Textured Proteins in Meats and Meat-like Products

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ABSTRACT

The forecasted use of textured soy protein by 1980 is 10-20% total beef market. Important factors in the use of textured soy protein are cost control, improved functionality, fat control, and nutrition. Blends of textured soy protein and ground beef give nutritional quality exceeding protein efficiency ratio of 2.5 (casein) in several products evaluated. Animal feeding data are given for these blends. A description of the proper use of soy in meat is given. Bacteriological and color problems are not due to the addition of textured soy but increased temperatures of handling the blended product.

INTRODUCTION

This paper primarily will discuss the thermoplastic extrusion type of textured soy proteins. These vegetable protein sources were developed for elaborating a fibrous texture into an economical and highly nutritional protein source. Among the textured food categories, meat or meat-like products have become dominant.

Recent world food and feed protein changes have significantly altered forecasts of textured soy protein usage in meat systems, primarily because of changes in price and functionality. Some leading authorities in the U.S. are predicting that by 1980, ca. 25-50% all ground or processed meat products will be using textured soy protein as a significant ingredient.

Table I gives the 1972 production of three meat product categories. Because of the difficulty in accurately accounting for the total volume of ground beef, 20% total beef production was used. Assuming an overall usage of 8.0% textured soy (dry basis) in meat-like products (25% meat alternate level) ground beef, meat loaf products, and fresh finished sausage would use 440,389,920 lb textured soy/year. The U.S. Department of Agriculture predicts (1) that, by 1980, soy meat alternates will constitute 10-20% all meat consumed. This would suggest a 2-4 billion lb hydrated soy market. This shows the potential of this developing area of textured soy. Textured soy protein is used in meat products for the important reasons discussed below.

COST CONTROL

The inflationary trends that are taking place with conventional protein foods, i.e. meat, milk, and eggs, are causing many people to seek other materials to help control the price of products for the consumer. Product development is being pursued toward meat-like or meat combination products of high quality and acceptance. The most rational approach for supplying textured proteins to a greater base of the population whose food budget is restricted is blending good quality proteins to strengthen a product. Unless meat protein products continue to exist at a price that the majority of people can afford, consumers may be forced to purchase non-meat protein products, thus eliminating a desired meat product from their diets.

TABLE I

U.S. Production of Various Meat Products—1972

Product	Weight (lb)
Ground beef	4,482,600,000
Meat loaf products	283,391,000
Fresh finished sausage	738,883,000
	5,504,874,000

TABLE II

Meat Yield in Chili Using Textured Soy Protein

	Level of hydrated soy			
	0%	12%	21%	30%
% Yield of meat	70	75	80	87.4

IMPROVED FUNCTIONALITY

At the core of this new product development program is improved functionality, making the product more acceptable to the consumer with knowledge of the protein composition. A recent informal poll was taken by an employee of our company among those who were users of soy protein in meat-like products. They were asked how their customers reacted to the use of textured soy protein. Ca. 100% those using textured soy products stated their subjects did not want to return to all meat products because of the improved texture and physical characteristics of the meat textured soy blends. For example, it has been demonstrated that a superior product can be made for the growing pizza topping market by the use of textured soy protein. In the processing step to remove excess juices, an all meat product sticks together and lacks the proper spreading characteristics in contrast to a meat soy blend. In chili the addition of textured soy, not only increases the protein level beyond what is normally expected, but improves the consistency, appearance (reduces the floating fat and increases the meat-like texture), and acceptability

TABLE III

Fat in Ground Beef and Textured Soy

Product	Moisture	Fat	Consumer acceptance rating[a]
Ground beef	60.3	20.1	5.71
Ground beef 67% Textured soy 33%	64.4	13.3	6.58

[a]Basis 10 = top score.

TABLE IV

Percentage of Adult Requirement[a] of Amino Acids Found in 45 g Protein from Beef, Textured Soy, and Beef Soy Blends

Essential amino acids	Beef	Textured soy	70% Beef 30% soy
Lysine	490	330	440
Threonine	400	330	380
Valine	310	280	300
Methionine	100	50	90
Total sulfur AA	150	120	140
Isoleucine	340	330	330
Leucine	370	350	340
Phenylalanine	170	190	170
Tryptophan	210	220	220

[a]New U.S. recommended daily allowance (adult) is 45 g protein (protein efficiency ratio 2.5).

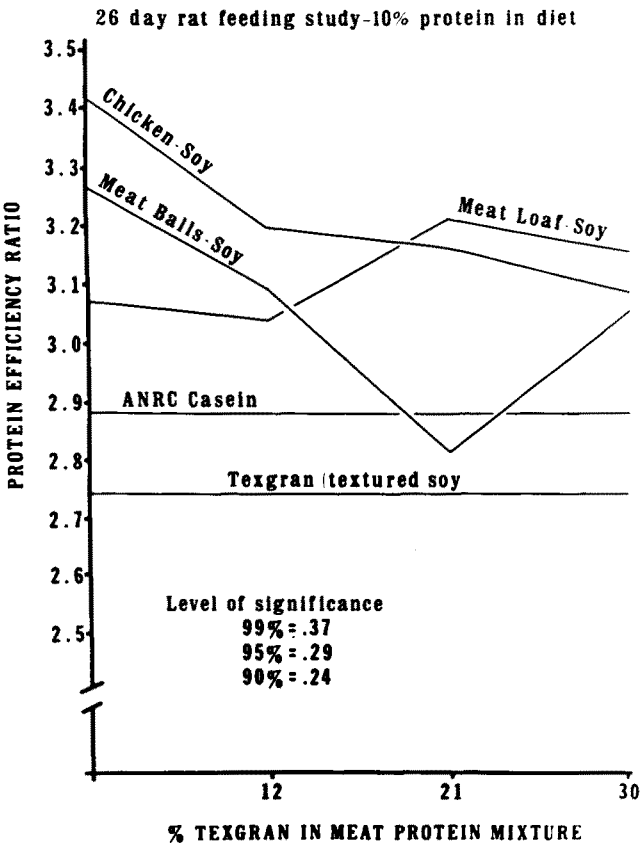

FIG. 1. Nutritional value of meat soy protein mixture.

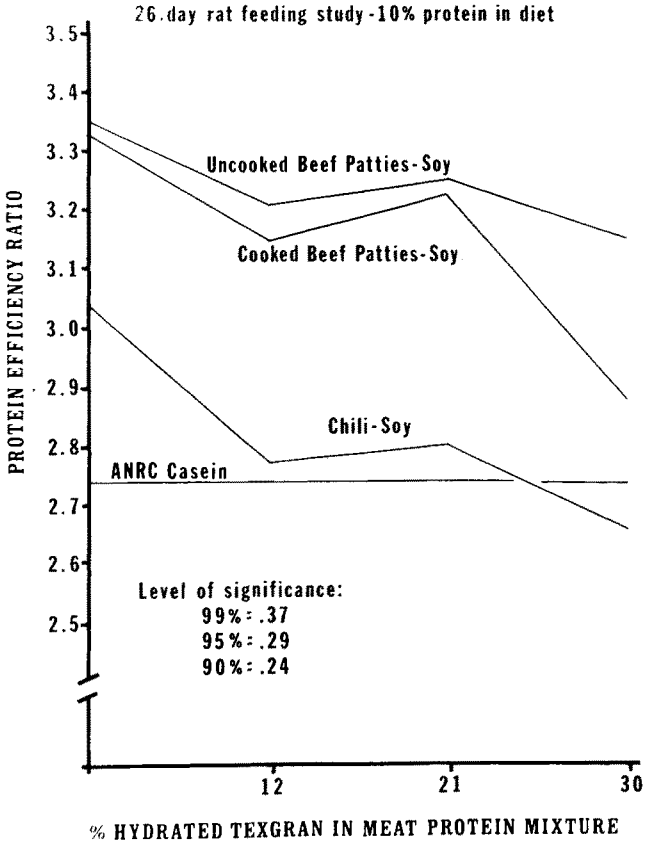

FIG. 2. Nutritional value of meat soy protein mixtures.

of the product.

Other types of ground meat mixtures with textured soy protein can retain the natural desirable juices and flavors that ordinarily would be lost during cooking of the products. Research and market testing have shown that the open and juicy texture provided by a mixture of ground meat and textured soy often is preferred over a comparable all meat product by the average consumer, even though the product may be slightly different. The increased juice retention contributes to acceptability.

Increased yield using textured soy protein is shown more precisely in Table II. These values for chili represent the normal shrink loss for all meat and meat soy blends. We have observed that the increased absorption during cooking (lower shrink loss) occurs preferentially in the water phase in contrast with the fat phase.

FAT CONTROL

Many recent discussions and papers have expressed the pros and cons of saturated fats and the total level of fat in the diet relative to good health. If producers, marketers, and consumers of meats are concerned about these relationships, the level of fat can be reduced significantly by improved mixtures of meat and textured soy protein, because textured soy contains less than 1% fat (Table III).

NUTRITIONAL QUALITIES

For many years, nutritionists have recognized the excellent quality of meat protein. Thus, any product that fills this market need should be nutritionally comparable to meat. Several studies (2,3) have shown that soy protein does not significantly degrade meat protein nutritionally.

Table IV gives the percentage of adult requirement of amino acids found in 45 g protein from beef, textured soy, and a blend of 70% beef and 30% textured soy. It should be noted that the balance of amino acids in the blend is comparable to beef. As noted later, a slight supplementation of methionine will improve the overall quality significantly.

To define these meat soy mixtures further, biological rat feeding studies were conducted on six different types of meat protein mixtures (chicken patties, meat loaf, meat balls, cooked and uncooked patties, and chili). Each mixture was tested in combination of 0, 12, 21, and 30% levels of hydrated textured soy. The soy was hydrated to a 65% moisture level, and the samples were divided based upon their fat content. The chicken pattie, meat loaf, and meat ball soy diets were adjusted to 17.5% fat. All other nutrients were equated; each group had its appropriate casein control. All samples were frozen and freeze-dried to prevent quality changes.

Figure 1 shows the protein efficiency ratios (PER) for the low fat group at the various levels of soy. It should be noted the textured soy has a PER 95% the value of casein. Even though there were some biological variations, the experimental values fell significantly above the casein control.

Figure 2 shows the PER's for the high fat level diets with its control. In all cases the data were analyzed by using individual rat feed consumption and growth data and not group averages, which commonly are used in the official method.

Linear regression was used to test trends in PER with changes in textured soy levels. Figure 3 shows the trends significant at the 95% level of confidence. There is no difference in the regression slope between cooked and raw patties, even though the raw pattie tended to give slightly higher protein values. The increased negative slope for chili suggests that extended cooking may decrease the protein value slightly with soy mixtures by increased browning reactions, as compared to all meat mixtures.

The above data demonstrate the adequacy of using textured soy protein when blended with meat protein at a 30% level, to exceed the nutritional value of casein.

Other studies (4) have shown that a 1% addition of

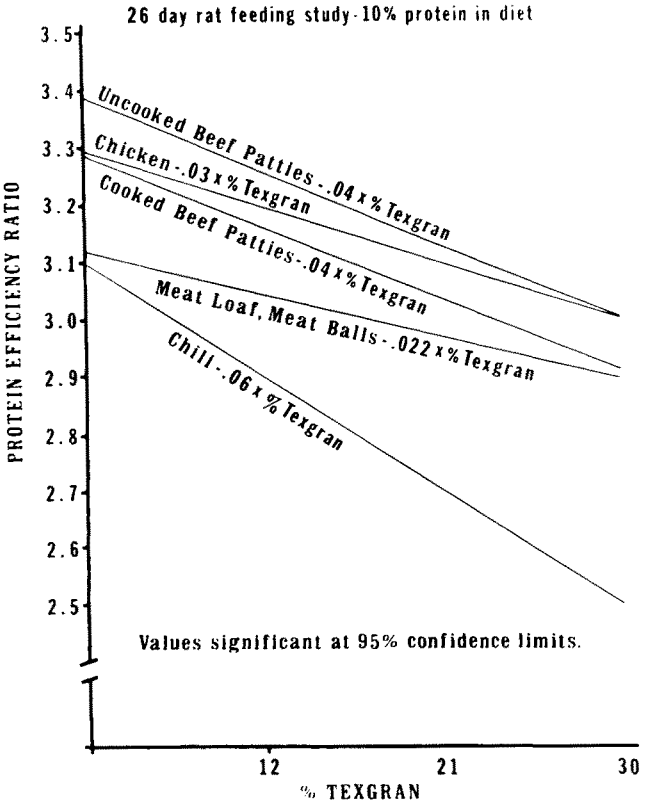

FIG. 3. Linear regression curves showing changes in protein efficiency ratios vs. textured soy level.

methionine to a beef soy mixture enhances PER to 2.82, when ground beef has PER of 2.37.

HOW TO USE TEXTURED SOY PROTEIN

Textured soy protein when hydrated should be handled like meat when preparing meat products. First, the lean and fat meat portions are cut into chunks. Next, the meat, textured soy, water, and spices are weighed to the correct proportions. Next the spices or flavorings are added to the water and then added to hydrate the soy. All are mixed together thoroughly before coarse grinding through a 1/2 in. die. Then, this product is fine ground to the desired degree of texture before forming into patties, meat balls, loaves, etc.

To minimize the soy flavor (that can be characteristic in these products), spices and seasonings should be added to the hydration water and the hydrated mixture allowed to set (refrigerated) for flavor penetration into the soy, rather than the meat. In certain types of products, such as sloppy joe, the lowering of the pH tends to enhance undesirable flavors and should be avoided, if possible.

BACTERIOLOGY AND COLOR

New users of textured soy protein tend to blame the soy for any problems that arise in product development and usage. Chief problems are off-color and bacteriological growth.

It should be noted that textured vegetable protein processed under normal conditions is essentially sterile. Thus, any addition of textured soy protein does not contribute to the bacteriological load but should have a dilution effect. Workers at the University of Minnesota (5) have reported that "beef products offer an excellent medium for rapid growth of *Clostridium perfringens* and that the addition of soybean additives did not show any significant effects." Other work (6) shows an inhibitory effect on bacterial growth of soy protein in certain meat products.

To avoid these problems, it is important that the meat and hydrated soy be used at a temperature not exceeding 35 F. Often the soy is hydrated with warm water, thus increasing the overall temperature. If temperatures of 45-55 F are used: (A.) the fat will smear during mixing, grinding, and forming; (B.) there will be a high degree of meat discoloration, ranging from a grayish to a green color (this is not because the soy has been added but because the oxymyoglobin meat pigments are oxidized to the metmyoglobin or oxy-bile pigments); and (C.) the fresh shelf life will be shortened from 4 days to 1 day.

The uses of textured soy in meat products are as varied as one's imagination. They are finding their way into virtually all ground meat products for patties, loaves, meat balls, tacos, chili, pizzas, meat spreads, poultry and fish patties, and fresh and cured pork sausage, to mention only a few. The use of textured soy protein in high fat products, such as fresh pork sausage, can have a protective effect in reducing oxidative rancidity, because of the natural antioxidation properties of soy. The extent to which soy will be used in new products will be governed by: (A.) following proper manufacturing procedures, (B.) using flavoring ingredients properly, and (C.) maintaining and improving textured soy varieties by the manufacturer.

We view these new protein products as being in their infancy. As the world grows toward a more critical need for the essential nutrient—protein—our present utilization patterns are but symbols of that which is to come.

We share with A.M. Altschul the view that:

> . . . the invention of textured soy protein foods [promises] to be one of the great food developments of all time. We must keep in mind that they are not imitation meat products. They are truly new foods that eventually can help you serve more nutritious and tasty meals for less than you have been accustomed to spending.

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