeding purposes. These products have been prepared with the concentration of soya ranging from 20 to 25 percent. They have been subjected to rigid nutritional and taste tests in this country and all reports from Lend-Lease countries and relief agencies indicate that they have been received favorably.

Soya products can be used in the home to add protein and lend variety to meals. It is really surprising how much protein can be added to a meal by including a small quantity of soya flour or soya grits to a selected home recipe for vegetable chowder, vegetable stew, sweet potato souffle, potato cakes or cream soup, to mention a few.

Historically, the oldest foods prepared from the soybean are the soybean milks, soybean curds and soybean cheeses of the Orient. There has been no large volume production on products of this type in the United States. Some processors are now experimenting with extraction processes using whole soybeans, expeller products and extraction flakes with the view to developing curds and cheeses or spray dried products which can be produced on a volume basis at low costs. The possibilities in this direction seem very bright.

Soya products are being used extensively in the manufacture of candies. Increased use in this field has been linked closely with the activities of the campaign of the National Confectioner's Association to improve the nutritional balance of candies especially with respect to protein, mineral salts and vitamins.

In conclusion it can be stated that:

1. There appears to be a real nutritional need for more equitable distribution and consumption of high quality protein food.

2. Since maldistribution and underconsumption of these foods appear to be due to economic causes, the basic remedy for this need would seem to be the provision of low-cost high-quality protein foods.

3. Soya products are a source of high-quality protein and can be produced at low cost.

4. Soya products when used as ingredients of prepared foods have, in many instances, a supplemental action on the quality of the proteins contained therein.

5. The most efficient and economically practical use of soya products appears to be as ingredients for prepared foods.

6. Soya products can be used in many prepared foods at levels high enough to increase their protein content and enhance the nutritional efficiency of the protein without adversely affecting palatability.

7. Soya products may have physical properties which can be used to advantage by the housewife and food manufacturer.

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