Food Technology

Soy protein use in meat, seafood

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The use of cereals, fruits and legumes in meat food analogs is well documented throughout the history of man. The Chinese discovered the miracle of the soybean 4,000 years ago. The Western world took a little longer.

Soybean derivatives made their initial impact on the meat industry in the 1960s. The ability to texturize soy flour into discrete particles that, when hydrated, had textural properties similar to coarse ground meat, opened up opportunities in the meat industry and paved the way for product innovations and advances in technology.

Textured soy proteins

The first form of soy protein to be textured for commercial application was soy flour. Archer Daniels Midland Co. (ADM) patented this technology in 1970.

Soy protein concentrates have provided the base for a second generation of textured proteins. Textured soy concentrates are 70% protein on a dry-solids basis, and they have excellent textural and water-binding properties. Unlike textured soy flours, textured soy concentrates are bland in flavor and do not cause flatulence when consumed, because the soluble carbohydrate has been removed.

Textured soy protein concentrates are generally used in ground meat systems. Textured concentrates are typically added to meat and poultry products at levels of 4-6% and are hydrated with two-and-a-half to three times their weight in water. Because textured proteins do not have the binding properties that meat has, it is common to use functional soy concentrates or isolated soy proteins in patty applications to maintain cohesiveness in the product.

Functional soy concentrates

Functional soy concentrates have been commercially available for about 20 years. In recent times, due to technological improvements, functional concentrates can be manufactured that are bland in flavor and that exhibit functional properties rivaling those of isolated soy proteins.

Two major companies—ADM and Central Soya Co. Inc.—currently produce functional soy protein concentrates. These products are increasingly found in processed meat, poultry and seafood products throughout the world. The excellent water-binding and emulsification capacities of these functional concentrates provide exciting product-application possibilities for today's food scientist.

Isolated soy proteins

Isolated soy proteins contain a minimum of 90% protein on a dry-solids basis and are the purest form of protein derived from soybeans commercially available today. Isolated soy proteins are produced in many forms, including dried powders, textured granules and frozen meat-like fibers.

Isolated soy protein, at its isoelectric point at pH 4.2–4.5, has extremely limited functionality. However, various functionalities can be produced from this base material using a number of manufacturing techniques. Functionalities of prime importance to the food scientist are emulsification of fat, water absorption, viscosity, gelation, dispersibility and solubility.

Isolated soy proteins are used in a wide variety of foods throughout the world today. Because of their exceptional functional and nutritional properties, they are of major interest to the scientist working with muscle food products including red meats, poultry and seafood. Isolated soy proteins can be used to replace traditional muscle proteins and still maintain excellent product quality and nutritive value.

Isolated soy proteins may be used in muscle food products in a variety of ways including powdered form, prehydrated gels or liquid dispersions such as brines.

Diet meat analogs

The injection of protein-fortified brine into whole muscle tissue is not a new concept. The use of isolated soy proteins and Kappa carrageenan to create a reduced-calorie restructured ham or pork steak has gone beyond the experimental stage in New Zealand and Japan. It now is possible to manufacture a meat analog with the texture, appearance and taste of its all-meat counterpart, with less that 100 calories per 100-gram serving (Table 1).

TABLE 1

Diet Ham Analog[a]

Item	Composition (%)
95% Lean ham	49.42
Water	46.04
Isolated soy protein	1.83
NaCl	1.43
Sodium phosphate	.34
Seasonings	.36
Curing agents	.06
Kappa carrageenan	.52
Total	100.00

[a]Note: The processing format incorporates an injection phase, an absorption phase and a protein-extraction sequence. All are necessary to achieve the proper texture and appearance.

TABLE 2

Kamaboko-type Products

Parameters	Control kamaboko[a]	Kamaboko with isolated soy protein[b]
Color L	74.3	88.3
Color a	−1.4	−0.6
Color b	5.7	7.1
Strength (g)	420.	440.
Strain (mm)	11.	11.
Folding test	AA	AA

[a]Composition: For every 100 parts surimi, add 10 parts water, 2.5 parts salt and 5 parts starch.
[b]Composition is the same as the control except replace 10% surimi with isolated soy protein curd (curd composition is an emulsion of 10% isolated soy protein, 50% ice water and 40% soy oil).

Isolated soy proteins in fish

Whenever possible, manufacturers of fish products prefer to use fresh fish for processing such products as fish balls (canned, frozen, refrigerated), fish cakes and kamaboko.

Fresh fish supplies are not always available. In recent years, the fleets have been forced to go farther afield for catches of sufficient quantity to fill the hold, and it has become a general practice to filet and freeze the catch while still at sea. Inland locations of some of the factories make it necessary to transport the fish in the frozen state.

The fishing industry still has to rely on "hunting." It is not always possible to guarantee the size of the catch or the timing of the return to port. In order to ensure continuity in production, it is much better to purchase frozen fish from a central store. The price of fish also fluctuates, depending on such factors as seasonal variations in availability and weather.

Finally, it is not always possible to use all the material produced in minced fish production. The unused portion must be stored frozen.

Fish protein is very susceptible to denaturization when frozen and subsequently thawed. Most of the damage occurs during the freezing state, but thawing undoubtedly has some influence. Factors such as how fast the fish was frozen, the formation of ice crystals in the flesh, and the storage temperature and duration determine the extent of denaturization of the protein. However, even if these factors are carefully controlled, there still is irreversible damage caused to the fish protein.

This damage may be manifested in various ways. The result, however, is always the same: the loss of the binding ability of the proteins. The myofibrillar proteins of fish in their undamaged state will bind water, and when cooked, will coagulate. This ability provides the finished product with the texture and elasticity that is organoleptically described as having the right amount of bite and chew. In these products, the effect of using frozen fish is to make products that, for all practicality, have "lost their bite." That is, elasticity is lost and they have become soft and crumbly. Subsequently, high frying losses occur and the shape deforms when the product is cooled.

Two methods currently are used for minimizing the damaging effects of freezing on the finished product. The principles of the two are quite opposite. The first method, favored by the Japanese, is to attempt to prevent the damage by treating the fish before it is frozen. Treatments with phosphate, sugar and sorbitol after washing with clear water are the basis of surimi manufacture. The second method is to restore the binding power of the fish protein to the fish after it is frozen.

Emulsified fish products rely very heavily on the functional properties of the salt-soluble myofibrillar proteins. The denatured fish protein that has lost this ability through freezing can be restored by fortification with isolated soy proteins. Isolated soy proteins assist the weakened fish protein by binding moisture (natural and added), emulsifying oils or coagulation upon heating. The whitening of fish flesh is greatly enhanced by incorporating soy, oil and water curds.

Testing performed in Japan indicates that kamaboko-type products can be made significantly whiter and firmer by the proper use of isolated soy products (Table 2). Technologically, soy derivatives can be effectively used by the food scientist today to maintain traditional product quality and nutritive value.

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