

PATENT SPECIFICATION

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(54) PROCESS FOR PREPARING PROTEINACEOUS MATERIALS

(71) I, HAROLD ABRAHAM HOFFMAN, a citizen of the United States of America, of 105 Bayeau Road, New Rochelle, State of New York, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to the preparation of an edible, bland, high-protein textured composition derived from proteinaceous plant material.

There is a great need for a relatively simple, relatively inexpensive method for converting widely available vegetable proteinaceous materials containing a high percentage of protein into a food product that is palatable when cooked and resembles meat.

A principal problem is to remove undesirable flavors and to provide a texture similar to meat. Vegetable proteins such as soybean in flour or flake form have been treated with solvent aqueous extractants or steam. Such processes are described in, for instance, United States Patents Nos. 3,126,286; 2,881,076 and 2,683,091. In some processes, for example in United States Patent No. 3,047,395, soybean is cooked to provide a shred-like material or as in United States Patent No. 3,142,571 to produce a spongy material from a dough. Fibers have been formed which require bonding into a final product or extruded products expanded to give a porous structure.

Soybeans have been compacted by passing through a screwpress under conditions which remove part of the moisture as steam and also remove some objectionable flavor. This is described in United States Patent No. 2,162,729 using an "Anderson" expeller (i.e. screw-press) as described in United States Patent No. 731,737. In United States Patent Nos. 3,485,636 and 3,620,755 compacted or fused chunks of protein were treated with oils or fats to improve hydration.

It has now been found that if chunks of compacted fused vegetable proteinaceous

materials are leached in water to hydrate the chunks and dissolve certain soluble components and the chunks are dried, a product is obtained which is generally cohesive, bland, meat-like and usually easy to rehydrate, i.e. cook.

According to the invention therefore there is provided a process in which chunks of hard compacted fused proteinaceous material having textured characteristics are leached with water for a time selected in accordance with the mean size of the chunks and sufficient to hydrate the chunks to at least a substantial extent and dissolve at least some of the soluble constituents therein and after separation of the chunks from the leaching water the chunks are dried to a cohesive porous storable product.

It is surprising that this treatment in water not only normally improves flavor but also usually improves the texture and does not generally cause significant deterioration of the nutritional values. The product is normally rehydratable in much quicker periods than the products of the prior art for example in a matter of minutes as compared to 1½ hours. The dry product in addition to ready rehydration is not limited in cooking techniques to maximum temperatures since the chunks already contain denatured protein. Also the products of the process of the invention generally have a higher protein content than products of the art. Also the use of chemically treated flours can be avoided. The flavor is generally superior as is the simulation of the natural structure of meat and unlike many products of the art the product of the present invention does not require bonding of fibrous material.

The fused proteinaceous material which is treated by the leaching step is produced by a method which plasticizes and denatures some of the protein preferably using a modified form of the Anderson "expeller" mentioned earlier. In addition to the structure resulting from the heat and pressure treatment, a porosity results from the leaching step which apparently removes carbohydrates, soluble minerals, ash

[Price 25p]

and parts of fibers. This structure is fixed by the drying step. The leaching is simpler than the leaching carried out on soy or proteinaceous flour materials which have not been subjected to compaction since it is not necessary to control the critical conditions as closely.

The final products are dry, cohesive, porous, bland storable and easy to cook to palatable, like-colored, meat-like products which are chewable chunks.

This invention is eminently suited for the treatment of soybeans but alternatively or in addition there can be substituted proteinaceous plant or vegetable materials containing high amounts of protein (e.g. up to 30 or 40 per cent) such as nuts, including peanuts, beans including lentil and mung beans, seeds such as rape seed, cotton seed, sesame seeds and other plant or vegetable material (e.g. alfalfa or millet).

The soybeans or other proteinaceous material are usually initially processed to prepare meal, flour, or flakes by conventional steps. Hulled or dehulled soybeans can be used as can be defatted or full-fat soybean flour. Solvent treatment and deodorizing treatment can be used. While not critical care should be observed in the selection of initial particle size since this does affect the compaction.

The protein solubility range of the starting material is usually expressed in NSI or PDI, respectively, Nitrogen Solubility Index and Protein Dispersability Index (AOCS Test BA10—65) which is a standard test of American Oil Chemist Society. A suitable range of NSI for the particulated material used herein extends from 30 to 70, preferably 45 to 60. Too low an NSI or PDI provides a mass which is too loose for suitable compaction and leaching and too high an NSI results in the highly compacted chunk which is relatively difficult to hydrate or rehydrate.

The particulated material (preferably flakes) which contains some moisture, is then subjected to mechanical pressure on the mass of at least 1,800 pounds per square inch (126,500 g./sq.cm) for a time under the temperature sufficient to convert moisture into steam. The material is partially disembittered, toasted without scorching and compacted into a hard and substantially fused mass.

The pressure used is at least 1,800 psi (126,500 g./sq.cm) generally from 2,000 to 5,000 psi (140,600—351,500 g./sq.cm) and preferably 2,000 to 3,000 psi (140,600—210,900 g./sq.cm) in which range less energy is generated which results in less chance of scorching the product. Too low pressures results in too loose compaction, extremely long times to achieve any degree of disembittering and gives a product which is mushy on hydration.

Pressures in the above range together with

the heat result in a substantially uniform cake in which the fines and hulls are intimately held and which can be fragmented into chunks which remain cohesive enough to be a commercial product after the process of the invention. Control of the compaction process controls the hydration and rehydration of the chunks. The higher the degree of compaction generally the slower the rate of hydration and the reverse is also true. This applies, to a lesser degree, to the rehydration step. The moisture content of the material should be from 5 to 10 per cent by weight before the pressure treatment. This range gives sufficient moisture for disembittering but avoids scorching of the product or uneven toasting which occurs with too great moistures. The preferred range of moisture control after the pressure treatment is 6 to 8% by weight.

The proteinaceous material should be heated at the stated pressure from 1.5 to 5 minutes. Preferably the time is 3 minutes.

The heat and pressure can be applied by conventional means for example a press plate having heated plates. The desired results are preferably obtained by a modified screwpress of the type disclosed in United States Patent No 731,737 customarily referred to in the art as "Anderson expeller". In the modified form there are no holes in an outer casing surrounding the screw as usually oil has already been removed. A preconditioning chamber is provided which is, for example a 14 inch wide by 14 foot long steam jacketed continuous ribbon blender to preheat the material to from 160 to 200°F. (71—93°C.). A vertical force feeder then conveys the particular material to a main horizontal pressing chamber in which solid polished plates replace the barrel spacing bars of the conventional design. A tapered cone is inserted into the press case outlet space along the shaft of the main press worm (screw) to increase the internal pressure along the press worm and to obtain a uniform, compacted material (usually about $\frac{3}{8}$ " (0.95 cm) thick). All internal surfaces of the press subject to contact with the proteinaceous material are hardened and highly polished for smooth flow of the material through the press. The thickness of the resulting cake is preferably $\frac{1}{4}$ to $\frac{3}{8}$ inch (0.64—0.95 cm) thick but this is not critical and is only desirable.

Heating coils can be added around the outer wall of the screwpress casing housing the rotatable screw to heat uniformly the casing but this is not normally done when the proteinaceous material has been preheated in a preconditioning chamber.

The desired temperature of the soybean material during the pressing is from 302—392°F. (150 to 200°C.) so that the inner casing wall should not have a temperature which will cause the temperature of the proteinaceous material to rise above 200°C. Pre-

ferably the temperature of the proteinaceous material e.g. soybean material should be 165—180°C. to insure partial or substantial disembitment without scorching. The preheating can be from 160 to 200°F. (71—93°C.). Proteinaceous or soybean material with too high a moisture content can be preheated and dried to a proper moisture content in a tempering chamber before the pressure step. With equipment like a press plate having heated plates equipment can be used to preheat the material by standing therein.

Products obtained by the conventional processes using an Anderson expeller can be employed but some products are either insuffi-

ciently or excessively compacted. The art gives no guidance on this point since only compaction was required. As illustrated in the above discussion the conditions of compaction should be such that a compacted material is secured in which cohesion is retained during subsequent processing and yet is capable of hydration and leaching in a reasonable period.

The mass obtained from the screw press or other equivalent processing equipment is fragmented by a convenient means for example chopping blades or crushers. The resulting chunks are sized so that they have a more uniform size range. For example, four suitable portions of different but individually uniform size ranges include chunks that:

Pass through a screen having openings of	But are retained on a screen having openings of
1 inch (2.54 cm)	1/2 inch (1.27 cm)
1/2 inch (1.27 cm)	4* (0.48 cm)
4* (0.48 cm)	10* (0.2 cm)
8* (0.24 cm)	20* (0.08 cm)

*U.S. Standard Sieve mesh sizes.

A wide variety of sizes can be employed but too large a size is difficult to hydrate and too small a size (e.g. a "flour") is subject to undue losses in yield and structure properties and the selection of chunk size should be guided appropriately.

Preferred chunks pass through a 1 inch (2.54 cm) opening screen and stay on a 1/2 inch (1.27 cm) opening screen. The oven and under sized material can be removed. The resulting chunks are light yellowish brown or buff in color and are relatively nonporous.

The chunks are then leached preferably in boiling water or hot water for a period of time selected in accordance with the mean size of chunks and sufficient in length to hydrate the chunks to a substantial extent, preferably completely, and to dissolve out some of the soluble constituents. Again the precise choice of conditions is empirical to secure ultimately a porous easily hydratable product and can vary depending on extractant and conditions.

The boiling water is usually at atmospheric pressure, although a lower or higher pressure can be used. The use of pressures above atmospheric produce chunks which are darker in color and have a poorer consistency. The extraction and leaching (and subsequent washing) can be achieved using water having a temperature as low as 32°F. (0°C.), but warm water is preferably used because it is more efficient. When hot water is used, it should

have a temperature of at least 150°F. (66°C.) and preferably a temperature of from 190° to 212°F. (88—100°C.). The use of the higher temperature levels assures that a bactericidal processing is achieved.

The chunks are leached as long as necessary, which is often from 1 1/4 to 1 1/2 hours, for example, for chunks of a size of about one inch. The chunks can be leached much longer than the time necessary to completely hydrate them (e.g. up to 1 3/4 hours) without the chunks becoming mushy and losing their integrity. The amount of water used is not narrowly critical and should be that minimum amount to cover the chunks during leaching. There is no technical upper limit except one of economics in providing excessive amounts of hot or boiling water. Illustratively, water to chunks ratios can be 6:1 or lower to 9:1 or higher.

The pH range of the hot water or boiling water is quite wide, usually from 5 to 10, preferably between 6 and 7 and most preferably, as close to neutral as possible. The use of a pH above about 10 tends to produce off-flavors and aromas. Various pH adjusting agents can be used which can be used in foods including organic and inorganic acids and alkalis. The pH can be adjusted by the addition of natural foods or extracts thereof, which would flavor the end product, but will not be likely to reduce the shelf life of the end product.

The leached chunks are removed from the hot or boiling water and preferably washed with warm water. Normally the leached chunks are removed from the hot or boiling water by pouring the mass onto a screen which retains the chunks. An appropriate screen would be one having $\frac{1}{8}$ inch (0.32 cm) openings. The temperature of the warm wash water, if used, is usually from 130° to 160°F. (54—71°C.). Abundant amounts of warm water should be used. Also, the washing can be done using boiling water and hot water having temperatures up to 212°F. (100°C.). The length of the washing time depends on the batch size. Illustratively, it varies from 1 minute to 2 or 5 minutes. The object of washing is to remove substantially all solubles and a wide variation in water to chunk ratio needed to accomplish this can be used, illustratively 6:1 or less to 9:1 or more. The washing step can be a batch or a continuous scheme and preferably is at atmospheric pressure. The washed chunks should be allowed to drain after washing, with or without agitation. The moisture content of the drained chunks at this point in the process is usually about 65 to about 75 per cent by weight.

The hydrated chunks are then dried to a low moisture content, preferably down to from 4 to 7 per cent by weight final moisture content. The drying is preferably achieved using dry air having a temperature of from 150° to 250°F. (66—120°C.), usually about 200°F. (93°C.). The dry air should have a low relative humidity, e.g., 30 per cent, for an efficient drying operation. The length of the drying time is in the order of 2 to 4 hours, depending on the batch size. A continuous drying scheme can be utilized. Various drying methods can be used, including vacuum drying or freeze drying. After drying, the average yield of solids for the entire process is about 75 per cent by weight. The chunks, at this stage, have an increased protein content by about 8 to 10 per cent by weight (on a dry basis) as compared to the chunks which have not yet been subjected to the hydrating/leaching (boiling or hot water), washing and drying steps. This increased protein content probably is one of the reasons why the dried chunks of this invention are when rehydrated more meat-like in texture than the hydrated chunks of the prior art. The resulting dried chunks are golden brown in color, which is most appetizing in appearance, are relatively porous, bland, dry, cohesive, storable, quick-cooking and, after substantial or complete rehydration, are chewable, light-coloured, meat-like in texture, bland and palatable.

Typically the moisture content of the compacted chunks is between 6 and 8 per cent while the moisture content of the dried processed chunks can be from 4 to 8 preferably 4 to 6 per cent.

The chunks can be stored for extended

periods of time in the absence of moisture or very high humidity, and can be stored almost indefinitely if packaged. Clear packages can be used because the chunks are golden brown and are very appetizing in appearance.

The chunks can be used as a meat substitute by placing the chunks in boiling water for about 5 to 15 minutes or in hot water (preferably 190° to 212°F. (88—100°C.)) for 10 to 15 minutes. The chunks are rehydrated to a moisture content of about 65 to about 75 per cent by weight. The rehydration time depends upon the particle (chunk) size and water temperature, but they have a short rehydration time i.e., in the order of minutes as compared to unleached material. The same is true at the various pressures at which cooking can be achieved. The water to solids ratio can be varied to obtain textural difference in and for particular applications. The usual weight ratio of water to solids varies from 3:1 to 1:1 with 3:1 being preferred.

As a variation of this invention flavoring systems including flavor enhancers and/or agents can be added, but are usually not needed. Usually the flavor enhancers are added in an amount of 0.1 to 2 per cent by weight. Flavoring agent in the usual amount of 10 to 20 per cent by weight can be added.

The only function of final cooking is to rehydrate the chunks to prepare them for serving. While long term cooking might eventually destroy the protein, there is no maximum cooking temperature in the sense that some upper temperature must be avoided so as not to deactivate the protein because the chunks which are cooked already have denatured protein.

The chunks can be (though not usually) coated or impregnated by an edible oleaginous material after the drying step. Such treatment may affect the time required for rehydration.

The chunks produced by the invention can be rehydrated for consumption or can be used as a raw material that is, for example, oiled and flavored and treated according to the method described in United States Patent 3,485,636.

The dried chunk produced by this invention can be used in a variety of ways to furnish vegetable protein as a meat protein substitute. The dried chunks can be rehydrated and eaten cold though preferably hot. The dried chunks can be before or after rehydration, mixed with other food ingredients, flavor enhancers and other edible ingredients.

The dehydrated product is usually supplied in multiwall bags or fiber drums and rehydrated products are usually supplied in cans or frozen packages. After being rehydrated, the chunks of this invention generally retain their meat-like textural integrity during frying, grilling baking or retorting. The rehydrated chunks weigh 2 to 3 times that of the dry material and in the rehydrated

form readily mix with ground meat, rice, corn meal or other protein enrichment.

5 A very important feature of this invention is that the dried processed chunks or the rehydrated chunks can withstand the usual retorting conditions for canned products (i.e., 250°F. (120°C.) for 1 hour).

10 Unless otherwise stated or indicated in the following examples and throughout the rest of the specification and in the claims, all percentages, parts and portions are expressed on a weight basis, based upon total compositions.

EXAMPLE 1.

15 Flakes of dehulled, solvent-extracted, soybean having a moisture content of 7.5 per cent and an N.S.I. of about 50 are processed in a "modified Anderson expeller" as described above.

20 The soybean flakes are preheated to about 180°F. (86°C.) in the preconditioning chamber for 1 minute, and steam having a pressure of 65 p.s.i.g. (4900 g/sq.cm) is used in the steam jacket. The soybean flakes have a moisture content of 6.8 per cent are then
25 passed through the vertical force feeder into the main horizontal pressing chamber where a pressure of 2000 p.s.i. (140,600 g/sq.cm) is applied for 2 minutes, the thickness of the cake is about $\frac{3}{8}$ inch (0.95 cm). The cake during the pressing has a temperature of 305°F. (152°C.). The exiting cake has a moisture content of 5.5 per cent, is allowed to cool and is fragmented by means of chopping blades into chunks. The chunks have a light yellowish

brown or buff color and are not porous in appearance. 35

The chunks are separated by screens to give retained chunks having a chunk size that pass through a one inch screen and stay on a $\frac{1}{2}$ inch (1.27 cm) screen. 40

25 Pounds (11.3 kg.) of the chunks are placed in 225 pounds (101 kg.) of water (pH is 6.8) vigorously boiling (212°F.; 100°C.) in a steam jacketed tilting kettle and leached or rehydrated at that temperature for 1.5 hours. The leached chunks are drained by tilting the kettle and dumping on a $\frac{1}{8}$ inch (0.32 cm.) opening screen where they are washed with 300 lbs. (135 kg.) of warm water at 150°F. (66°C.) over a period of 15 minutes. 50
The leached chunks are drained and have a moisture content of 75 per cent by weight. The chunks are then placed on $\frac{1}{8}$ inch (0.32 cm) openings screens in a cabinet dryer. The bed depths are about one inch (2.54 cm) and the dryer screen area is 4.28 square feet (1.28 sq. m.). Air, having a temperature of 200°F. (93°C.) and a relative humidity of 30 per cent, is used to dry the chunks to a final moisture of 5 per cent by passing the air upwardly through the leached chunks for 2 $\frac{1}{2}$ hours at a velocity of 500 feet per minute (255 cm/sec.). The average yield of solids for the entire process after drying is 75 per cent. 65
The final chunks have an analysis (weight per cent on a dry basis) as shown in Table I which is compared with that of the initial chunks.

TABLE I

	Compacted Chunks	Final Chunks
Protein (N $\times$ 6.25)	53.5	61.5
Fat	1.2	3.3
Fiber	4.0	3.0
Ash	6.7	5.2
Carbohydrate (difference)	34.6	27.0

The noted calculation basis for the protein is N $\times$ 6.25, wherein N is the value obtained by an analysis for protein nitrogen using the

Kjeldahl Test and 6.25 is the standard factor for soy to get total protein. 75

The following is the vitamin analysis for the compacted soybean chunks:

TABLE III

No.	Pressure Treatment Time, Minutes	Pressure psi.	Cake Thickness Inches	Chunk Size Inches		Leaching Hydration Conditions	Rehydration (Final Cooking) Minutes
				Through	On		
3	3	2500	0.25				
4				1/2	1/4		10
5				1/2	1/4		12.5 (15—18 psi)
6				1/4	0.1		5
7							90
8							92.5 (15—18 psi)
9				1/2	0.1		3.5
10				1/2	1/4		5
11						190°F.	
12						pH 5	
13						pH 8.5	
14						washed at 135°F. for 10 minutes	
15							
16	2	5000					
17						3 days at 35°F.	

Notes: 2500 psi = 177,750 g./sq.cm.
5000 psi = 351,500 g./sq.cm.
15—18 psi = 1050—1265 g./sq.cm.

1 inch = 2.54 cm.
0.5 inch = 1.27 cm.
0.25 inch = 0.63 cm.
0.1 inch = 0.25 cm.

35°F. = 1.7°C.
190°F. = 88°C.
135°F. = 57°C.

This shows a high percentage of vitamins are retained.

Comparison of this analysis of the dry leached chunks with the analysis set for the feed chunks shows that the final chunks possess a protein content which is 8 per cent higher (based on the protein content of the feed chunks) than the feed chunks.

An mineral analysis of the dried processed chunks shows 0.25 per cent magnesium as compared to 0.28 per cent in the chunks before leaching. This shows that a very high percentage of minerals is retained.

One part of dried chunks is placed in 2 parts of boiling water for 11 minutes. (The chunks can absorb from 1 to 3 times their weight of water). The resultant rehydrated chunks are bland, light-colored, meat-like in texture and palatable. They do not contain any noticeable bitter beany flavor and taste. Further, there is no objectionable odor when any storage package is opened, during the rehydration or at any time thereafter. The rehydrated chunks are very high in protein content.

EXAMPLE 2.

Rehydrated products with final properties

similar to those of Example 1 are obtained by a process in which the dried final product is stored in sealed plastic bags at room temperatures before rehydration.

EXAMPLES 3—17.

This process of Example 2 with storage was then repeated with the same conditions except for those modified as indicated in appropriate places in Table 3. In each case the final rehydrated products were comparable with those of Example 1. Only in Examples 5 and 8 with high pressures for rehydration the products were darker and of poorer consistency showing pressures above atmospheric have no advantage. In Example 13 and 14 the pH's are modified with citric acid and sodium hydroxide respectively.

In Example 16 the initial feed is soybean meal of 8.5 percent moisture which is preheated to reduce to 7.5 per cent moisture and to a temperature of 85°C.

In Example 17 while a good product is obtained the danger of bacterial spoilage is great and economic analysis indicated a temperature of at least 150°F. (66°C.) is desirable.

TABLE II

Amounts mgs per lb. or mgs per 0.45 kg.

Vitamin	Starting Chunks	Final Chunks
Thiamin	3.49	2.62
Riboflavin	2.18	1.07
Niacin	8.17	7.19
Vitamin B ₆	2.27	0.62
Vitamin B ₁₂	None detected	None detected

EXAMPLE 18.

Repetition of Example 2 gave comparable result with as feeds: soybean grits, soybean flour, soybean meal, non-preheated soybean flakes, soybean meal of moisture content 5 and 8.5 per cent (fed to expeller) and soybean flakes containing non-soluble coloring agent.

EXAMPLE 19.

Rehydrated soybean chunks are prepared as in Example 1 (water to chunk ratio of 2:1). 300 pounds (135 kg.) of the rehydrated soybean chunks, 720 pounds (324 kg.) of red kidney beans, 960 pounds (430 kg.) of beef gravy, 120 pounds (54 kg.) of tomato sauce, 20 pounds (9 kg.) of chilipowder and 10

pounds (4.5 kg.) of salt are placed in a kettle and mixed. The kettle ingredients are heated to 185°F. (85°C.) and then canned. The cans are retorted at 250°F. (121°C.) for one hour, cooled and stored. After a period of time the cans are opened, placed in a large container and heated. The warm chili is delicious and has no objectionable soybean taste or odor. The soybean chunks have a meat-like texture.

EXAMPLE 20.

A laboratory size experimental run was made to evaluate the leaching/hydration of initial compacted chunks under pressure.

Two pounds (0.9 kg.) of compacted soybean chunks (obtained as described in Ex-

ample 1) are added to 18 lbs. (8.5 kg.) of pre-boiled water and the mixture pressure leached at 18 p.s.i.g. (1265 g/sq. cm.) for 1½ hours. The pressure drops on cooling and the vessel is opened. Excess water is drained and the leached chunks were washed with warm water. The pressure leached chunks contain about 75 per cent moisture, and they appeared to be a dark grayish color (much darker than the product obtained from atmospheric cooking). The surface appears to be mashed or finely grained in structure. There is no significant difference detected in the flavor of both types of products. The mashed surface characteristics of the pressure leached product is believed to be detrimental to product yield since more fines will result in subsequent processing i.e. drying and rehydrating.

EXAMPLE 21.

Example 1 is repeated twice up to the rehydration step, except that the drying times of the leached chunks are 50 minutes Sample A and 4 hours Sample B, respectively. Also, the compacted chunks which are used pass through a ¾ inch (1.9 cm.) screen and are retained on a ⅜ inch (0.95 cm.) screen. 50 grams of each batch of dried, processed chunks

were rehydrated by placing each in 200 ml of boiling water for 15 minutes.

Texturometer tests are run having the tested material in a loosely packed single layer in the cup platform. Three samples of each batch of rehydrated chunks are tested, five trials being run on each sample.

Fifteen trials are reported above for each batch of chunks. Rehydrated chunks A (50 min. drying) are consistently slightly more cohesive than rehydrated chunks B (4 hours drying).

EXAMPLE 22.

Example 1 is repeated up through the drying step. The dried processed soybean chunks are rehydrated by placing 100 grams thereof in 400 ml of boiling water for 25 minutes. These chunks are termed rehydrated chunks C.

200 grams of compacted soybean chunks obtained using the process described in United States Patent 2,162,279 are fully hydrated by boiling them for 1 hour 45 minutes (enough water is periodically added to keep the chunks covered as the water evaporated off). These chunks were termed prior art chunks 1.

Texturometer tests are run on 20 specimens of each type of chunk, and the data therefrom is:

Chunks	Data Headings	Average Cohesion Values
Rehydrated Chunks C	- x (Mean Value) SD (Standard Derivation)	0.738 0.067
Prior Art Chunks 1	- x SD	0.606 0.041

The hydrated chunks obtained from compacted chunks prepared according to United States Patent 2,162,729 are significantly less cohesive than rehydrated chunks C.

EXAMPLE 23.

Example 1 is repeated up to the rehydration step. Three batches of the dried processed soybean chunks are rehydrated in boiling water, one for 10 minutes, one for 20 minutes, and one for 30 minutes. These are termed the invention chunks.

Oiled and compacted soybean chunks prepared as described in United States Patent 3,485,636 are hydrated in boiling water, one batch for 105 minutes, one batch for 120 minutes and one batch for 150 minutes. These are termed prior art chunks.

Texturometer tests and moisture analyses

carried out on 5 specimens from each batch showed slightly lower moisture for prior art products and similar texture properties.

EXAMPLE 24.

The starting material is a commercial defatted dehulled, solvent-extracted, soybean material in chunk form and obtained by a thermoplastic compaction process as described in United States Patent 2,162,729.

The chunks are separated by screens to give retained chunks having a chunk size that pass through a United States Standard No. 1 sieve (2.5 cm.) and stay on a United States No. 2 sieve (1.2 cm.). The feed chunks are then treated by hydration and drying as in Example 1 to obtain the final chunks. The feed and final chunks have the analyses (weight per cent on a dry basis) as follows:

	Feed Chunks	Final Chunks
Protein (N $\times$ 6.25)	52.5	61.5
Fat	1.0	3.3
Fiber	3.0	3.0
Ash	6.5	5.2
Carbohydrate (Difference)	37.0	27.0

The comparison shows that the chunks as prepared by this invention possess a protein content which is higher than the feed chunks.

- 5 The final chunks were rehydrated as in Example 1. The resultant rehydrated chunks are bland, light-colored, meat-like in texture and palatable. They do not contain any noticeable bitter beany-flavor and taste. Further, there is no objectionable odor when any storage package is opened, during the rehydration or at any time thereafter. The rehydrated chunks are very high in protein content. The rehydrated chunks have improved
- 10 Texturometer cohesiveness over the "starting" chunks when hydrated and can be rehydrated much more rapidly.

WHAT I CLAIM IS:—

1. A method of preparing a proteinaceous product in which chunks of hard, compacted, substantially fused vegetable proteinaceous material are leached with water for a time in accordance with the mean size of the chunks to hydrate the chunks to at least a substantial extent and dissolve at least some of the soluble constituents and thereafter the chunks are dried.

2. A method according to claim 1, in which the chunks of proteinaceous material have been prepared from an initial vegetable material containing some moisture by heating under a pressure of at least 1,800 lbs. per sq. inch to convert said moisture into steam and compact the vegetable material.

3. A method according to claim 2, in which the initial vegetable material contains from 5 to 10% by weight moisture.

4. A method according to claim 3, in which the moisture is reduced by the heating under pressure to from 6 to 8% by weight.

5. A method according to any one of claims 2 to 4, in which the initial proteinaceous vegetable material has an NSI of 30 to 70.

6. A method according to any one of claims 2 to 5, in which the pressure is from 2000 to 5000 lbs. per sq. inch at from 150 to 200°C.

7. A method according to any one of claims 2 to 6, in which the heating and pressure is applied for from 1.5 to 5 minutes. 50

8. A method according to any one of the preceding claims, in which the water is at a temperature of at least 150°F. (66°C.).

9. A method according to claim 8, in which the water has a temperature of from 190 to 212°F. (88°—100°C.). 55

10. A method according to any one of claims 1 to 9, in which the leaching is for from 1½ to 1¾ hours.

11. A method according to any one of claims 1 to 10, in which the leaching is carried out at atmospheric pressure. 60

12. A method according to any one of claims 8 to 11, in which the water has a pH of from 5—10. 65

13. A method according to any one of claims 1 to 12, in which the chunks are washed before drying.

14. A method according to claim 13, in which the wash is with water of from 130 to 212°F. (74—100°C.). 70

15. A method according to any one of the preceding claims, in which the drying is effected with hot air.

16. A method according to any one of claims 1 to 15, in which the final moisture content of the dried chunks is from 4 to 8% by weight. 75

17. A method according to any one of claims 1 to 16, in which the compacted chunks pass through a 1 inch opening screen and are retained on a ¾ inch screen. 80

18. A method of preparing a proteinaceous material according to claim 1, substantially as hereinbefore described. 85

19. Chunks of proteinaceous material when produced by a process according to any one of the preceding claims.

20. Chunks according to claim 19, which have been hydrated in hot or boiling water. 90

21. A food formulation containing chunks according to either of claims 19 and 20.



	Feed Chunks	Final Chunks
Protein (N $\times$ 6.25)	52.5	61.5
Fat	1.0	3.3
Fiber	3.0	3.0
Ash	6.5	5.2
Carbohydrate (Difference)	37.0	27.0

The comparison shows that the chunks as prepared by this invention possess a protein content which is higher than the feed chunks.

- 5 The final chunks were rehydrated as in Example 1. The resultant rehydrated chunks are bland, light-colored, meat-like in texture and palatable. They do not contain any noticeable bitter beany-flavor and taste. Further, 10 there is no objectionable odor when any storage package is opened, during the rehydration or at any time thereafter. The rehydrated chunks are very high in protein content. The rehydrated chunks have improved 15 Texturometer cohesiveness over the "starting" chunks when hydrated and can be rehydrated much more rapidly.

WHAT I CLAIM IS:—

- 20 1. A method of preparing a proteinaceous product in which chunks of hard, compacted, substantially fused vegetable proteinaceous material are leached with water for a time in accordance with the mean size of the chunks to hydrate the chunks to at least a 25 substantial extent and dissolve at least some of the soluble constituents and thereafter the chunks are dried.

- 30 2. A method according to claim 1, in which the chunks of proteinaceous material have been prepared from an initial vegetable material containing some moisture by heating under a pressure of at least 1,800 lbs. per sq. inch to convert said moisture into steam and compact the vegetable material.

- 35 3. A method according to claim 2, in which the initial vegetable material contains from 5 to 10% by weight moisture.

- 40 4. A method according to claim 3, in which the moisture is reduced by the heating under pressure to from 6 to 8% by weight.

5. A method according to any one of claims 2 to 4, in which the initial proteinaceous vegetable material has an NSI of 30 to 70.

- 45 6. A method according to any one of claims 2 to 5, in which the pressure is from 2000 to 5000 lbs. per sq. inch at from 150 to 200°C.

7. A method according to any one of claims 2 to 6, in which the heating and pressure is applied for from 1.5 to 5 minutes. 50

8. A method according to any one of the preceding claims, in which the water is at a temperature of at least 150°F. (66°C.).

9. A method according to claim 8, in which the water has a temperature of from 190 to 212°F. (88°—100°C.). 55

10. A method according to any one of claims 1 to 9, in which the leaching is for from 1¼ to 1½ hours.

11. A method according to any one of claims 1 to 10, in which the leaching is carried out at atmospheric pressure. 60

12. A method according to any one of claims 8 to 11, in which the water has a pH of from 5—10. 65

13. A method according to any one of claims 1 to 12, in which the chunks are washed before drying.

14. A method according to claim 13, in which the wash is with water of from 130 to 212°F. (74—100°C.). 70

15. A method according to any one of the preceding claims, in which the drying is effected with hot air.

16. A method according to any one of claims 1 to 15, in which the final moisture content of the dried chunks is from 4 to 8% by weight. 75

17. A method according to any one of claims 1 to 16, in which the compacted chunks pass through a 1 inch opening screen and are retained on a ¼ inch screen. 80

18. A method of preparing a proteinaceous material according to claim 1, substantially as hereinbefore described. 85

19. Chunks of proteinaceous material when produced by a process according to any one of the preceding claims.

20. Chunks according to claim 19, which have been hydrated in hot or boiling water. 90

21. A food formulation containing chunks according to either of claims 19 and 20.



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