

PATENT SPECIFICATION

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(54) TEXTURIZATION OF PROTEIN

(71) We, SOCIÉTÉ DES PRODUITS NESTLÉ S.A., a Swiss body corporate of Vevey, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present application relates to a process for the production of a texturized protein.

In recent years, substantial efforts have been directed toward the treatment of untexturized protein materials to imbue them with greater chewiness. These protein materials, which ordinarily comprise vegetable protein, are thereby changed into a more textured and desirable form.

Many methods and apparatus are being used to texturize protein. Not only do these methods and apparatus differ, but also the physical characteristics of their texturized products may vary.

One such prior art method for texturizing protein involves extrusion. This method is exemplified by United States Patent 3,488,770. In accordance therewith, a moistened paste of a defatted vegetable flour is treated with heat and pressure in an extrusion chamber. Upon release from the chamber through a restrictive orifice, the protein is expanded to produce a porous, texturized product.

Another texturization technique involves the spinning of protein fibers. Spinning is typically performed by one of two means. As in United States Patent 2,682,466, an aqueous solution of protein may be forced through a spinneret to produce fine streams which are fixed into protein fibers in a bath of chemical coagulants. Alternatively, as in United States Patent 3,821,453, heat-coagulation is substituted for the chemical bath.

More recently, the approach of texturization with steam has been explored. This technique, which is exemplified in United States Patent 3,836,677, ordinarily requires the inclusion of a starch or other gelling agent to

implement the texturization. In United States Patent 3,863,019, however, there is disclosed a process where such an additional gelling agent appears to be unnecessary. There, a slurry of untexturized protein is sprayed into a pressurized steam flow and, upon release of the pressure, the protein is texturized and rendered porous through flash evaporation of water.

Each of the foregoing techniques has drawbacks. In most, only particular forms of vegetable material can be texturized. Also, the texturized products resulting from the various techniques are normally peculiar to, and dependent upon, the specific technique employed. Further, many of these techniques can be performed only under rigidly controlled conditions and/or utilizing complex and expensive machinery.

An object of the present invention is a process for texturizing protein which is useful with the many different forms of untexturized protein which are available.

It is also desired that the process permit the presence of additive materials during texturization of the protein. The resultant product would then comprise a dispersed mixture of components.

A further object of the present invention is a process which can be performed without careful control of processing conditions and with simple, inexpensive equipment.

Another object of this invention is a process which will permit the production of texturized protein having a spectrum of physical characteristics and appearances, so as to permit selection of the properties of the resultant product, having regard for the specific intended use.

These objects, and yet further advantages as are described hereinafter, are achieved through the present invention.

This invention involves the texturization of protein with steam. More particularly, it relates to a process for producing a texturized protein product comprising introducing a slurry of untexturized protein in an aqueous dis-

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persant having a pH of from 4 to 6.7 into an enclosed treatment zone, injecting steam into said zone to produce a temperature and pressure sufficient to texturize said protein and removing the texturized protein from said zone. After treatment, the texturized protein may be recovered as an aqueous slurry.

This process may be performed very simply using minimal apparatus. The essential feature of the apparatus is that it include an enclosed treatment zone which permits maintenance of appropriate texturizing conditions. Most conveniently, the treatment zone should be one suitable for continuous processing. For example this zone may comprise a short length of tubing having, at one end, a pressure valve which permits the exit of treated slurry while maintaining the pressure and temperature within the zone. At the other end of the zone, there should be entrance ports for both the steam and the slurry of untexturized protein. Although back pressure valves can be disposed at these ports, they are unnecessary. The pressure within the enclosed treatment zone can be maintained simply by generating steam at the desired pressure and pumping the slurry with adequate means.

The aqueous slurry of untexturized protein need not be at any particular temperature before introduction to the treatment zone. Any convenient temperature, for example from 0 to 90°C., may be used. Lower temperatures of from 15 to 60°C are ordinarily employed, however, to avoid unnecessary heating.

Only a very short time is required for this texturization of protein. Under many conditions of operation, texturization is virtually instantaneous. Thus, the residence time of protein in the zone is ordinarily within the range of from 1 to 60 seconds, with 2 to 30 seconds being preferred. Still longer periods of residence time are not, however, detrimental.

Although some increase in the resiliency or toughness of the particles occurs with longer residence times, almost none occurs after about 30 seconds. Within the preferred period of 2 to 30 seconds, some control of the eventual texture of the present proteins is permitted by increasing or decreasing the residence time as desired. Accordingly, the shorter periods of residence are most preferred because they permit increased speed of processing and consequently high production of texturized protein.

The conditions of temperature and pressure required for the texturization may also vary greatly in accordance with the present invention. The practical limits of operation depend upon the concentration of protein in the slurry, residence period of treatment in the zone, the particular protein being treated, the presence or absence of other slurry constituents, and the desired degree of texturization. Ordinarily, however, the temperature and pressure conditions in the zone will be maintained at from 100 to 200°C and .5 to 15 kg/cm². Particularly preferred conditions of operation are 120 to 160°C and 2 to 10 kg/cm².

To ensure most efficient texturization of protein, the untexturized protein in the slurry should be fully exposed to the steam. This may be accomplished by, for example, maintaining the aqueous slurry as a shallow stream or sheet as it passes through the zone. Contact between the protein and steam is then effected at the interface of the aqueous slurry.

More preferably, however, steam is injected into the aqueous slurry. It may, for example enter from the bottom of the zone and pass upwardly through the slurry. The steam then agitates the slurry in the treatment zone, thus ensuring homogeneous texturization of dispersed protein. This technique of steam injection permits higher slurry volumes to be texturized and is particularly preferred.

During texturization treatment, the slurry is heated to a higher temperature by virtue of the contact with steam. Thus, for example, the exit temperature will normally range up to 100°C., more usually from 60° to 100°C. The slurry is not ordinarily heated sufficiently during the steam texturization to cause boiling or substantial evaporation of the aqueous dispersant. Substantial amounts of water are absorbed by the slurry solids incident to treatment, thus reducing the content of free water. However, at the same time, steam is ordinarily liquified by loss of heat to the cooler slurry. The texturized protein product is therefore normally recovered in combination with at least some free—as opposed to absorbed—water. Thus the material exiting the treatment zone may also be termed a slurry and normally contains about the same amount, or more, of total moisture as the slurry of untexturized protein.

The fact that this texturization process does not require vaporization of water affects the physical characteristics of the present products. In contrast to prior art proteins texturized at least in part by flashing substantial volumes of water from within the protein particles, the products of this invention are dense and unexpanded. This further enhances their meat-like appearance and properties.

Upon exit from the treatment zone, the slurry may cool somewhat as the steam pressure is released and the gaseous steam expands. This expansion occurs automatically. To control this expanding steam, it is ordinarily desirable to vent the steam. This may be done, for example, by removing the slurry and steam through an open-ended conduit connected to the treatment zone. In the conduit, the steam and slurry separate thus permitting controlled venting of the former.

Although control of the expanding steam is desirable, it is not intended to suggest that

cooling of the slurry need be minimized. This is not the case and the texturized protein is not adversely affected. Indeed, in a further desired embodiment, the exiting slurry is quenched by rapid cooling. This may be performed by, for example, injecting the slurry into cold water. Quenching to a temperature of from 0° to 50°C, more usually from 5° to 25°C, has been discovered to enhance the product characteristics by yielding more distinct particles resembling cooked ground beef in appearance.

A critical aspect of the present method resides in the condition of the untexturized protein during treatment with steam. As described above, this protein must be dispersed in water as a slurry. In addition, however, it is essential that this slurry be of proper acidity. It has been discovered that, unless the aqueous slurry of untexturized protein has a pH of from 4.0 to 6.7, the desired texturization will not occur.

Where the acidity of the aqueous slurry of untexturized protein is such that the pH lies below 4, the present treatment with steam has no apparent effect on the protein. After treatment with steam, the slurry remains essentially unchanged. At a pH higher than 6.7, an aqueous slurry of untexturized protein treated in accordance herewith exists as an undesirable liquor. Such a liquor may gel if cooled sufficiently, however, it does not exhibit the desired texture and other characteristics.

Within the foregoing range of from 4.0 to 6.7, texturized protein having variant physical characteristics and degrees of texturization is produced. Within the lower portion of the present pH range, from about 4.0 to 5.8, most preferably from 4.0 to 5.0, separate and highly texturized particles are obtained. These particles have an appearance similar to that of hamburger or shredded beef. At higher pH within the present range, ordinarily from about 5.0 to 6.7 preferably from 5.0 to 6.0, there is obtained a homogeneous and plastic product. This product is more similar to the consistency and appearance of a luncheon meat such as bologna or of cheese.

This discovery that the consistency and appearance of the texturized meat-like products of the present invention can be controlled and varied dependent upon the pH of the untexturized protein during steam treatment is highly advantageous. It permits, in contrast to most prior art techniques, selection of a product consistency from a spectrum of desired alternatives. Thus, it significantly expands the utility of the present process by permitting the production of different products tailored to specific intended uses.

Although the pH of the untexturized protein during steam treatment is the primary factor determining the eventual consistency of the present products, it is not the only such factor. As previously indicated, the period of steam treatment, or residence time in the

treatment zone, influences these product characteristics.

Additionally, some modification of these characteristics may be obtained through variation of the steam conditions at which the untexturized protein is treated. In general, lower temperatures and pressures of texturization result in more plastic and less resilient products, with more complete texturization being obtained at higher temperatures and pressures within the foregoing ranges. Also, the sizes of the products vary with these conditions. The texturized protein produced at lower temperature and pressure is composed of fine particles, ordinarily having a volume of as little as .03 to .3 cm³. Higher conditions ordinarily produce particles of up to 1 to 2 cm³.

Another parameter which affects the eventual appearance of the products of this invention is the concentration of solids and solubles in the slurry during steam treatment. The total concentration is ordinarily within the range of from 2 to 60%, preferably 40 to 50%, by weight of slurry, with the amount of untexturized protein being preferably from 2 to 35%, more preferably from 10 to 25% by weight of slurry.

The slurry concentration of untexturized protein may be provided by untexturized protein in any of its available forms of protein material. Exemplary of protein materials which have been successfully texturized are flours, defatted flours, concentrates and isolates of proteins of soya, peanut and other well-known vegetable sources.

The concentrations of untexturized protein in these various forms differ. Protein flours normally contain from 30 to 50% by total weight of untexturized protein. Defatted flours normally exhibit 50% untexturized protein. Concentrates and isolates are conventional terms in the art which refer to still more concentrated protein sources having 70 and 90%, respectively, of untexturized protein by total weight. Consequently, the amount of protein material added to the slurry should reflect these differences in untexturized protein content.

Protein isolates and concentrates are preferred in accordance with this invention. These forms of protein differ from others in that they do not contain carbohydrates such as raffinose and stachyose. These carbohydrates—which are common to soy and certain other vegetable protein sources—have been discovered to be most undesirable. After ingestion, they produce gases in the lower intestinal tract. These gases—as well as the beany or bitter note of such materials as soy—are primarily responsible for the poor consumer acceptance of many prior art texturized meat substitutes. Concentrates and isolates, however, are produced by methods which include aqueous, acid and/or alcohol leaching which remove undesirable flavorants and carbo-

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hydrates. Consequently the texturized proteins produced from them avoid these drawbacks and represent highly advantageous sources of untexturized protein.

5 A further advantage to the present invention is that, in addition to the untexturized protein, the slurry to be treated may contain numbers of additional additives which will contribute to the desirable characteristics of the
10 eventual products. Although many such additional additives are incompatible with prior art texturization techniques, the present process is substantially unaffected by their presence. At most, these additional ingredients
15 (and any non-protein content of the slurried protein material) appear to interfere only slightly with texturization. Consequently, fully texturized proteins remain available and additives may be included in the initial slurry to
20 permit their homogeneous dispersion within the eventual texturized products.

One such desirable additional ingredient is fat. Being a normal constituent of natural meat, cheese and other foods, the presence of
25 fat in the present products renders them even more like the foods they are intended to replace. Moreover, it has been discovered that the presence of from 0 to 25%, preferably from 4 to 10%, by total weight of the slurry
30 significantly improves the mouthfeel of the eventual texturized product. Accordingly, it is preferred to incorporate such a fat, most preferably a solid fat having a melting point of at least 50°C, most preferably at least 70°C
35 into the initial slurry. These fats may be any which are available in the art, including unsaturated, saturated and modified fats of animal or vegetable origin.

Another desirable ingredient comprises 0
40 to 25%, ordinarily 1 to 10% of a carbohydrate or gelling agent filler such as starch or corn syrup solids. In addition to the economic advantage of incorporating one or more of these fillers, they further improve the appearance and texture of the eventual products. Such a filler
45 may be utilized to increase the size of the eventual texturized particles. In addition, they imbue the product with a more solid and chewy mouth-feel, thus rendering them still more meat-like.

Flavorants may also be added to the initial slurry to provide the particular flavor and aroma notes desired for any specifically intended purpose. Thus, for example, a meat,
55 cheese or seafood note may be provided in from 0 to 15%, ordinarily from 1 to 10%, by weight of appropriate flavorant in the initial slurry. In addition to the specifically food-like flavorants, flavor enhancers may also be utilized. Thus, condiments, spices, and like seasonings may also be added to the initial slurry.

It is also possible to include already texturized protein within the slurry. Thus, for
65 example, actual meat, cheese or similar protein

may be included within the slurry to provide a desired flavor and render the eventual product even more similar to the compositions which they are intended to replace. From 0 to 40%, preferably from 10 to 30%, of such material may be included in the slurry and thereby homogeneously dispersed within the eventual product.

In incorporating the foregoing, and such other customary materials as may be desirable, within the slurry prior to texturization, only from about 2 to 60%, most preferably from 40 to 50%, of the total weight of the slurry should ordinarily comprise solids or solubles. Thus the slurry usually contains from 40 to 98%, most preferably 50 to 60%, free water dispersing those ingredients. This limitation prevents the slurry from becoming so viscous as to impede processing. Also, it ensures that total texturization of untexturized protein will occur, while avoiding undesirably dilute concentrations.

If the eventual product is intended to contain solids in excess of the foregoing amount, it is preferred that only some of those solids be incorporated into the slurry to be steam treated. The excess solids may thereafter be added to the product of the process by simple admixture therewith. This is ordinarily performed after separation of the excess free water with which the products are recovered after steam treatment.

The textured protein products of this invention are directly useful as substitutes for the meats or other foods they imitate. They may be utilized as replacements, in whole or in part, in recipes calling for natural food. Exemplary of such recipes are chillies, soups, chowders, and meat loaves. These compositions may be made up using the present textured product. Then, for example, they may be cooked, as by retorting in cans. Significantly such cooking does not, as is common with prior art textured materials, give rise to off-flavours or other undesirable results.

Alternatively, these texturized protein products may simply be dried. In dry form, they are very stable. Moreover, they are readily rehydrated, for example, by boiling them in water for a few minutes, and thus convertible back into a meat or other desirable form.

When it is desired to provide a composite texturized protein product, i.e., one having a variety of discrete physical, tactile and/or organoleptic characteristics, two or more untexturized protein slurry streams, each with its own formulation, can be treated in accordance with the process of this invention and the resulting texturized streams combined to form protein products simulating the appearance, density, cohesiveness and flavor of many varieties of sausage, processed meat, and meat loaf. Thus, for example, by treating two or three slurries of different pH, one can obtain a like number of texturized proteins each hav-

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ing its own distinctive bite and appearance. When the proteins are assembled in final product form, each component protein will retain its individual character thus imparting still greater resemblance to the corresponding meat product.

Each untexturized protein slurry stream can be texturized in its own enclosed treatment zone and ejected, together with the other texturized slurries, through a common duct into a holding tank. If desired, the common duct may be provided with one or more barriers along part of the length thereof thus providing for a brief period separation of the texturized protein streams emerging from the treatment zones. It is also within the scope of this invention to texturize two or more protein slurries in a common treatment zone, and to subject a protein slurry treated under one set of texturizing conditions to further texturization in a second enclosed treatment zone located downstream of the first.

Following ejection of the combined texturized protein slurries into a holding tank, the composite product can undergo such additional processing steps as compression, and extrusion, to provide a product of predetermined density and configuration. The individual proteins can be assembled within the composite product in any number of ways. For example, each texturized protein can be randomly, but substantially evenly distributed throughout the product, or can be arranged in the product in layers or strata or to provide a marbling effect.

The present method for producing edible texturized protein will be more apparent from the following examples which are chosen from the many specific combinations possible. They are intended to illustrate this invention and are not limitative of its scope.

EXAMPLE 1.

Steam treatment of an untexturized protein slurry was performed utilizing a treatment zone composed of a 30 centimeter length of 4 centimeter diameter pipe. The slurry exit port at one end of the pipe was adapted with a pressure valve adjustable to maintain a back-pressure within the pipe at any desired level. At the other end of the pipe there were two entrance conduits, one is for the aqueous slurry of untexturized protein. The other terminates in a jet nozzle from which steam is injected into the slurry. The temperature and pressure within the tube are maintained with a one-way valve between the boiler and treatment zone and by pumping the aqueous slurry into the treatment zone at a pressure higher than the prevailing zone pressure. Treated slurry exited the zone through an open-end, 20 centimeter length of 4 centimeter diameter pipe and was collected in an open-air holding tank.

A slurry of 25% by weight of soy protein isolate in water at a pH of 4.5 was thus treated at steam conditions of 165°C and 7 kg/cm².

The slurry was pumped through the treatment zone at a rate which permitted a residence time of about 5.5 seconds.

The product collected in the holding tank consisted of slurried 1 to 2 cm³ chunks of dense well-texturized protein having a completely bland taste.

EXAMPLE 2.

The process of Example 1 was repeated except that the steam conditions were maintained at 100°C and 0.7 kg/cm². The resultant product was more textured and chewy than that of Example 1 and was composed of finer particles of .03 to .3 cm³.

EXAMPLE 3.

Using the apparatus of Example 1, texturization was obtained using the formula:

Ingredient	Percent by Weight
Soy Protein Isolate	18
Water	57
Meat Flavoring	9
Fat (M.P. 50°C)	7
Corn Syrup Solids	9

The slurry was treated with steam at 165°C and 8.5 kg/cm². The acidity of the slurry was maintained by addition of 4 N hydrochloric acid and product was obtained at pH's of 4.0, 4.5, 5.0 and 6.0.

The collected texturized protein showed substantial variation in appearance. Product of lower pH was composed of individual particles of from 0.5 to 1 cm³ and resembled ground beef. Product obtained at the higher pH's, however, was more plastic. Further, the 1 to 2 cm³ particles exiting the treatment zone tended to fuse prior to cooling in the holding tank. This product was moldable and more loaf-like, imitating soft luncheon meat.

EXAMPLE 4.

Using the apparatus of Example 1, texturization was obtained utilizing the formula:

Ingredients	Percent by Weight
Soy Protein Concentrate	19
Starch	3
Water	57
Corn Syrup Solids	5
Fat (M.P. 60°C)	8
Chicken Meat	8

The slurry was adjusted to a pH of 4.5 and treated at 170°C and 8 kg/cm².

The texturized product closely imitated the consistency and texture of natural chicken meat. It was also close in appearance to shredded meat of chicken.

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EXAMPLE 5.

Using the apparatus of Example 1, texturization was obtained using the formula:

	Ingredients	Percent by Weight
5	Soy Protein Isolate	14
	Water	63
	Fat (M.P. 50°C)	16
	Flavoring	7

10 The slurry was at a pH of 4.0 and was treated at 110°C and 12 kg/cm².

15 The first half of the treated slurry was simply collected in the holding tank. The particles, which were soft, adhered together into a plastic loaf-like product. The second-half, however, was collected in a tank containing ice water. The particles recovered from this tank were distinct and resembled cooked ground beef in appearance and texture.

EXAMPLE 6.

20 Using the apparatus of Example 1, texturization was obtained utilizing the formula:

	Ingredients	Percent by Weight
	Soy Protein Isolate	10
	Water	40
25	Fat (M.P. 70°C)	5
	White Cheddar (Spray Dried)	40
	Food Coloring	(trace)
	Sodium Chloride	5

30 This slurry was treated at a pH of 4.0, 165°C and 6.5 kg/cm². The product closely resembled natural yellow cheddar although its flavor was slightly weak.

EXAMPLE 7.

35 Using the apparatus of Example 1, texturization was obtained utilizing the formula:

	Ingredients	Percent by Weight
	Soy Protein Isolate	16
	Water	51
	Fat	4
40	Beef (ground)	25
	Flavoring	4

45 This slurry was treated at a pH of 4.25, 145°C and 5.6 kg/cm². The product resembled cooked ground beef in appearance and texture. The meat and vegetable proteins were not individually discernible.

EXAMPLE 8.

Using the apparatus of Example 1, texturization was obtained utilizing the formula:

	Ingredients	Percent by Weight	
	Soy Protein Isolate	11	50
	Water	59	
	Fat	7	
	Fish (ground)	23	

This slurry was treated at a pH of 4.5, 154°C and 7.7 kg/cm². Nicely textured chunks were recovered. They were similar in texture to fish.

EXAMPLE 9.

Using the apparatus of Example 1, texturization was obtained utilizing the formula:

	Ingredients	Percent by Weight	
	Soy Protein Isolate	13	
	Water	54	
	Fat	7	65
	Shrimp (ground)	26	

This slurry was treated at a pH of 4.79, 160°C and 7.7 kg/cm². The texture and flavor of final product was similar to that of shrimp.

EXAMPLE 10.

230 grams of the texturized soy product produced at a pH of 4.0 in Example 3 was incorporated into a chili also containing 3 kg of kidney beans, 310 grams of tomato paste, 1.5 kg of tomato sauce, and 160 grams of commercially packaged chili spices.

The texturized protein was boiled in 400 grams of water for 10 minutes. It was then drained, added to the chili base and canned. The cans were retorted at 120°C for 45 minutes and stored.

After two months at room temperature, the cans were opened and the chili examined. None of the off-flavors or aromas often associated with soy products was detected. Moreover, the textured protein had remained firm and chewy with the result that the chili was substantially identical to true meat-based products.

EXAMPLE 11.

An aqueous slurry of defatted soy flour (40% by total weight) was treated in the apparatus of Example 1. The slurry was at a pH of 4.5 and the steam was at 138°C and 3.5 kg/cm². The flour was recovered as large (1 to 2 cm³) chunks of well texturized, firm product.

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These chunks—which were similar in appearance to fresh ground beef—were then separated from the water with which they exited the apparatus. The solids were then dried in an oven at 125°C for 25 minutes. This dried product was stored for two months. It was then reconstituted by addition of hot water and then added to an equal amount of

ground beef. Hamburger patties made from this mixture were broiled and judged to be of acceptable flavor and mouth feel.

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EXAMPLE 12.

A two component composite texturized protein product was prepared from the following untexturized protein formulations:

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Formulation (Percent by Weight)

Ingredient	Formulation (Percent by Weight)	
	A (brown color)	B (natural white color)
Soy Protein Isolate	18.06	18.06
Soy Flour	7.23	7.23
Water	69.71	69.36
Fat (M.P. 50°C)	4.00	4.00
Calcium Chloride	.25	.25
Caramel Color	.60	.60
Imitation Beef Broth Flavor	.15	—
Imitation Beef Enhancer	—	.50
Total	100.00%	100.00%

Untexturized protein slurry formulation A was adjusted to pH 6.0 and processed in apparatus identical to that of Example 1 at 150°C and 7.0 kg/cm².

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Untexturized protein slurry formulation B was adjusted to pH 4.5 and processed in identical apparatus at 135°C and 4.2 kg/cm².

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Each of formulations A and B, following texturization, were simultaneously brought together in a common duct as the texturized protein streams emerged from their respective

treatment zones. The resulting composite texturized protein product which was discharged from the duct possessed an acceptable texture and flavor. The product sliced well and demonstrated an excellent texture upon frying.

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EXAMPLE 13.

A three component composite texturized protein product was prepared from the following untexturized protein formulations:

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Formulation (percent by weight)

Ingredient	Formulation (percent by weight)		
	A (brown color)	B (natural white color)	C (yellow color)
Soy Protein Isolate	18.06	18.06	18.06
Soy Flour	7.23	7.23	7.23
Water	66.96	67.46	67.21
Fat (M.P. 50°C)	6.00	6.00	6.00
Calcium Chloride	.25	.25	.25
Caramel Color	.50	—	—
Beef Flavor	.50	.50	.50
Wheat Gluten	.25	.25	.25
Egg White	.25	.25	.25
FD & C Yellow No. 5	—	—	.25
Alum Lake	—	—	—
Total	100.00	100.00	100.00

Each of formulations A, B and C were adjusted to a pH of 6.0.

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Formulations A and B were processed in apparatus identical to that of Example 1 at 150°C and 5.0 kg/cm².

Formulation C was processed in identical apparatus at 150°C and 5.6 kg/cm².

The texturized protein streams emerging from each treatment zone were simultaneously brought together and ejected from a common

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duct into an open air holding tank. The composite texturized protein product had acceptable color distribution, texture and flavor.

WHAT WE CLAIM IS:—

- 5 1. A process for producing a texturized protein product comprising introducing a slurry of untexturized protein in an aqueous dispersant having a pH of from 4 to 6.7 into an enclosed treatment zone, injecting steam into said zone to produce a temperature and pressure sufficient to texturize said protein and removing the texturized protein from said zone.
- 10 2. The process of Claim 1, wherein the steam is injected into the aqueous slurry in the treatment zone.
- 15 3. The process of Claim 1 or Claim 2, wherein the texturized protein is recovered from the zone at a temperature up to 100°C and is then cooled.
- 20 4. The process of Claim 1, 2 or 3, wherein the slurry introduced into the zone is at a temperature of from 0 to 90°C.
- 25 5. A process according to any preceding Claim, wherein the aqueous dispersant of the slurry introduced into the zone comprises from 40 to 98% by weight of said slurry.
- 30 6. The process of claim 4, wherein the slurry introduced into the zone is at a temperature of from 15 to 60°C.
- 35 7. A process according to any preceding Claim, wherein the temperature and pressure of the steam in the zone are from 100 to 200°C and 0.5 to 15 kg/cm².
- 40 8. A process according to any preceding Claim, wherein the slurry is treated with steam for from 1 to 60 seconds.
- 45 9. A process according to any preceding Claim, wherein the slurry introduced into the zone has a pH of from 4.0 to 5.8 and the steam in said zone is at a temperature and pressure sufficient to texturize the protein of said slurry into discrete chunks of texturized protein.
- 50 10. A process according to any one of Claims 1 to 8, wherein the slurry introduced into the zone has a pH of from 5.0 to 6.7 and the steam in said zone is at a temperature and pressure sufficient to texturize the protein of said slurry into a plastic solid of texturized protein.
- 55 11. A process according to any preceding Claim, wherein the aqueous slurry introduced into the treatment zone comprises:
 - a) from 2 to 35% of texturizable protein
 - b) from 0 to 25% of fat

- c) from 0 to 25% of carbohydrate
 - d) from 0 to 40% of texturized protein, and
 - e) from 0 to 15% of flavorant by total weight
- and has a total solids content of from 2 to 60% by weight.
- 60 12. The process of Claim 11, wherein the aqueous slurry contains from 4 to 10% by weight of fat.
 - 65 13. The process of Claim 11, wherein the aqueous slurry contains from 1 to 10% by weight of carbohydrate.
 - 70 14. The process of Claim 11, wherein the aqueous slurry contains from 10 to 30% by weight of texturized protein.
 - 75 15. The process of Claim 11, wherein the aqueous slurry contains from 1 to 10% of flavorant.
 - 80 16. A process according to any preceding Claim, wherein the untexturized protein comprises protein concentrate.
 - 85 17. A process according to any one of Claims 1 to 15, wherein the untexturized protein comprises protein isolate.
 - 90 18. A process according to any preceding Claim for producing a composite texturized protein product comprising introducing a plurality of slurries of untexturized protein into at least one enclosed treatment zone, each of said slurries containing the untexturized protein in an aqueous dispersant having a pH of from 4 to 6.7, injecting steam into each treatment zone to produce a temperature and pressure sufficient to texturize each of said proteins, removing the texturized proteins from each treatment zone, and discharging each texturized protein through a common duct to provide the composite texturized protein product.
 - 95 19. The process of Claim 20, wherein at least two slurries having a different pH are treated.
 - 100 20. The product produced by a process according to any preceding Claim.
 21. A process for producing a texturized protein substantially as herein described with reference to any one of the Examples.
 22. The product produced by the process of Claim 21.

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duct into an open air holding tank. The composite texturized protein product had acceptable color distribution, texture and flavor.

WHAT WE CLAIM IS:—

1. A process for producing a texturized protein product comprising introducing a slurry of untexturized protein in an aqueous dispersant having a pH of from 4 to 6.7 into an enclosed treatment zone, injecting steam into said zone to produce a temperature and pressure sufficient to texturize said protein and removing the texturized protein from said zone.
2. The process of Claim 1, wherein the steam is injected into the aqueous slurry in the treatment zone.
3. The process of Claim 1 or Claim 2, wherein the texturized protein is recovered from the zone at a temperature up to 100°C and is then cooled.
4. The process of Claim 1, 2 or 3, wherein the slurry introduced into the zone is at a temperature of from 0 to 90°C.
5. A process according to any preceding Claim, wherein the aqueous dispersant of the slurry introduced into the zone comprises from 40 to 98% by weight of said slurry.
6. The process of claim 4, wherein the slurry introduced into the zone is at a temperature of from 15 to 60°C.
7. A process according to any preceding Claim, wherein the temperature and pressure of the steam in the zone are from 100 to 200°C and 0.5 to 15 kg/cm².
8. A process according to any preceding Claim, wherein the slurry is treated with steam for from 1 to 60 seconds.
9. A process according to any preceding Claim, wherein the slurry introduced into the zone has a pH of from 4.0 to 5.8 and the steam in said zone is at a temperature and pressure sufficient to texturize the protein of said slurry into discrete chunks of texturized protein.
10. A process according to any one of Claims 1 to 8, wherein the slurry introduced into the zone has a pH of from 5.0 to 6.7 and the steam in said zone is at a temperature and pressure sufficient to texturize the protein of said slurry into a plastic solid of texturized protein.
11. A process according to any preceding Claim, wherein the aqueous slurry introduced into the treatment zone comprises:
 - a) from 2 to 35% of texturizable protein
 - b) from 0 to 25% of fat
 - c) from 0 to 25% of carbohydrate
 - d) from 0 to 40% of texturized protein, and
 - e) from 0 to 15% of flavorant by total weightand has a total solids content of from 2 to 60% by weight.
12. The process of Claim 11, wherein the aqueous slurry contains from 4 to 10% by weight of fat.
13. The process of Claim 11, wherein the aqueous slurry contains from 1 to 10% by weight of carbohydrate.
14. The process of Claim 11, wherein the aqueous slurry contains from 10 to 30% by weight of texturized protein.
15. The process of Claim 11, wherein the aqueous slurry contains from 1 to 10% of flavorant.
16. A process according to any preceding Claim, wherein the untexturized protein comprises protein concentrate.
17. A process according to any one of Claims 1 to 15, wherein the untexturized protein comprises protein isolate.
18. A process according to any preceding Claim for producing a composite texturized protein product comprising introducing a plurality of slurries of untexturized protein into at least one enclosed treatment zone, each of said slurries containing the untexturized protein in an aqueous dispersant having a pH of from 4 to 6.7, injecting steam into each treatment zone to produce a temperature and pressure sufficient to texturize each of said proteins, removing the texturized proteins from each treatment zone, and discharging each texturized protein through a common duct to provide the composite texturized protein product.
19. The process of Claim 20, wherein at least two slurries having a different pH are treated.
20. The product produced by a process according to any preceding Claim.
21. A process for producing a texturized protein substantially as herein described with reference to any one of the Examples.
22. The product produced by the process of Claim 21.

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