# Synthetics and Substitutes: The Challenge to the Food Industry

*Oilseed Proteins - Present Utilization Patterns*

Food 70's

Emphasizes the importance of soy beans as a source of protein in the human diet. Provides examples of soy-protein products on the market today and speculates as to their future.

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● Perhaps the most dramatic success story in U. S. Agriculture has been the development of the soybean and its major food and off food usages. Historically, the soybean is indigenous to China and one of the oldest crops grown by man. As Dr. A.A. Horwath has said, "The Chinese nation exists today because of the use of the soybean as a food." It might also be predicted that the future of our own nation along with many other peoples of the world will depend upon the technological food developments from vegetable protein sources of which the soybean will play a major role.

In order to orient everyone as to the growth of this industry, the first slide shows this phenomenol growth during the past four decades. In 1926 the total production of soybeans in the U. S. was less than 5 million bushels. The 1968 crop exceeded a billion bushels. This represents a 200-fold increase in just over four decades. Another comparison of interest is made by noting that more protein is produced from soybeans than from any other crop. Also,they return a greater export value to U. S. agriculture than any other crop.

This brief background should give some orientation to this important source of protein. We would like to discuss some of the reasons why it is considered a prime raw material for present and future food products.

We could talk at length about the critical protein food needs that lay before us as the projected world population doubles in the next 35 years. Let us turn our attention to some of the approaches that have been taken here in the United States to shorten the protein food chain as contrasted to the conventional animal body route.

The next slide shows the relative efficiencies of protein conversion from some of our major protein sources. The time has now come as predicted by Dr. H. W. Miller in 1943, that our chief interest in the soybean is in its value as a human food. As noted on the slide there is a great difference in cost per pound of protein from various sources. The next slide illustrates why the cost per pound of protein is low. Note the ten fold difference in protein conversions per acre via the soybean as contrasted to protein in the form of meat.

The next slide summarizes a number of distinct advantages of soy as a protein food. The first of these is a large amount of protein that can be grown per acre of farmland cultivated as shown in the previous slide. As noted the cost per pound of protein produced is quite low compared to other protein sources. Both of these facts would be unimportant if the soy protein were poor in quality. As will be shown later the quality of soy protein is very good and has particular advantage as a supplement to

the protein of cereal crops. Finally, of course, a food is not a food unless it has some desirable qualities that cause a person to want to eat it. Fortunately, it has been found that soy protein has functional properties that make it possible to develop textural characteristics in this protein source.

The next slide will point out to those of you who are unacquainted with the various classifications of soy product, the types of protein material that we want to consider.

By far, the largest group of protein raw materials now used is 50% soybean meal, flour and related forms. This is the raw material from which all of the other food types are derived. Of course, some of these require further processing. Presently the major portion of this goes into animal feeds. After oil extraction if the solvent is removed by low heat or vacuum, a protein retaining its functional properties is produced. This flour or flake form then becomes a base material for either further extraction of protein for soy isolates to be used as a protein powder, or to be spun in fibers for the development of texture. This flour can be processed directly into textured products.

Before we get into the details of each of these protein categories, the next slide shows the estimated production and pricing structure of these three major groups of soy protein.

The next slide shows the estimated use of soy flour projected to 1969. Large percentage usage of this flour in various food products is limited because of inherent flavor properties that exist from the defatted bean. Thus, additional processing steps are necessary in order to expand the volume usage of soy protein in existing and new food products.

It should be mentioned in passing that one should not under-estimate the textural properties of foods in either U. S. or world feeding programs. This can be illustrated by comparing a cooked beef steak with the same piece of cooked meat ground to a puree in a blender. The flavor, color, or nutritive value has not changed but but there is a vast difference in eating quality. The difference exists mainly in the textural properties of the two foods. This principle should not be forgotten when relating our challenge to our foreign or domestic feeding programs.

The next series of slides will deal with various soy protein products that are approaches to alter the textural, color, and flavor properties of defatted oilseed proteins.

The soy protein concentrates are prepared by extracting defatted soybean meal with suitable polar solvents that will remove the more soluble carbohydrates but retaining the protein. For example, if a 50% protein soybean meal is extracted with 70% alcohol, very little protein is solubilized while most of the carbohydrates, flavor, and color bodies are removed. The next slide shows a typical composition of soybean concentrates.

The soy protein concentrates have several important functional advantages in food products. (Next Slide). When used as a component in food products such as meat loaf, hamburger patties, and meat balls, they help to retain the moisture, juices, and fat during cooking because of their good absorptive properties (Next Slide). Further, where the ground meat items are being manufactured on a commercial production basis, the incorporation of soy protein concentrates improves the machineability of these items. The soy protein concentrates represent a relatively low cost source of good protein supplement.

In our experience, the flavor acceptance of these products can be evaluated more accurately in the finished product than as a raw material by itself. It's a matter of finding the right product compatibility. For example, we show on the next slide a picture of some bread and rolls that have been prepared containing 15% soy protein concentrates. From a commercial point of view, the most important characteristic of this bread and rolls is they have met with good consumer acceptance. A leading university has evaluated this bread and found it to be the most acceptable of the several bread types tested by a panel of 7 women. From a scientific point of view, it is much more interesting to consider what the conclusion of only 15% of soy protein concentrate has done to the nutritional quality of over-all protein protein of the bread.

While we as scientists may be impressed by this dramatic nutritional data, we have to be practical minded and realize the hard cold facts that the average consumer does not buy foods on the basis of nutritional quality. Rather, she buys for tecture, flavor, and

functional characteristics that are often of distinct advantage. They do not, however, have the type of textural properties that characterize popular protein foods, such as beef, poultry and fish. Consequently, considerable research attention has been directed toward producing soy protein products that have the fibrous texture usually associated with animal products.

The first significant breadthrough was made in 1947 by Robert A. Boyer, who made an edible fiber by a process similar to that used for textile fibers. A typical flow sheet of the process for making these fibers and food products from these fibers is shown in the next slide. Basically, this is what is done:

Defatted flakes and flour are extracted and purified to a pure protein. This pure protein is dispersed in alkali and then precipitated at the isoelectric point in a bath by drawing it away continuously from the face of the spinnerets to form tiny micro-filiments (10/100 inch in diameter). These fibrils are combined with such standard, edible items as wheat gluten, egg albumin, vegetable or animal fats, flavors, and colors. The mixture is then cooked, which sets up and binds the protein fibers together. The resultant products are used as refrigerated, frozen, canned, or shelf stable products. The composition (Next Slide) of a typical product is shown next. These products are the type that are being produced commercially by General Mills, Worthington Foods, and Ralston Purina. Some highly sophisticated engineered meat-like items are now being produced on a pilot or semi-plant scale by these companies. Recently, General Mills announced plans to build a multimillion dollar plant to manufacture these fabricated engineered foods. Some of these products have very desirable flavors and textures. They appear to have excellent consumer acceptance. Their rapid penetration into the U. S. and more specially the foreign market has been limited primarily because the process is quite involved, resulting in a comparatively costly finished product. This fact is of significance as we consider the lower purchasing power of the people in the world who need it most. Another point of scientific importance is that a fractionation of protein occurs to some extent to not only reduce the yield of protein, but it changes the amino acid balance in the protein which apparently reduces the protein quality. This lowering of protein quality can be corrected, however, by addition of certain amino acids back into the fabricated food product.

Considering the above limitations, at least two U. S. companies have taken the approach of producing textured soy products more directly from soy flours and/or grits. While details of the processes used cannot be disclosed, they are much more economical than the process for making food products via the spun fiber route.

Several products representing this class of materials are being produced commercially at the present time; the consumer response has been very gratifying.

The physical properties of the textured soy proteins made by one of these more direct processes is shown in the next slide. The functional advantages of these products are shown in the next slide. These products when hydrated have textural properties closely simulating the chewability of ground meat products. It is important to add that in addition to these functional advantages, the textured soy proteins have excellent nutritional qualities quite comparable to meat and other animal protein sources.

The flavor of the textured soy protein is particularly important. The basic material has a slight toasted flavor. These products have been stored for as much as a year at room temperature with no development of adverse flavors. Because of their low moisture content, they are not susceptible to micro-biological deterioration. Because these products do have a very mild initial flavor and good flavor stability, their flavors can be modified to resemble many different types. The next slide shows some of the types of flavors that have been successfully applied to the textured soy protein products.

We can talk about nutritional,physical, and chemical properties of these new food products, but "the proof of the pudding is in the eating." A food is not a food until some person has put it into their mouth, chewed it, and swallowed it. It cannot be considered commercially successful until a substantial number of people will come back and repeat this process over and over again. In our experience thus far, the textured soy protein food products are going to pass these tests. The following slides show some typical food applications using these textured products which will but illustrate the

many more uses that have been used by other people in commercial products. The next slide shows some of the dry mixes in which the higher protein or meat-like portion is a textured soy protein. These products are chicken ala king, chili with beans, and Spanish rice. The next slide shows a Spanish Rice after it is cooked. This is made simply by heating the dry mix as shown for about 5 minutes. The next slide is a chicken ala king made from one of the dry mixes and placed in a pastry shell. Also is shown a fried patty made from a blend of chicken meat with textured soy protein. This product has had good consumer acceptance when used at relatively high levels. The next slide shows stuffed peppers containing a bacon and a cheese flavored soy protein product. The next slide shows a bacon flavored product used in an egg omelette, in a salad, and a casserole dish. The next slide is a cheese dip containing flavored textured soy protein.

In the development of this imitation bacon-like product we wanted to get some estimation of its consumer acceptance and the correlation of our own laboratory testing facilities of the average public as measured by a facility at the Museum of Science & Industry. Results of both panels indicate that there was a 2-1 preference of the fabricated imitation bacon-like product compared to pre-fried crumbled bacon. This development merely highlights what can and is being done in simulating acceptance in food products from oilseed protein sources.

The next slide illustrates a wide variety of applications in which it is used in a ground meat product shown here in canned chili or sloppy joe type formulations. It should be emphasized again that all of the above products, and many like them, have been evaluated both by expert flavor panels and by consumer panels from various national origins. Our criteria for evaluation has been contrasting them to the natural or customary food concept. The response to date using these panels as judgements for the population have been extremely encouraging.

Another product concept that we can quickly mention shows a different type of texture, color, and flavor variation made from soy - that of a vegetable spread. This product is made to resemble peanut butter in color,texture, and flavor. We were asked by AID to make an economical-protein and calorie product for overseas feeding. The next slide shows the nutrient contribution of two slices of wheat bread, spread with this new soy vegetable spread served with a glass of reconstituted skim milk powder. If a child consumed this twice a day, they would approximate their minimum daily requirements. From a practical point of view, the product is quite acceptable as a food, in addition to being quite well balanced nutritionally.

One of the great stimuli to the development of these new protein sources is the increased pricing structure between the conventional protein for food and the vegetable proteins. Another area other than the textured meat area is in imitation dairy products. Recent work in our laboratory has demonstrated the utility of a new product from vegetable proteins to replace non-fat dry milk solids. In all applications from meat emulsions to imitation ice cream (next slide) its performance has been equal to or superior to milk solids. This kind of development merely illustrates the kind of application that can be made of oilseed proteins to simulate the conventional products.

Another large protein usage area that is developing is in the fluid beverage area. In Brazil, Coca-Cola has introduced a chocolate flavor beverage- "Saci". Monsanto is marketing an oilseed protein drink called "Puma" in British Guiana. In the far east a soy milk called "Vitasoy" is being sold with good commercial success.

In our country the sale of filled milk is paving the way for a completely non-dairy beverage referred to as imitation milk. We are confident that oilseed proteins will be major source for this new technological challenge. There are many problems to solve among which are nutritional equivalence, proper viscosity properties, and complete flavor acceptance. We have adequate evidence in the past it is near impossible to legislate against progress in areas of obvious challenge and opportunities even though there may be some temporary restrictions. If these challenges are met, many changes could occur that would alter the type of products we see at the consumer level.

Major efforts are now under way to bring solutions to these new potential developments.

There are many new oilseed proteins that

are used in products such as bakery items that are a different protein content than the typical flour, concentrate, or isolate. Each of these items are designed to perform a definite functional purpose to improve the existing food.

The next slide summarizes some of the major uses of oilseed proteins in the commercial world feeding programs. There are many reasons why our present technological know-how is not being used in more uses of oilseed proteins. Some of these reasons will be given by other speakers. Some of the problems result in the fact that those people who need protein the most can least afford to pay for it.

Thus, we can except in the future an entire family of products that will vary in protein composition, functionality, and flavor characteristics. We believe that this new technology is just in its infancy and that our present utilization patterns are but symbols of what is to come. ●

EDITOR"S NOTE:
The discussion which followed these papers identified these issues:

1. The general subject of consumer acceptance of synthetic foods.
2. The possible conflicts which might arise between "agricultural interests" and "synthetic food manufacturers."
3. The problem of information concerning nutrition in both "natural" and "synthetic" foods.
4. How does one approach extension educational work in synthetic foods?

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