Vegetable Proteins in Cooked and/or Fermented Sausages

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ABSTRACT

Man is the only animal cooking meat for food. Various arts and degrees of heat treatment were devised by the early Egyptians, Greeks and Romans; this was often combined with a surprisingly high degree of sophisticated fermentation. From initial meat searing in the Iron Age to modern barbecue pits, electronic conveyers, rotomats, the introduction of steam and controlled smoking, development of curing salts, and the controlled production of meat itself, man created new meat processing technology designed to improve flavor, texture, shelflife, availability, acceptability and economy, thus satisfying the crucial demands of both the consumer and processor. During this time man also discovered the disadvantage of heat, namely the inevitable loss of volume, changes in texture, color and palatability. At the same time, he started using various tubers, cereals and salts to minimize cooking losses. These functional comminuted meat product ingredients, today known as binders and fillers, have traditionally been locally available. They include potatoes, cereals, milk derivatives, hydrocolloids and vegetable proteins. It is estimated that 17,000 tons of various soy proteins were used in 1977 in Europe alone in heat-treated and fermented meat products. Since sausages, fermented and hard salamis and similar ready-to-eat comminuted meat products are an important segment of European convenience meat consumption, this paper concentrates on the technological, nutritional and economical impacts of soy proteins on these products. While in heat-treated meats bacteriological growth is not desired, it is a regulation factor in the production of fermented sausages. In both types of products, soy proteins in their present form as isolates, concentrates, textured, various grits and flours, as well as spun or structured, play an important role in providing the consumer with appealing, nutritional products at acceptable prices. Examples of applications of soy proteins are discussed.

HISTORY OF SOY PROTEINS IN COOKED SAUSAGES IN EUROPE—REASONS FOR ACCEPTANCE

The role of soy proteins in sausage industry applications is well known. Isolated proteins are recognized for their rheological, emulsifying, gelling and stabilizing properties; concentrates, textured proteins, and various types of modified flours for their ability to absorb water and fat, their texture-forming capabilities, heat integrity and valuable protein content. They are established functional ingredients in many meat, poultry and fish products as well as in other sectors of food production.

It is estimated that in Europe alone more than 17,000 tons of soy proteins were used in cooked sausages in 1976 and another 1,500 to 1,800 tons of isolates employed in dry or fermented sausages. I personally consider both figures modest. Soy proteins have now been used in European food production since 1960. Gradually, processing improvements and modifications have practically eliminated the earlier negative "side effects," such as over-extension resulting in taste and color deviations. Today, soy proteins with their various concentrations and versatile properties are contributing factors in the functional, economical, and nutritional aspects of the meat industry, designed to make more nutritional meat products available to more people at acceptable prices.

What are the main attractions of soy proteins for sausage and salami processors? They are functionality, economy, nutrition, and consistency.

ECONOMICAL FACTORS OF INCREASED SAUSAGE CONSUMPTION—REASONS FOR THE TVP NEED

Economy lies in the direct modification of recipes, better yields, easier handling, lower transportation, and keeping costs as compared to replaced meats.

Various types of legislation limiting the use of emulsifiers, fillers and functional additives make the production of cooked or fermented comminuted meat products costly and determine the potential of volume.

With the appearance of edible soy proteins as well as the increased demand for sausage type products, several rigid regulations concerning these products have been amended to permit limited use of nonmeat proteins, emulsifiers, fillers and flavoring agents, but at the same time they often require strict label declarations and terminology changes so as to ostensibly indicate to the consumer the presence of the new ingredients.

Soy isolates and concentrates have contributed considerably to world protein improvement and provided functionality to advance available food technology. But because of their extraordinary binding quality, they were limited to the role of functional ingredients and provided only marginal product extension as traditionally accepted by consumers. An increased demand for sausage type meat products called for products that would not only provide nutrition and function, but also result in a meat-like texture and eating sensation at lower costs. This led to the development of textured vegetable proteins. After the initial enthusiasm, a prosperity impass stimulated customers' resistance to such products as a part of meats, and it was only when the soy industry modified its approach that the need for textured soy proteins was recognized, and they became a rather significant factor in the essential nutrition of various social systems.

In short, textured proteins combined with isolates made it possible to cope with limited budgets and meat supplies, and to extend the same to satisfy the growing demand at acceptable prices.

Soy proteins used in sausage meat production can be generally classified in two groups – emulsifiers and extenders; they are usually applied in combination with fat or skin emulsions or "as is," dry.

TABLE I

Comparative Frankfurter Trials

	A	B	C	D[a]	E[a]
Beef (19% protein, 10% fat)	30.00	20.00	20.00	15.00	15.00
Pork (18% protein, 10% fat)	20.00	20.00	20.00	---	---
Prok trimmings (10% protein, 50% fat)	30.00	30.00	30.00	40.00	40.00
Back fat (5% protein, 90% fat)	12.00	13.00	13.00	10.00	10.00
Isolated soy protein (90% protein)	---	2.00	---	1.50	1.50
Soy protein concentrate (66% protein)	---	---	3.00	---	---
TVP (54% protein)	---	---	---	7.60	---
Structured soy concentrate (66% protein)	---	---	---	---	6.20
Phosphate	0.40	---	---	---	---
Salt	1.80	2.00	2.00	2.00	2.00
Spices and flavors	1.80	2.00	2.00	3.00	3.00
Water-ice	4.00	11.00	10.00	20.90	22.30
	100.00	100.00	100.00	100.00	100.00
Processing yield % (weighed 24 hr. after cooking)	89.00	96.00	95.50	94.00	94.00
Protein content %	13.20	13.20	13.20	13.20	13.20
Fat content %	30.80	30.00	30.00	30.60	30.60
Batch costs[b]	444.00	384.00	384.00	266.60	268.90
Cost per kg of product sold	5.10	4.00	4.02	2.84	3.05

[a]In practical applications to extend the diluted color in 30% meat replacement as in cases D and E, 1/3 of the beef has been replaced by trimmed beef hearts.

[b]Combined European prices for meats used for sausages in April 1977 (DM, FF, DF, DK, SP, IL, PZ) converted to DM and averaged. (Beef 7.00, Pork 6.00, Trimmings 3.00, Back fat 2.00).

TABLE II

Comparative Production Cost of Sausage Binders[a]

Binder	SPC_1	SPC_2	ISP_1	ISP_2	$NaCas_1$	$NaCas_2$
Price/kg	2.25	2.25	4.50	4.50	4.00	4.15
Anal. protein %	66.10	65.90	91.20	89.60	88.35	89.10
Meats added	100.00	100.00	100.00	100.00	100.00	100.00
Salt	2.20	2.20	2.20	2.20	2.20	2.20
Spices	0.60	0.60	0.60	0.60	0.60	0.60
Phosphate	0.50	0.50	0.50	0.50	0.50	0.50
Water added	33.00	33.00	34.00	34.00	34.00	34.00
Binder %	3.00	3.00	2.00	2.00	2.00	2.00
Batch total	139.30	139.30	139.30	139.30	139.30	139.30
Cost batch	416.75	416.75	419.00	419.00	418.00	418.30
Weight stuffed	136.50	137.00	137.20	136.80	135.60	136.10
Weight after process.	124.10	124.40	128.10	128.40	125.60	127.30
Processing loss %	9.10	9.00	6.60	6.20	7.40	6.50
Rejected at factory	5.30	4.90	3.50	3.40	4.90	5.00
Rejected by dispatcher	8.40	7.90	8.00	7.80	10.00	10.30
Net weight sold	110.40	111.60	116.60	117.20	110.70	112.00
Cost per kg sold	3.78	3.73	3.59	3.58	3.78	3.73

[a]Protein content: 14.1%; fat: 25.4%.

[b]Source: Auditing department of European Corporation (Jan., 1976).

SPUN VEGETABLE PROTEINS

During the last 10 years, spun vegetable soy proteins emerged as meat replacers, especially in the production of dietary and imitation meat products. These proteins are usually superior in texture and flavor to meat extenders and have found acceptance among a certain captive clientele. Limiting factors to their more rapid growth have been production and handling costs, as well as over perfection of texture, but there is no doubt that we have seen only pioneer products in this line so far. Laboratory samples have been made of granular isolates – fat-interlaced protein fibers – that could be easily rehydrated and formed into any shape of reconstructed meat. Researchers are also working on the spinning combination of proteins of various vegetable and animal sources that would produce a more plyable and elastic fiber, easily integrated in the actual meat system.

What the present introduction of soy proteins means for the extension of available sausage meats can be seen from Tables I and II.

NUTRITIONAL ASPECT OF SOY PROTEINS IN SAUSAGES

Even though the PER of soy proteins used is lower than in meats due to the limited profile of amino acids such as methionine, the AA balance improves favorably in the presence of meat proteins. Futher improved soy proteins such as isolates and concentrates, from which oligosaccharides were removed during processing, were found to be acceptable even in the most sensitive applications such as hospital and geriatic sausage foods.

BRINE EXTENSION OF SAUSAGE MEATS

The new and accepted approach in the technology of sausage production was introduced by the author and his associates about three years ago. Sausage meats were extended and tenderized prior to use by mixing with a fortified soy protein dispersion in a regular meat mixer for 30-40 min., depending on the size and fat content of the meat. In a typical case, the meats were ground through a kidney plate or smaller, and mixed with one of the following dispersions:

	A	B
ISP HV dispersible	10.00	10.00
Salt	6.50	6.50
Dextrose	1.50	1.50
Polyphosphate	1.20	1.20
MSG	0.50	0.50
Nitrite	0.035	0.035
Nitrate	0.070	0.070
Concentrate (1:3 hydrated)	---	6.00
Water	80.195	74.195
	100.00	100.00

When phosphates are not allowed, NaCitrate or half the amount of guar gums may replace the phosphates.

ADVANTAGES OF SAUSAGE MEAT EXTENSION

According to the levels of soy proteins permitted in the meat products of a particular country, 30-60% of this dispersion is mixed into the meats left curing overnight in the curing room, or at least for 2 hr at a temperature of 18 C; it is then used to replace regular nonextended meats in various recipes.

Furthermore, meat extended this way has been used in hams, poultry rolls, roast beef, pie fillings and sterilized corned beefs. When stuffed into casings or in molds and left for 24 hr at curing temperatures, the cooking losses of the 50% extended meat described above were a maximum 1.5%, the slicibility was excellent, and color, taste and mouthfeel were found acceptable by present users.

Similarly encouraging results were obtained in certain types of fish and crustaceous products, and the procedure is presently used there. It was also established that in extensions of over 40%, the presence of structured concentrate improved the firmness, slicibility and texture of the extended product, especially in recipes where mechanically deboned meats were used.

USE OF SOY PROTEINS IN DRY AND SEMIDRY MEAT PRODUCTS

During the past 10 years, other successful applications of soy proteins were employed in dry, semidry and fermented sausages including salamis, Kabanosses and dry beef sticks.

The production of dry sausages such as salamis depends on controlled bacteriological, microbiological and chemical processes, resulting in the development of the desired flavor, color, consistency and degree of preservation.

GENERAL PROCESSING PROCEDURES WITH SOY PROTEINS

A proper rate of pH drop is essential. This is accomplished by selecting the meats and activating their microflora by the addition of stimulants in the form of sugars (only those sugars that can be converted into glucose by bacteria present in meat), starting culture, curing salts, and by maintaining the required temperature and humidity during the first stage. The necessary binding, rate of evaporation and guided microactivity are achieved by the time the pH drops to 5.4, by inhibiting unfavorable bacteria and stimulating the beneficial ones. At the same time, increases in salt concentration and acidity create conditions for conservation of the product. In a continued drop to a pH of 4.8, the necessary degree of acidity and color, and their fixation are completed. Of course, there are variations in the effort to develop some traditional flavors, but, in general, the process is the same; only the means of activation and the rate of speed differ.

Over the past 10 years, the addition of isolated soy protein with its neutral pH proved to be a desirable stimulant, shortening the processing time without any negative effect on quality. On the contrary, a better juiciness, slicibility and a more stable color were achieved.

In most cases, isolated soy proteins of high viscosity are added (either dry or in the form of a dispersion) to the coarsely cut meat and fat that has already been treated with dry curing salts. ISP is then mixed into the meats for 15-20 min but not longer, so that the temperature of the mix does not increase over 2 C. The resulting mass is exposed to vacuum, put on trays and kept at 6 C for 24 hr before stuffing.

The stuffed sausages are processed according to regional procedures or preferences: (a.) either wet cure, using selected brine, followed usually by cold smoking and controlled drying; (b.) or dry cure, which is the most popular method for dry products containing soy proteins. (The casings are punctured by small holes to enable trapped air to escape.)

PRODUCTION OF FERMENTED AND DRY SAUSAGES WITH SOY PROTEINS

The common procedure for dry cure is to keep the fresh sausages at a temperature of 6 to 18 C and a high RH (98-100%) for the first 2-3 days, then continue curing at a temperature of 22 to 24 C and a RH of 70-75% in green rooms with moderately circulating air until the desired color of the product has developed and fermentation started. This can take anywhere from 1-6 days, depending on the type and diameter of the salamis. Selected smokes are often circulated to develop the desired tanginess and to control mold formation. Sausages are then transferred into the drying room where they are kept at a temperature of 12 to 16 C and a RH of 70-73% with uniform air changes. The sausages are kept in the drying room until the required consistency and weight loss are achieved. This may require from 10 to 15 days for fermented sausage, 15 to 40 days for semidry, and 40 to 60 days for hard dry salamis. Without ISP the drying periods are ca. 20% longer.

Typical example of applications of ISP to dry sausages:

Lean beef at -5C	40 kg
Lean pork at -5C	25 kg
Back fat at -10C	25 kg
ISP HV disperson	10 kg
	100 kg

The ISP dispersion is usually made at least 24 hr in advance at a ratio of 1:4 ISP to water by chopping in a fast cutter for 15 to 20 min. Then curing sugars such as lactose, dextrose and milk proteins are added in amounts complying with the local rules for finished products, and the whole dispersion is left at 6 C for at least 24 hr. Curing salts, flavorings and eventually coloring agents are usually mixed with the meats before the slurry is added. When ISP is used in dry form directly in the mixer, it is employed at a 1.5 to 2.0% level on the total quantity of meats (including fats), and 5 to 6% of snow is added to prevent overheating, improve the protein dispersion and the succulence of the final product.

ROLE OF STRUCTURED CONCENTRATES AND TEXTURED PROTEINS

During the last few years, structured protein fines, such as structured concentrates (Response), have been introduced at a 1 to 2% level in order to regulate the moisture migration from the inner part of the sausage and to prevent hardening of the surface of the sausage resulting in discoloration.

Structured oligosaccharide-free concentrate fines swell and moderate a uniform moisture release and migration to the surface of the sausage. The result is uniform consistency and color of the final product.

Present users of ISP and Response in dry sausages claim the following advantages: 1. Time and weight losses are reduced (one processor increased the production of his dry sausages by 28% during 1975 by using a combination of ISP and Response). 2. Firmness and slicibility are improved (less fat smearing during the portioning of sausages). 3. Presence of ISP gel prevents further hardening and loss of weight of salamis during sales exposure. 4. Less spoilage (some users claim better fermentation control than with the use of milk proteins).

Naturally, the economical aspect is also most welcomed. Even with the addition of 8% free water in the dispersion, required color and consistency are achieved in a shorter time with losses usually between 25 and 33% of the starting weight, as compared to 30 to 38% for the control samples.

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