June 13, 1972

MEATS AND STRUCTURED VEGETABLE PROTEINS

by Louis Sair, the Griffith Laboratories, Inc.
Chicago, Illinois presented at the
18th Meeting of the Meat Research Workers,
Guelph, Ontario, Canada, August 20-25, 1972

Food scientists and engineers are, today, applying great effort to utilize vegetable proteins in forms that make them suitable for use in many food products and especially in combination with meats.

The major effort is being applied to the protein derived from soybeans since soybeans offer an economical, nutritional source of protein. In general, it can be stated other proteins are being evaluated but certainly for the near future the soybeans command the major effort.

In many food applications there is no need to use spun proteins, textured proteins, or structured proteins and in these applications spray dried or roller dried soy protein concentrates or isolates can be used for their functional and nutritional qualities. In the United States very substantial quantities of soy protein concentrate made by the isoelectric wash process (U.S. 2,881,076) have been used to enhance the emulsifying qualities of the meat proteins. This process does not denature the soy protein and the concentrate has excellent emulsifying qualities. In other food applications the concentrates have been used to improve and increase the nutritional qualities of breakfast cereals, moist pet foods, and many other applications.

A major interest has developed in vegetable proteins or soy proteins that have texture or structure. Where substantial quantities of vegetable protein are added to existing food, a very important attribute in the food is the eating quality, bite, or texture. People do not wish to eat foods that are different from existing foods.

You are familiar with the work of Boyer (U.S. Patents 2,682,466 and 2,730,448) who developed a very ingenious procedure for texturizing vegetable proteins. The protein is dissolved in an aqueous alkaline solution and is then forced through fine spinnerettes and the spun material then is coagulated in an isoelectric water bath. This spun material can be formed in various ways and on cooking or addition to foods the spun protein has definite bite qualities and texture. The process is costly and although enormous effort has gone into this program by many major industrial food companies, it is still very questionable whether this original process will stand the test of time.

A second method was developed in the United States and products sold by this process are normally referred to as textured vegetable proteins. The procedure is well described in a patent assigned to Dr. Atkinson of Archer-Daniels-Midland Company, U.S. 3,488,770.

The protein material is moistened with water. Normally, alkali and other ingredients are added and the moist mass is then passed through an extruder where a high temperature and pressure develops. Under these conditions the protein material is converted to a hot melt and when this material reaches the tip of the extruder expansion occurs. This expanded material can then be dried and brought to the required particle size. The protein does have texture and very substantial quantities of textured vegetable protein are now being manufactured in the United States by, at least, five major food companies.

The textured vegetable process offers an economical alternative procedure to the spun method. For certain applications the textured vegetable protein gives the structure and form required. In other food applications it has been found that the texture developed during extrusion is insufficient to withstand the processing conditions required for the manufacture of foods. For example, if the textured vegetable proteins are used under canning or retorting conditions the organization of the protein granule is largely destroyed and the chunk softens and loses the desired bite characteristics. This also occurs, to a lesser extent, in foods which are brought to boiling temperatures.

As pointed out initially, there is tremendous effort going on in research in the development of these type of food proteins and I would like to briefly describe a third process which we refer to as structured vegetable proteins.

Griffith Laboratories has placed much effort on this process and expect to commercialize their product this year.

When moist protein material is subjected to temperature and pressure, the material forms a melt and when this hot melt is exposed to conditions of lower pressure it immediately expands to form what we now call textured vegetable proteins. The cells in this expanded product are longer than they are wide and the cell structure is fragile which causes the softening and distintegration of the granule in many food applications. In our process (U.S. 3,440,054) we deliberately prevent the expansion of the hot melt. A cooling die is installed in the extruder which lowers the temperature of the hot melt so that when the material reaches the tip or orifice of the equipment it flows as a molten plastic or glass. No expansion occurs at this stage of the process.

The conversion of the hot melt to a plastic-like material makes it possible for the protein material to orient itself into a more defined structure. The cooled material is then cut to the desired shape to form a mass of beads which can then be dried if desired prior to puffing.

The puffing or expansion step of the protein material is a distinctly different operation from the formation of the cooled plastic glass or beads.

By separating these two processing steps it makes it possible to produce formed protein products with almost any conceivable hydration or textural qualities. Puffed products can be made of very low hydration qualities; that is material which takes up only 1.5 pounds of water to the pound of protein material or the process can be adjusted to give very high hydration qualities with lesser textural qualities with hydration capabilities up to 600%. Various factors determine the textural qualities or hydration of the structured vegetable protein dependent on the nature of the protein material, the moisture content during extrusion, the pH of the mass, other additives, and the character of the cooling die as well as the temperature and pressure during extrusion. Other factors involved are moisture content of the glass or beads during puffing. Puffing may be accomplished by the use of a conventional puffing gun, hot air puffing, hot oil puffing, microwave, and other procedures.

Use of Structured Vegetable Proteins in Meats

Structured or textured vegetable proteins will undoubtedly find application in a wide variety of food products. I would like to limit my presentation to a brief discussion on the use of these protein products in meats.

In the United States the demand for beef continually increases and meat becomes more expensive. In the United States the Federal Government provides for lunches for the school children and this has become an enormous undertaking and a very expensive one.

In the last year the U.S.D.A. has written a regulation which states that 30% of the meat used in the School Lunch Program can be replaced with a hydrated textured vegetable protein.

This regulation was largely based on the fact that the U.S. Government wished to provide the students with good lunches but also wished to do it more economically.

A typical formulation for an all meat hamburger and one based on the School Lunch Program is shown in Table I.

TABLE I

School Lunch Patties

	All Meat	Patties Based on Proposed School Lunch Regulation
Meat	100 lbs.	70 lbs.
Patti-Pro GL-219	-	10 lbs.
Water	-	20 lbs.
Type A School Lunch Seasoning #715-8951	1 lb. 3 oz.	1 lb. 3 oz.

On analysis of the all meat hamburger and the School Lunch patty, as shown in Table II, the protein content remains the same but the fat content is reduced 25% as would be expected.

TABLE II

Analysis of School Lunch Patties

	All Meat	School Lunch Patty
Moisture, %	54.2	58.8
Protein, %	17.3	17.6
Fat, %	24.9	18.1

The all meat product and the School Lunch patty were grilled and the data is given in Table III.

TABLE III

Grilling Yields

	All Meat	School Lunch Patty
Weight of Raw Patty	38 lbs. 8 oz.	38 lbs. 12 oz.
Weight of Cooked Warm Patty	27 lbs. 15 oz. (70.4% Yield)	32 lbs. 2 oz. (82.9% Yield)
Weight of Cooked, Cooled Patty The Following Morning	26 lbs. 11 oz. (69.3% Yield)	31 lbs. (80% Yield)

The all meat product shows greater loss on grilling with a finished yield of 69.3%. In contrast, the textured soy protein concentrate retains the juices more firmly with a finished yield of 80%.

The cooked all meat hamburger and the School Lunch patties were analyzed with the results given in Table IV.

TABLE IV

Analysis of Cooked Patties and Cost

	All Meat	School Lunch Patty
Moisture, %	52.1	54.4
Protein, %	24.3	22.9
Fat, %	21.8	17.6
Ash, %	1.84	2.80
Crude Fiber, %	0.13	0.61
Yield of Cooked Patties, %	69.3	80.0
Cost of Cooked Patties per Lb.	72¢	47.5¢

The School Lunch cooked patty costs 24.5¢ per lb. less than the all meat cooked patty which works out to a reduction of 34¢ in cost.

Because of the higher yield with the School Lunch patty the protein content of the grilled patty is somewhat lower than what is found in the grilled hamburger. The fat content is lower. Perhaps the most striking thing to look at is the cost of the cooked patty. There is a marked reduction in cost by the inclusion of 30% of hydrated vegetable protein in the mass. This cost is based on fresh meat at 50¢ per pound.

In writing up the regulations, the U.S.D.A. incorporated nutritional specifications indicating that the PER of the grilled patty must be, at least, 2.5 in relation to casein being 2.5. As shown in Table V, the nutritional value of the protein in the School Lunch patty is equivalent to that found in the all meat product.

TABLE V

Nutritional Data

Sample	PER As Is	PER Corrected	Relative Value % PER
All Meat	2.51	2.71	108
School Lunch Patty	2.50	2.70	108
ANRC Casein	2.31	2.50	100

These few tables strikingly demonstrate why such a great interest has developed in the textured or structured protein products. They offer economical sources of protein which can be added to existing foods to produce foods of excellent quality and nutrition but with substantial savings in costs dependent on the particular application. In the United States alone we grow well in excess of 1 billion bushels of soybeans which offers an inexhaustible supply of excellent vegetable protein which can be adapted for human consumption. On a 100% protein basis the vegetable protein sells in the order of 35 to 50¢ per pound while meat protein today, costs in the order of $2 to $3 per pound. Certainly no one wishes to replace meat which forms the most substantial portion of the American diet. However, by proper utilization we can develop meat products which have excellent flavor, texture, and quality at a substantially lower cost. It is for this reason that the great interest in the development of vegetable proteins will continue.

LS:bk