# Textured and Shaped Oilseed Protein Food Products[1]

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## ABSTRACT

The major emphasis in developing textured and shaped protein foods has been with the use of soy proteins. The availability at a low stable price, the high protein content and quality, and the inherent chemical properties of the protein allowing for unique structure development are major reasons for its strong world-wide use. The changing economic trends of many basic protein foods are creating a need for the use of unique textured proteins either as ingredients in existing foods or allowing improved functionality in new products. The two main procedures for texturing and shaping oilseed protein are spinning of protein isolates, and direct extrusion of flour. The spinning technique is more expensive and has greater product functionality in contrast to the direct extrusion method. Consumer acceptance is in large part correlated with the technological success of imparting desirable colors, flavors and textural properties in the finished food product. Examples of these variations are given. The use level of these textured proteins, particularly in meat products, are restricted by labeling standards. The present regulations are not clearly defined. Current proposals for labeling textured vegetable proteins when used with meat products involve standards on a ratio to meat basis.


## INTRODUCTION

Previous papers have discussed the production, functional and nutritional aspects of oilseed food products. This paper will deal with the somewhat narrower topic of textured and shaped oilseed proteins. Although soy proteins are considered primarily they are representatives of other oilseeds.

The economic implications of soybean proteins on a dollar per pound of protein basis are compared with other typical or potential protein sources in Figure 1 which shows 1971 prices. The comparison of soy flour at $.14/lb of protein is significant compared to other more expensive conventional sources at considerably higher prices. It is obvious that the difference is more than sufficient to allow a good deal of additional processing while retaining an adequate margin for profit.

The need for further processing becomes clear when one considers that in its unprocessed state soybean flour and meal has rather limited appeal and hence relatively limited application. It will not easily serve as an acceptable food—at least to western tastes—until the inherent flavor and textural form has been modified to appeal to the user. In addition to separate fad products, there exists a growing requirement and demand for low cost ingredients that serve the food industry's needs, particularly as they relate to equal or improved nutritional or functional properties. It is widely recognized that soybean flours, concentrates and isolates have excellent nutritional value but one should remember that a protein source is not necessarily a food unless it has desirable qualities which cause a person to eat it. One should not underestimate the importance of the textural properties of food in either United States or world feeding programs. This point can be illustrated by comparing a cooked beef steak with a similar piece of meat ground to a puree in a blender. There has been no change in nutritional value or flavor and only a slight change in color, but what a difference in consumer acceptance. This difference can be attributed to the textural properties inherent in the original product. This brings us then directly to the point of the paper, the ability to reproduce and simulate texture from oilseed proteins.

## DISCUSSION

Defatted soy flour has an unappealing and amorphous disorganized appearance in its unprocessed condition. There is no textural structure of protein fibers. By contrast a textured vegetable protein product produced from soy

[1]One of 21 papers presented at the Symposium, "Oilseed Processors Challenged by World Protein Need," ISF-AOCS World Congress, Chicago, September 1970.

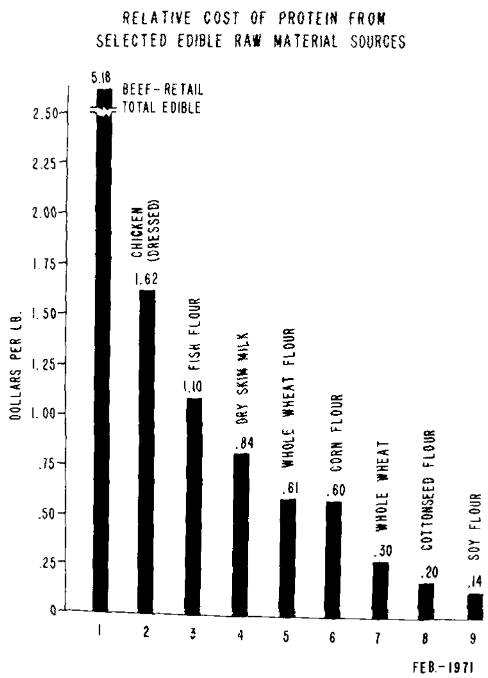


FIG. 1. Relative cost per pound of protein from selected raw material sources.

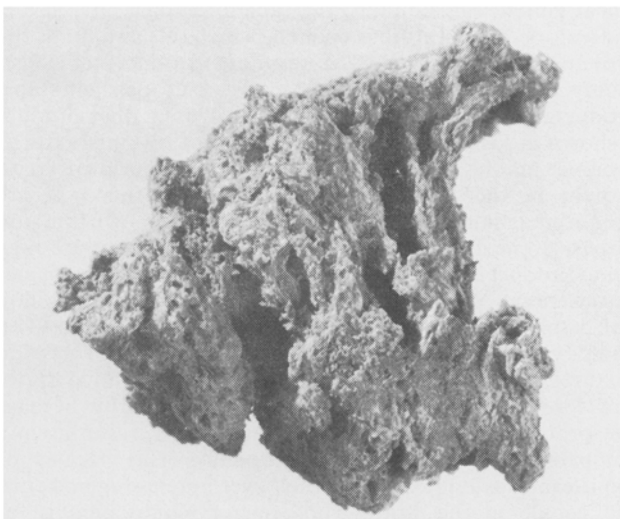

FIG. 2. A piece of extruded textured soy protein showing the structured form of the protein.

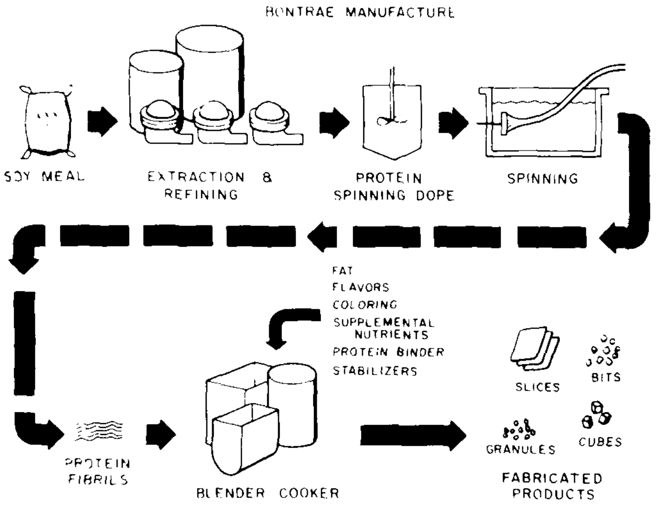


FIG. 3. A typical schematic flow chart for the process of making spun fiber food products.

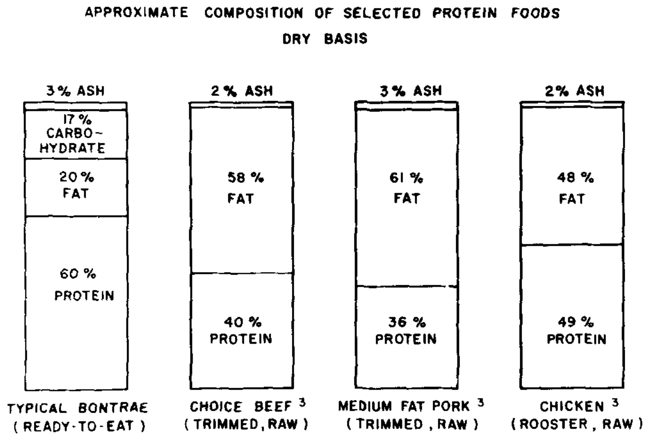


FIG. 4. An approximate composition comparison (dry basis) of selected meat products with a typical spun soy protein analog.

flour by the extrusion process has an ordered fibrous form as illustrated in the photomicrograph section of Figure 2.

The spinning process is a second method to introduce a fibrous character to oilseed protein (1). Photomicrographs show clearly the fibrous proteinaceous nature of essentially pure protein fibrils containing a minimal amount of carbohydrate. By comparison, a longitudinal section of naturally occurring meat muscle stained in a similar manner shows great similarities to the spun soybean fibers.

As indicated, two general techniques exist for imparting fibrous texture to oilseeds: the spinning of fibers from protein isolates and the extrusion of soy flour, flakes or concentrates.

The first significant breakthrough in producing textured vegetable proteins was made in 1947 by Boyer, who made an edible fiber by a process similar to that used for textile fibers. A typical flow sheet of the process for converting protein into food products is shown in Figure 3 (1). The process is summarized as follows:

Defatted flakes or flour is extracted and purified to produce an isolated protein (a product containing in excess of 90% protein). Then this isolate is dispersed in alkali and precipitated at the isoelectric point in the bath by drawing it away continuously from the face of the spinnerettes to form tiny microfilaments (0.03 in. 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 cooked, which sets and binds the protein fibers together. The resultant products are commonly used as refrigerated, frozen, canned or shelf stable products. The composition of a typical spun fiber product is shown in Figure 4 (1). This procedure of making textured foods is unique in that one can control the ratio of fat to protein in the finished food. Products of this type are produced commercially by General Mills and Worthington Foods. Some highly sophisticated meat-like items are now being produced on a pilot or plant scale by these companies and General Mills has recently completed a multimillion dollar plant to manufacture these fabricated foods (2). Some of the products have very desirable flavors and textures, but their rapid penetration into the United States and foreign market has been restricted primarily because the process is technologically quite involved, resulting in a comparatively costly finished product. This fact is of significance as one considers the lower purchasing power of the people in the world whose major requirement is for additional protein. Another factor of scientific importance to be considered relates to the isolation of the protein. During this process one not only reduces the yield of the protein but, to a certain extent, changes the amino acid balance in the isolated protein, thus slightly reducing the protein quality (3,4). However, this reduction in protein quality can be corrected by addition of certain amino acid supplements to the fabricated food product.

Considering these limitations, particularly the added cost, several United States companies have taken the approach of producing textured soy products more directly by direct extrusion of soy flours or grits or both. The economics for this process are much more favorable in that one is converting all of the protein in soy to a textured form. This is an important factor not only for the United States but more significantly for the world markets. For example, a country like India that is inherently vegetarian and poor, this type of an approach appears to have a more economical merit.

Several products representing this class of material are being produced commercially at the present time with gratifying consumer response.

With two such methods of texturizing oilseeds to choose from, it becomes important to realistically assess the advantages and disadvantages of each. Without question the spinning process produces a textured raw material presenting a good deal of technological flexibility. By virtue of its continuous filament character, this product can be layered, wound or fabricated to nearly any size or shape to produce simulated chicken legs, steaks or hams thus becoming the basis for an intact, formed and finished food. In comparison, the texturized vegetable proteins produced by direct extrusion do not possess the continuous structure necessary to facilitate with ease the formation of such fully formed items, as ham, steaks, etc. They find their most profitable application as a food ingredient. Despite their relatively high content of carbohydrate-protein complexes these extruded products are fairly bland allowing for compatibility in various artificial flavoring systems. As an example, an extruded soy bacon flavored product gave a 2 to 1 preference where compared with regular prefried bacon in a cheese base dip, by panelists at the Museum of Science and Industry in Chiago (Table I) (5).

An advantage possessed by both forms of textured materials is the ability to be manufactured with a variable flavor and textural level with the option of controlling the chemical and nutritional composition. Thus, depending on the application, the processor can choose an overall flavor intensity or a particular flavor note to best suit his requirements.

The extruded material also functions quite well in unflavored forms in various ground meat products, such as a chicken patty (6) or sloppy joes. Economically the extrusion process for texturizing vegetable proteins is a good

TABLE I

Consumer Preference Comparisons of Bacon-Flavored Textured Soy With Prefried Bacon

| Testing center | Per cent preference[a] | | |
|---|---|---|---|
| | Bacon-flavored textured soy | Prefried bacon | No preference |
| Swift Laboratory | 51.1 | 24.4 | 24.5 |
| Museum of Science and Industry | 51.6 | 28.4 | 20.0 |
| Combined average | 51.4 | 26.7 | 21.9 |

[a]Per cent preference results from panelists preferring one sample over another when given the samples in a cream cheese base. (5).

deal cheaper than the spun fiber technique, not only on the basis of raw material but also in unit processing cost.

Due to this latter distinction, it would seem that the food processor must make his choice on the need for versatility of this product. Completely formed foods would require the additional flexibility provided by spun fibers while extruded materials would seem to be the material of choice if it is desired to upgrade or change a food with a material at an ingredient level only. It is in this area that extruded soy protein has found its greatest acceptance in ground meat products.

The nutritional value of textured soy proteins have been repeatedly validated, not only by the companies in the field, but by university and governmental organizations (7). Extensive feeding trials have been conducted under a wide variety of conditions on both animal and human subjects. There can be little doubt by even the most hardened critic that textured soybean proteins constitute a nutritious, easily assimilatable source of proteins and other necessary nutrients.

After satisfying the human safety and nutritional value of these new textured foods by repeated chemical and animal tests, it would appear that the marketing and sale of these products should be left up to the consuming public to determine their acceptability rather than to regulate this acceptability by artificial standards which are often times acting contrary to the interests of the consuming public. The whole concept is aimed at giving the public a highly nutritious and improved functional product at a lower cost than could be obtained by other sources of protein.

The USDA's consumer and marketing services have set standards for the manufacture of various meat and sausage mixtures allowing soy flour and concentrates to be used at 3.5% levels and soy isolates at a 2% level (8). Private correspondence from the USDA has stated that textured flour can be included under the standards of soy flour as discussed above. Manufacturers of meat products have been using either textured soy flour or soy flour terminology for labeling purposes.

In recent months the USDA is considering eliminating the 3.5 level standard for textured soy and allowing the addition of textured protein on the basis of a ratio to the meat in the product. A ratio of 13 parts meat to 1 part textured vegetable would require listing textured vegetable protein in the ingredient statement. At a ratio of 12:10 parts meat to 1 part textured vegetable protein, the processor would be required to list textured vegetable protein in a qualifying phase one third the size of the product name. At a ratio of 9:1 parts meat to 1 part textured vegetable protein, the label is approved on an ad hoc basis.

At present the procedure for labeling is ill-defined and most consumer products are approved on an ad hoc basis. The confusion and lack of understanding regarding labeling has caused many companies to drop projects where meat mixtures with textured soy protein has shown high consumer acceptance. Even though there are present problems and challenges the future for this class of protein foodstuffs is bright and is destined to significantly change the marketplace of protein foods.

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