Textural Contribution of Vegetable Protein Products

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ABSTRACT

Many textural characteristics of food products may be affected by soy protein products. Texture may produce, may limit, may restrict certain of the functional properties of soybean products which have been discussed at this meeting. This paper describes some of the types of textures which soybean products contribute to food products, some of the methodology employed in producing the more common textures, and the rationale for the production of varying textures.

Texture in soy products for food use is important primarily for the contribution it may make to the texture or the characteristics of the final product of which it becomes a part. Also, texture may affect the adaptability of the product in handling or in ease of incorporating it into the final product. Therefore, the texture of choice will be determined primarily by the effect that it has on the end product.

Texture is a complex term covering a multitude of characteristics. Corey (1) has described texture as "another name for the interaction of the human with mechanical properties of the material," and he goes on to state that "a foodstuff cannot have texture, only particular mechanical (and other) properties which are involved in producing sensory feelings or texture notes for the human being during the act of chewing the foodstuff." He also described texture as "the forces and feelings other than flavor sensed in the mouth while chewing a piece of food." Matz (2) had described texture as "those perceptions which constitute evaluation of a food's physical characteristics by the skin or muscle senses of the buccal cavity, excepting the sensations of temperature or pain." deMan (3) has taken a different view of the definition of texture. He defines it as "texture is a way in which the structural components of a food are arranged in a micro and macro structure and external manifestations of this structure." This latter definition, of course, is directed toward the possibility of developing objective methods of describing and measuring texture and eliminating the necessity of actual consumption of the products to determine the texture. Moscowitz and Kapalis (4) have further delineated the complexity of describing texture by listing many factors which should be considered in evaluting texture. These are hardness, viscosity, adhesiveness, cohesiveness, chewiness, gumminess, springiness, mushiness, crispness, creaminess, spreadability, toughness, crunchiness, tenderness, and juiciness. Many attempts have been made to develop instruments which will evaluate these characteristics in a manner that is correlatable with the human sensations when the food is masticated. Much emphasis has been placed on rheological measurements, and some of the problems have been discussed by Szczesniak (5). However, as Martinez (6) has pointed out, "application of rheological principles to individual ingredients in model systems as predictive measure of texture-forming capability in a food system is a misuse of the tool." This emphasizes the fact that until better methods are developed, the final measure of acceptance or evaluation of textural properties must be made by the human on the final product, permitting the recognition of the final textures expressed by the combination of all of the ingredients collectively.

Since texture is determined largely by the individual as he is chewing the food, food scientists have been attempting to improve the acceptability of many foods which may leave something to be desired in the texture of those products which are not completely adequate in their fulfillment of the sensory perceptions, and also, and more importantly, to utilize many foods which are not acceptable from the palatability standpoint. Since the soybean does possess many desirable functional characteristics, as described by Kinsella in the previous paper, the soybean has received a great deal of attention for this purpose.

All of the edible soybean products, including the flours, the concentrates and the isolates, contribute in some degree to the texture of products in which they are incorporated. Soy flour when added to puddings will increase the viscostity and make a thicker pudding. Soy flour when added to bread will also produce negative effects; that is, it will decrease the volume of a loaf and provide a more undesirable dense texture when incorporated in loaves of bread at significant amounts to increase the level of protein of the bread. However, this prompted the work of Tsen, et al. (7), who found that the addition of sodium stearoyl-2 lactylate would overcome this effect and permit the use of soy flour to increase the level and the quality of the protein in white bread.

The textural characteristics are quite critical in some products, such as yogurt, as discussed by Kolar at this conference. In this type of product, the consistency as related to its viscosity and gel characteristics is determined to a very significant degree by the milk protein in the product.

When a powdered soy protein isolate produced by the procedure described by Waggle and Kolar (8) is substituted for nonfat dry milk on an approximate ratio of one part of the isolate to replace three parts of the milk, a gel structure is produced which is quite comparable to that produced by the milk at the higher level. It should be pointed out that the soy isolate is over 90% protein, wherease the dried milk product is ca. 33% protein; therefore, the protein content is approximately equal. Further, if a firmer gel is desired, the use of higher levels of the soy isolate will produce a firmer gel. This permits the manufacturer of the yogurt much wider latitude in the consistency of the product he is producing.

The physical-chemical basis for foams, as another desired texture in products such as toppings, has been described by Richert (9). While egg albumen is considered to be the standard for the production of stable foams, a substitution based on soy protein will provide a stable foam.

There are, of course, many other similar uses in addition to these examples; but the point here is that while we do not usually consider the powdered forms as contributing to texture, in fact there is a very significant contribution even

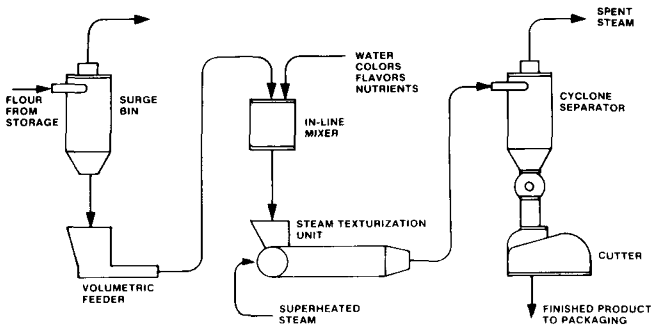

FIG. 1. Steam texturization process.

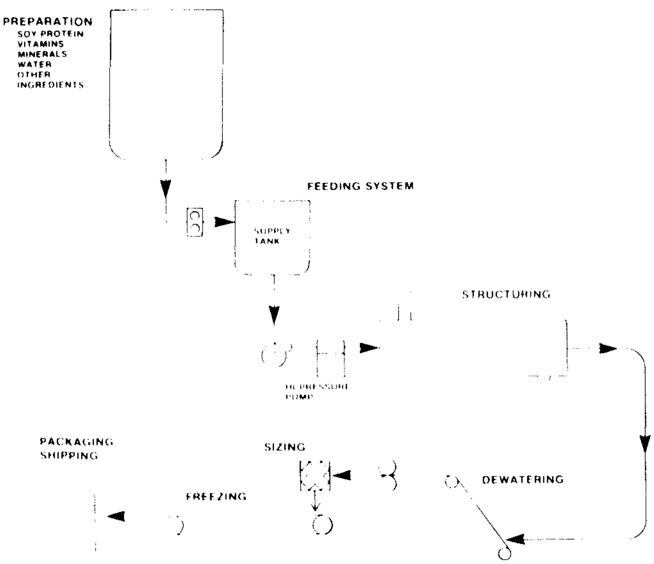

FIG. 2. Process for manufacturing structured isolated soy protein.

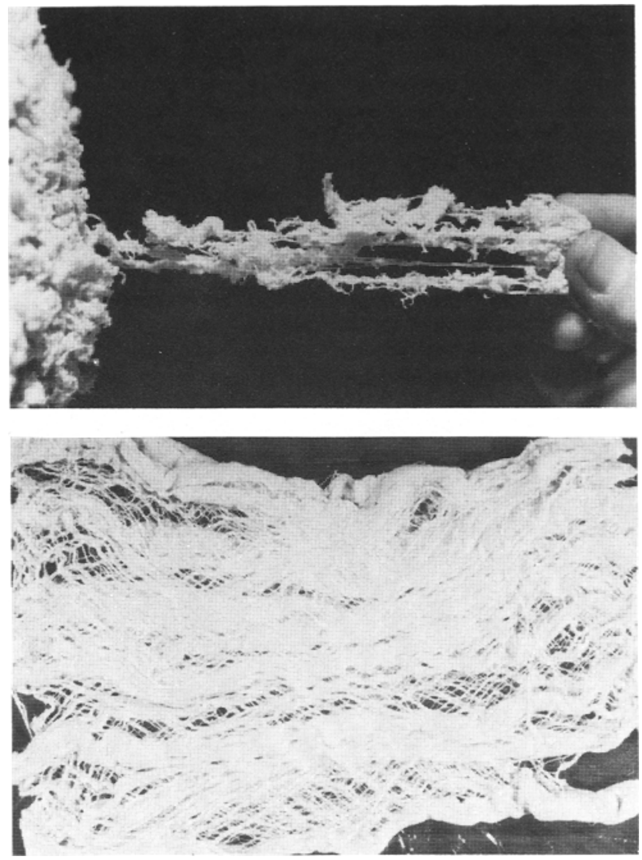

FIG. 3.

from the powdered forms, and there is a very definite place for the powders in the nonfibrous types of food products.

One of the areas where soy proteins make their greatest contribution and find their greatest usage is in the production of emulsified or comminuted meat products. This includes sausage type products, such as frankfurters, mortadella, bologna, and also fish balls, fish paste type products, and other similar foods. In this type of products, the soy protein has been found very desirable because of its fat-emulsifying and water-binding properties. In the production of emulsified meat products, the fiber structure has been destroyed, and the frankfurter produced from this is a meat gel which provides the characteristic texture for these types of products. Thus, the addition of a spray dried isolated soy protein, rehydrated in water at the proper concentration and mixed with a meat slurry and heated, will form a resilient gel. The soy protein isolate then has capabilities of forming gels similar to the meat protein in this type of application.

The use and manufacturing of textured soy flour products of ca. 50% protein has been described in detail in previous conferences. While other nontextured protein sources can be made into a fiber structure by this technique, soy flour offers advantages of an abundant supply which is also economical. Defatted soy flakes, grits, or flour can be used as a starting product for the extrusion process. Preconditioning with water and steam initiates the hydration of the protein-carbohydrates and decreases the stickiness of the raw material. The extrusion process combines blending, high shear mixing, elevated temperatures and pressures to form the proteinaceous material into a continuous phase. When passed through the die, the sudden release of pressure allows the superheated moisture to expand and flash off, leaving a cellular matrix which provides the desired texture. When added to certain types of meat products, this produces a texture which has a chewiness which is similar to meat.

More recently, a direct steam texturization process has been described (10,11). Soy flour is metered into a blender to which water, colors, flavors and other ingredients are added. The finely divided particulate protein material may be texturized by passing the material through an elongated cylinder or piper and applying elevated pressure and temperature. The textured particles are separated from the steam and then cut to the desired size. A resulting product is flakelike in form, it has the property of rapid hydration even in cold water, and it produces a very bland flavor. The process for producing this type of a texture is described in Figure 1 (12). These products are used to produce a desired texture in fresh, fresh-frozen or cooked-frozen meat patties and many other ground meat formulations.

One of the early processes for the texturization of protein fibers was that described by Boyer (13) in which the protein fibers were spun into a fibrous texture. Briefly, after extraction, acid precipitation, and washing, the soy protein is reslurried in water and metered to a mixing pump where alkali is added to form an alkaline spinning dope. The filtered dope is then forced through spinnerettes (in common usage in the rayon industry) into an acid-coagulating bath to form filaments or fibers about 0.0762 mm in diameter. The fibers are washed and stretched to alter the texture, which can range from tender to tough by controlling the degree of stretching. The stretched fibers are then treated with binders to form bundles of fibers to which fat, flavor, color stabilizers, and other ingredients are added. After cutting into the desired particle size, the products can then be processed to attain the final product characteristics. Texture of finished products can vary from a crisp crunchiness typical of fried bacon, to the chewiness of poultry meat. Obviously, since this is a fiber, it can be used as a source of fibrous texture to stimulate meats or to extend meats. This product has been used to produce simulated bacon, ham, and other familiar meat cuts.

Another process has been developed which will structure soy protein isolates. This is an indirect heating method which produces a structured isolated soy protein which can be directly incorporated into meat products. The structured protein has a pleasing taste and mouth feel. It is described in the patent issued to Hoer (14) and illustrated in Figure 2. The product is produced by heating a slurry of proteinaceous material by conducting the slurry through a heat exchanger under high pressure. After the proteinaceous slurry passes through the heat exchanger, it may be cooled and collected. The structured protein is recovered and dewatered. This product is kept in the frozen state until used. The product as produced is made up of ca. 35% solids and 65% water on an as-is basis. By varying the pH of the product, the texture may be made softer at higher pHs or tougher at the lower pHs. If desired, the structured protein may be cut into smaller particles for incorporation into food products. The filaments are tender and bland, quite irregular in shape and not as uniform as in the spun process, but, as illustrated in Figure 3, it does provide a very definite and desirable fibrous texture. This product is used to provide increased bite or texture in mechanically deboned (U.S.D.A. regulations require the name "mechanically processed – species – product") red meats, poultry, and fish where muscle fiber texture is destroyed; to simulate the texture of crab meat; to provide texture to turkey and chicken rolls which are prepared from high quality muscle tissue into a firm, stable form. It may also be used in other products where a definite texture is desired.

There are, of course, other methods of producing various types of texture in soy products and also for other plant proteins; but those under discussion today are the primary products and those which are available on the market at the present time. Soy protein products, regardless of their physical form, can and do contribute significant textural properties to the final food products in which they are used.

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