Recently, Poullain, et al., (2) in the course of a study on the utilization of textured soy protein in human food, demonstrated that there is no significant difference in the nitrogen balance between a diet of meat or one comprising TVP. However, seven out of 10 subjects had a better protein balance during the period in which they had the meat diet.

In general soy products are well established as a source of protein which can replace, at least partially, meat in the human diet. Their incorporation in the manufacture of meat products of the French type can be beneficial from a technological and economical point of view, when the level of substitution in meat does not exceed 15%, to assure the preservation of its highly organoleptic attributes.

Their use in France is, however, singularly held back by a regulation problem. In fact, demonstrational tests and data on dosage of soy proteins in meat products were proposed in foreign countries, particularly in Germany. In general, these tests are based upon methods of electrophoresis or immunology. Frouin, et al., (3) then presented a simple method at the last European Meeting of Researchers for Meat.

It seems that the curing industry is favorably inclined to the utilization of soy proteins in meat products. A revision of the methods and norms of additions must be undertaken; and, at the moment, there are two different tendencies. The first concerns isolates of 90% proteins and concentrates of 70%, the utilization of which would be authorized as additives, at a dry percentage of ca. 1%, analogous to that which is, at present, permitted for lactoproteins. Beside meeting the additive requirement, this addition would comply with the law on labeling of October 1972 and would be mentioned under the category of vegetable protein binding agent.

The second possibility of incorporation concerns the textured proteins, be it by means of thermoplastic extrusion or by means of spinning. Since the taste is neutral or can be camouflaged by other flavors, the texture would permit more widespread use. The labeling of these products would describe clearly their composition by using terminology, such as fancy vegetable patty.

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Soy Protein Concentrates and Isolates in Comminuted Meat Systems

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Although stable meat emulsions can be made using meat proteins alone, the variance in the quality and type of meat trimmings used in sausage making may lead to the breaking of the emulsion and excessive water and fat losses during cooking. The addition of soy proteins prevents such losses, and at the same time increases protein content and yield of the final product. Both soy protein isolate and soy protein concentrate are used for this purpose. In this paper their performance in coarsely and finely ground meat systems will be demonstrated by a number of practical examples.

SOY PROTEIN ISOLATE

Soluble soy protein isolates are used mainly for their emulsifying capability, their emulsion stabilizing effect, and their property of increasing viscosity and forming gels on heating. All these properties contribute to the formation of a stable meat emulsion and a high quality product without separation of fat or gelly. This is particularly important in products that require high processing temperatures.

An example is the use in cooked sausages; Table I shows the application in frankfurters. Two frankfurter formulations are given, one with a total meat protein content of 10% and another with a total meat protein content of 11%. In both cases, 1% of the meat protein is replaced by 2% soy protein isolate, and both are adjusted.

Table II relates the effects of isolated soy protein (ISP) on quality characteristics of the product. These data were obtained by subjecting the products to a trained taste panel. Flavor scores are based on a 7 point hedonic scale, with larger numbers indicating a more acceptable product. Soft/firm ratings also are based on a 7 point scale; the smaller numbers indicate a firmer product. Statistical evaluation of our taste panel procedure indicated that a differential of 0.4 units is necessary to obtain a significant

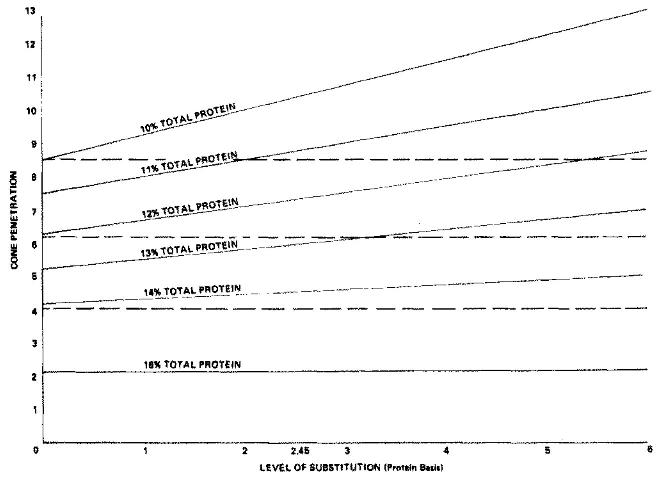

FIG. 1. Cone penetration vs. soy protein concentrate substitution.

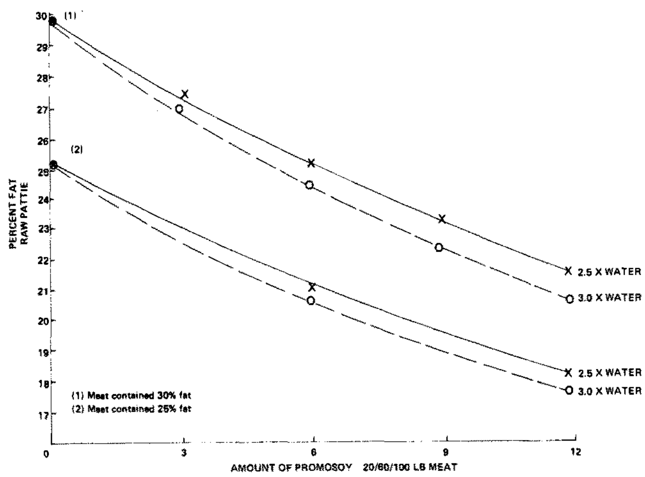

FIG. 2. Percentage fat in raw patties at various levels of soy protein concentrate and various levels of water addition. (Initial fat content of meat block 30 and 25%.)

TABLE I

Commercial Frankfurter Formulations Utilizing Isolated Soy Protein

Variable ingredient	A All meat 11% meat protein, g	C 10% Meat protein 2% isolated soy protein, g	A' All meat 10% meat protein, g	C' 9% Meat protein 2% isolated soy protein, g
Beef chuck	1183	958	958	746
Beef cheek	360	360	360	360
Pork trimmings	778	813	813	839
Beef navel	612	693	604	657
Pork fat	—	—	—	50
Beef fat	—	—	136	135
Ice	789	826	851	863
Seasoning mix	198	198	198	198
Isolated soy protein	—	72	—	72

TABLE II

Quality Criteria of Frankfurters Utilizing Isolated Soy Protein

Ingredient	All meat 11% meat protein	10% Meat protein 2% isolated soy protein	All meat 10% meat protein	9% Meat protein 2% isolated soy protein
Meat protein (analytical)	11.1	10.3	10.7	9.7
Total protein	11.1	12.1	10.7	11.5
Flavor	4.5	4.3	4.8	4.2
Soft/firm	2.8	2.9	2.9	3.2
Smokehouse shrink %	8.4	7.9	8.3	6.1
Consumer shrink %	2.0	1.2	1.8	1.1
Cost/lb emulsion	52.3	48.7	46.4	44.5

difference.

From these data, it is apparent that ISP can be used as a comminuted meat ingredient. According to taste panel results, an 11% meat emulsion can be converted to a 10% meat protein-2% ISP without significant changes in quality. Emulsion cost is reduced without considering the increased yields due to decreased shrink. The picture changes slightly when total protein is reduced in the emulsion. Flavor and overall acceptability decreased when 10% protein products were substituted with ISP. Although these values are significant, we have found differences larger than this between two commercial samples of the same brand.

ISP also is used to an advantage in canned meat items; it is not affected adversely by high processing temperatures.

TABLE III

Commercial Canned Luncheon Loaf Formulation Utilizing Isolated Soy Protein

Ingredients	Percent
Beef (5% fat)	15.00
Veal (7% fat)	10.00
Pork head meat (70% fat)	8.00
Trimmings (50% fat)	8.50
Rinds (including 25% ice)	5.00
Shoulder pork (20% fat)	10.00
Fat	26.50
Ice/water	12.00
Salt, spices, cure, and phosphate	2.50
Soy protein isolate	2.50

TABLE IV

Semimodel Frankfurter Formulation

Ingredients	Control, g	10% Meat protein 2% soy protein concentrate-protein, g	8% Meat protein 4% soy protein concentrate-protein, g
Beef chuck	2590	2158	1726
Lard	804	870	936
Water	786	1033	1281
Cure mix	180	180	180
Spice	40	40	40
Soy protein concentrate	—	119	237
% Total protein	12	12	12
% Total fat	30	30	30

TABLE V

Semimodel Luncheon Loaf Formulation (Non-specified)

Ingredient	Control, g	12% Meat protein 2% soy protein concentrate-protein, g	10% Meat protein 4% soy protein concentrate-protein, g	8% Meat protein 6% soy protein concentrate-protein, g
Beef chuck	3103	2660	2217	1773
Pork lard	506	562	618	675
Water	1154	1409	1665	1919
Spice	4	4	4	4
Cure mix	182	182	182	182
Soy protein concentrate	—	132	264	397
% Total protein	14	14	14	14
% Total fat	20	20	20	20

TABLE VI

Economic and Quality Considerations of Soy Proteins in Meat Patties

	All meat patties	6% Soy protein concentrate patties	10% Soy protein concentrate patties
Meat	100 lb	100 lb	100 lb
Soyabits	—	—	—
Soy protein concentrate	—	6 lb	10 lb
Water (added)	—	18 lb	24 lb
Total wt	100 lb	124 lb	134 lb
% Fat	30.0	24.0	22.4
% Protein (uncooked)	16.0	16.3	17.4
% Shrink	33.4	32.3	23.0
% Protein (cooked)	24.0	24.2	21.8
Cost/lb product[a]	0.91	0.71	0.66

[a]Meat price $.60/lb.

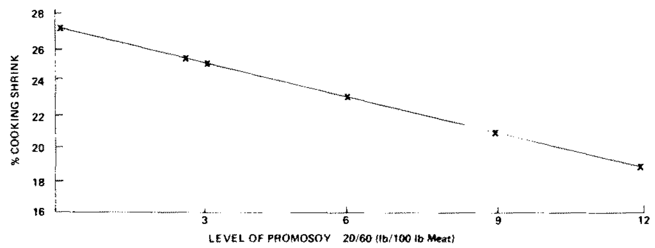

FIG. 3. The percentage of decrease in cooking shrink is shown at increasing levels of additive. (Meat block contains 25% fat.)

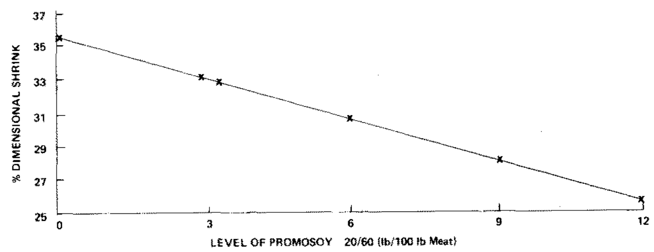

FIG. 4. The percentage of dimensional shrink is shown at increasing levels of additive. (Meat block contains 25% fat.)

There appears to be an additional stabilizing effect at the higher temperatures which may be explained by the formation of a three-dimensional network on gelling that entraps the fat globules and prevents them from coalescing. Suggested formulation for canned luncheon meat is shown in Table III.

SOY PROTEIN CONCENTRATE

Soy protein concentrates are used for both meat extension and functionality. All data presented are based on soy protein concentrate produced by the alcohol extraction process. Although the concentrate prepared by this process is essentially insoluble, it absorbs significant amounts of water and fat. Fat and water absorption are most desirable properties, and the addition of concentrate results in increased juiciness and reduced shrink during cooking or frying.

Basic formulations for frankfurters are shown in Table IV. These are semimodels because only beef chuck and pork lard were used to enhance our ability to control basic composition of the emulsion. Evaluations utilizing similar formulations were made at 10% protein. Standard commercial chopping and cooking procedures were used.

An example for luncheon loaves (non-specific) is given in Table V. In addition, luncheon loaves containing 10, 14, and 16% total protein also were studied.

In these frankfurter and luncheon loaf experiments the Instron and cone penetrometer were used to evaluate textural properties. Both the cone penetrometer and Instron correlated favorably with taste panel results; therefore, textural properties will be reported as cone penetrometer values.

Results are: (A) Soy proteins function better in low fat, high moisture emulsions; (B) product acceptability is increased as total protein increases; (C) products containing soy protein concentrate were equal to all meat products in juiciness and visual texture; (D) process shrink for soy protein concentrate emulsions was equal to or slightly superior to all meat. However, the differences were most significant; and (E) the most significant findings of this study are depicted in Figure 1, a plot of cone penetration vs. level of substitution. Ca. 70% of the variation in overall acceptability could be accounted for by this method with the balance of variation in flavor, color, etc. Using these data, one can predict the optimum amount of soy protein that can be used in a system to give a product of equal quality at less cost. As can be noted from this information, an increase in total protein causes a decrease in cone penetration. However, if protein level remains constant, cone penetration increases as level of soy protein concentrate substitution increases. There was no flavor or color problem at the levels of substitution investigated.

The use of soy protein concentrate in coarsely ground meat products such as meat patties is shown in Table VI. Amounts of 6 and 10% concentrate are added. It is important to add ca. 2.5-3.0 times its wt of water since otherwise the concentrate will compete for the meat juices and the pattie will be too dry. The advantages are lower fat content, decreased shrink, and considerably lower cost. Surprisingly the products containing soy protein concentrate were rated higher by the taste panel than the all-meat control, probably because of the increased juiciness. It appears that patties containing 6-10% soy protein concentrate and 20% fat would be the product of choice if prime consideration is given to palatability, nutrition, and economics.

Figure 2 shows the decrease of the fat content with increasing substitution resulting in a reduction of the initial fat contents from 30% and 25% to ca. 24% and 20% at the 10% substitution level. The dependence of the cooking and dimensional shrinks on substitution level is demonstrated in Figures 3 and 4. In both cases the shrink is reduced significantly as the level of substitution is increased.

It is not within the scope of this presentation to describe the application in all finely and coarsely comminuted meat products. However the few examples given are typical, and in principle most of this information is applicable to other similar meat products. The functional properties mentioned are the principal responsible factors in the performance of isolates and concentrates in meat regardless of the particular type of meat product.