

A PROCESS FOR THE PRODUCTION OF A PROTEIN GRANULE
SUITABLE FOR USE AS A MEAT EXTENDER

This invention relates to a process for the production of a hydrated protein granule from a vegetable protein isolate. The hydrated protein granule is suitable for use as an extender for meat products, or as an ingredient in meat analogues.

Vegetable protein products which include soy flour, soy concentrates and soy isolates have become widely used and accepted food ingredients. Among the vegetable protein products which have been the most widely accepted are the textured vegetable protein materials which have gained wide acceptance as a meat extender. The extended meat products are comparable in nutrition and quality to the natural meat products.

A variety of textured vegetable protein materials and processes for their production have been proposed. Generally recognised as one of the first processes for texturisation of protein was that described in US-A-2,682,466. Edible protein filaments were produced by a spinning process similar to that for the spinning of textiles. The starting material for this texturisation process was a protein isolate, which has the bulk of oil and carbohydrates removed to achieve a protein content of 90-95% by weight on a dry basis.

Although numerous texturisation techniques have been proposed for materials of lower protein content, such as soybean meal, soy flour or concentrates, the most widely used and commercially successful technique for the texturisation of vegetable protein material is the extrusion process described in US-A-3,940,495. This

process produces an expanded, meat simulating product which is capable of rehydration with water and, upon rehydration, is highly suitable as a meat extender. This type of extender was approved for use for the School Lunch Program by the U.S. Department of Agriculture, Food and Nutrition Service (FNS Notice 219) and, since then, has found wide usage in this program as well as by meat processors for the production of extended meat.

Other extremely numerous texturisation processes have also been proposed, following development of the extrusion process. These processes, including the extrusion process, employ lower protein content vegetable protein materials as well as vegetable protein isolates. Some of these processes describe variations in the extrusion process described above in US-A-3,940,495 to achieve differences in density or functionality of the textured product, as well as an improvement or modification of the flavour or texture of the resultant product. Other processes have been directed to the production of non-expanded textured products, such as an agglomerated protein material, disclosed in US-A-4,045,590, or an unpuffed proteinaceous extrudate as disclosed in US-A-3,498,794 and 3,968,268.

More recently US-A-4,276,319 discloses an extruded, dried and granulated protein gel suitable as a meat extruder which is prepared from a vegetable protein isolate.

A simple and effective procedure for the production of a composite protein material, consisting of meat and a vegetable protein isolate, is disclosed in EP-A-352062. Frozen meat is mixed with a vegetable protein isolate and water, and mixed under conditions of

shear to form a composite product that blends readily with meat. This procedure has the advantage of simplicity, does not require expensive equipment and can therefore be readily performed by a food manufacturer at minimal expense.

In spite of the commercially developed nature of the vegetable protein industry, a continuing need exists for specific types of meat extenders exhibiting specific functional properties for various food uses.

We have now developed a process for the production of a protein granule suitable as an extender for various types of meat which represents a simple but effective means for a meat processor to extend meat products with a vegetable protein material, but without the need for expensive equipment such as extruders and drying equipment.

In a first aspect, the present invention provides a process for producing a hydrated protein granule for use as a meat extender, comprising the steps of hydrating a vegetable protein isolate and blending the isolate to produce a granule, the hydration step being such that the isolate is mixed with water to a ratio of 1 : 2-3.5 parts by weight, the water being at a temperature of at least 50°C, and the blending step being under conditions of shear for a time sufficient to form the granule.

It is generally preferred that the vegetable protein isolate is a soy protein isolate.

Advantageously, the water used in the process of the invention is at a temperature of 50 - 100°C, preferably 60 - 80°C.

In order to obtain a good product, it is preferred that blending under conditions of shear is carried out for at least one minute, more preferably 1 - 3 minutes.

A useful hydration ratio is 3 parts by weight of water to 1 part of isolate.

Blending is advantageously carried out under a condition of reduced atmospheric pressure, preferably at or less than 25 inches of mercury (84.7 kPa), to improve stiffness of the product.

The present invention further provides a granulated protein product produced by a process of the invention.

In a preferred embodiment, the present invention provides a process comprising initially hydrating a vegetable protein isolate in order to provide a ratio of 2 to 3.5 parts by weight of water to 1 part by weight of the isolate. It is important to the texture and functionality of the granule that the water used to hydrate the granule be heated, preferably to a temperature of at least 50°C, and most preferably to a temperature of 60-80°C. The use of heated water in order to hydrate the isolate is an important step in providing the requisite degree of texture or firmness in the granule. Following hydration of the isolate the isolate is blended under conditions of shear for a period of time sufficient to form a granule which is suitable for use as a meat extender or meat analogue ingredient. A preferred procedure is to blend the isolate under conditions of reduced atmospheric pressure such as a vacuum in order to increase the firmness of the granule.

The process of the invention allows the production of a hydrated protein material from a vegetable protein

isolate which exhibits desirable functional characteristics and blends well with ground meat to provide a mixture comparable to the natural meat.

The granule is also suitable as an ingredient in meat analogues. The process for the production of the above material is convenient and reliable for practising on a commercial basis.

General considerations are provided hereinbelow. For example, the process of the invention will typically initially involve the selection of a vegetable protein isolate as the starting material. Vegetable protein isolates are a well-known product that are produced from vegetable protein materials such as soybeans. They may be produced by solubilisation of the protein from the soybeans, followed by removal of the residual carbohydrates.

Subsequent acid precipitation of the solubilised protein is useful to provide a high purity proteinaceous material. Drying of the precipitated protein provides an isolate with greater than 90% protein on a dry weight basis.

The choice of the exact isolate used in the present invention is not critical to its practise, although preferred isolates are those obtained from soybeans, and a variety of soy protein isolates are commercially available from various manufacturers. Typical isolates that may be used include "Supro 500E", "Supro 515", "Fujipro 545" and "Fujipro 540" (Trade Marks), all of which can be purchased from Protein Technologies International, Checkerboard Square, St. Louis, MO, USA 63164. Other isolates which may be used in the process of the invention include isolates from other oilseeds, such as oilseed rape and cottonseed.

Following selection, the suitable vegetable protein isolate is hydrated and blended under conditions of high shear in order to form a protein granule which is suitable as a meat extender or meat analogue ingredient. The present invention is not dependent on specific equipment, but it is preferred that hydration and blending are carried out virtually simultaneously using a standard commercial bowl cutter, such as Kramer Grebe VSM65, manufactured by Kramer-Grebe, Biedenkopf-Wallau, Germany. This type of equipment provides the rapid blending or mixing of the protein and water in order to rapidly hydrate the protein as well as to provide the conditions of shear for formation of the granule from the hydrated protein isolate. This equipment also includes means to reduce atmospheric pressure and create a vacuum, thereby permitting blending to be carried out under reduced pressure. This has been found to provide an effective means of increasing the firmness of the granule.

Hydration of the vegetable protein isolate is an important step in the process of the present invention. In this regard, the vegetable isolate is hydrated with water which has a temperature of at least 50°C, preferably 50-100°C, with a most preferred temperature range of 60-80°C. This can be quickly and conveniently carried out in the bowl cutter by the addition of the isolate to the heated water contained in the bowl. The use of heated water is important for obtaining the desired degree of structural integrity and firmness in the protein granule. Preferably, the heated water is added to the protein isolate in an amount sufficient to provide a ratio of 2 - 3.5 parts by weight of water to 1 part by weight of vegetable protein isolate. The most preferred ratio of water to isolate is 3 parts by weight of water to 1 part by weight of isolate.

Blending of the isolate and water is carried out in the bowl cutter or other suitable apparatus for a period of time sufficient in order to form a hydrated protein granule. The desired granular structure can be readily determined by visual observation. Typically, blending is carried out under conditions of shear or mechanical agitation so that the isolate is formed into a gel which is then chopped or subdivided into individual granules. The above identified bowl cutter, because of the chopping action of the blade, provides the requisite degree of shear or chopping action to produce the individual granule but, alternatively, the hydrated isolate may be separately passed through a mincing machine or similar type of apparatus.

The period of time sufficient to form the individual granules, as noted above, may be readily observed by visual observation but, typically, will be for at least one minute. Excessive blending is not particularly desirable, both from the standpoint that it represents a waste of energy and also that it could deteriorate the granular structure achieved. Therefore, a preferred range for purposes of blending or mixing of the isolate and water under conditions of shear is 1 - 3 minutes. This degree of blending or chopping usually produces the individual granules desired, assuming that the isolate is hydrated in the manner described above.

It is also preferable, as noted above, to carry out the chopping or shear step in a vacuum, since this has been found to significantly improve firmness of the granule and the above-identified equipment includes means to provide a vacuum or reduced atmospheric pressure for the cutter. Preferably, vacuum applied will be at least 25 inches of mercury (84.7 kPa), but can vary depending on the degree of firmness

desired. The length of time the vacuum is applied usually for the duration of the chopping, the strength of the vacuum being selected to take into account the conditions of shear used for making the gel formed by the isolate and water from which the granules are formed.

It is also desirable in the context of the present invention to include additional additives with the vegetable protein isolate, such as flavouring and colours, provided that the additive does not adversely affect the granular structure. Examples of suitable additives include hydrolysed vegetable proteins and natural flavourings. Salt can sometimes be added to the vegetable protein isolate, although this is not generally preferred for the purposes of the present invention, since the salt will sometimes interfere with the granule formation, depending on the amount added for flavouring purposes. It is preferable, therefore, to add any salt required during the time that the hydrated granule is mixed with, or used to extend, a meat product.

The hydrated protein granule, produced as described above, is suitable for use as a meat extender without further treatment. The hydrated granule can be frozen in order to provide extended storage, or can include various materials, such as antimicrobial or antimycotic agents to provide some degree of shelf stability for the hydrated granule, provided that these additives do not interfere with the formation of the granule or are added to the surface of the granules following formation.

The following Examples illustrate further the present invention, but are not limiting thereon.

EXAMPLE 1

In order to evaluate the effect of temperature on the water of hydration, a series of samples were prepared as described below. The soy protein isolate referred to in Table 1 was "Supro 500E", available from Protein Technologies International Checkerboard Square, St. Louis, MO, USA 63164, and was used in each formulation, varying as set forth in Table 1 below. The temperature of the water used for the hydration as well as the hydration ratio is also set forth.

TABLE 1

Sample	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
Soy Protein Isolate (gm)	4444	5000	5000	5000	5000	5000
Water (gm)	15556	15000	16250	15000	15000	15000
Hydration Ratio (water to Isolate)	3.5:1	3:1	3.25:1	3:1	3:1	3:1
Water Temp. (°C)	70	70	70	30	50	90

In each case, the entire amount of soy protein isolate was added to the indicated amount of water in a Kramer Grebe 65 litre chopper Model # VSM-65, available from Kramer-Grebe, Biedenkopf-Wallau, Germany. The soy protein isolate and water were chopped at slow speed for 20-30 seconds until mixing was achieved, followed by blending or chopping at high speed under conditions of shear for about 2 to 3 minutes, until a gel was formed. Sample #6 was blended at high speed for only about 1.5

minutes. A mix speed chop was then employed to break the gel into granules.

The following observations were made with regard to the processing of each sample.

Sample #1 - After chopping at high speed for 2 minutes, a gel formed that was softer than that achieved with a 3 to 1 hydration ratio. The gel formed was too sticky to form distinct granules, even after chopping for an additional minute.

Sample #2 - The gel formed well, and was cut into individual granules. The particles were fairly firm and formed distinct granules.

Sample #3 - Granules formed were stickier than those from sample #2, although they did not form into a mass when squeezed.

Sample #4 - The gel that formed was stiff but more sticky than that formed at 70°C. Distinct granule formation was inhibited.

Sample #5 - Stiff distinct granules were formed which were only slightly stickier than sample #2.

Sample #6 - A very stiff gel was formed which was easily cut into distinct granules which were firm and not sticky.

Each sample of granules produced as set forth above was placed in bags and refrigerated overnight before performing both an objective as well as a subjective texture evaluation. Each sample was objectively evaluated for firmness with an Instron Universal Testing

Machine (Model #1122, Instron Corporation, Canton, MA, USA). Subjective evaluation for firmness was carried out by usual inspection on a scale of 1 to 10, with 10 being the most firm and 1 being the least firm.

The testing procedure on the Instron machine is described below.

1. Calibrate the Instron with the Kramer-Shear cell according to manufacturer's standard procedure.
2. Weigh 100 ± 1 g of sample (sample at 68-70°F [20-21°C]).
3. Gently load the sample into the cage. Do not pack or shake.
4. Tilt the blade section slightly to straighten the blades, and slip the blades gently into the cage. Do not compress the sample.
5. Slide the assembled shear cage into place.
6. Press Down button.
7. When test is completed, gently slide the shear cell out and discard the sample.
8. Calculate the failure force (kg.) from the peak height recorded on the strip chart.

The results of the above evaluation are set forth in Table 2.

TABLE 2 - Firmness

Evaluation of Protein Granules

Sample	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
Instron (kg)	38.3	69.7	57.8	64.5	58.2	79.4
Subjective Firmness	3	5	3	4	4	5.5

It may be seen from the above data that the best granules in terms of firmness were obtained with Samples 2, 4, 5, and 6.

EXAMPLE 2

The procedure of Example 1 was repeated to prepare three samples of granules using a hydration ratio of 2.5 parts of water to 1 part of isolate at varying temperatures for the water of hydration. Each formulation is described in Table 3 below.

TABLE 3

<u>Sample</u>	<u>1</u>	<u>2</u>	<u>3</u>
Soy Protein Isolate (gm)			
Water			
Hydration Ratio	2.5 : 1	2.5 : 1	2.5 : 1
Water Temp. (°C)	70	60	55°C

Each of the samples produced above was evaluated for firmness on an Instron Universal Testing Machine as described in Example 1. Sample #1 had an Instron firmness of 89 kg, #2 had a firmness of 86 kg and #3 had a firmness of 94 kg. It may be seen, based upon the above values, that protein granules with a satisfactory degree of firmness were produced with each sample.

EXAMPLE 3

To illustrate the improvement in firmness that is achieved with the use of a vacuum during the gel formation and chopping or blending step, two samples of granules were prepared by using the soy protein isolate "Supro 500E" (available from Protein Technologies International, Checkerboard Square, St. Louis, MO, USA 63164) and forming a gel by hydrating both samples with water at 70°C, to a ratio of water to isolate 2.5 to 1. Each sample was blended in the chopper for 2 minutes during gel formation, then chopped into discrete granules, except that in the case of one sample a vacuum equivalent to 25 inches of mercury (84.7 kPa) was applied during the chopping step. The firmness of each sample was measured by the Instron test procedure described in Example 1. The sample obtained without application of a vacuum had an Instron firmness of 125.6 kg. The sample prepared with application of vacuum had an Instron firmness of 159.7 kg. It may be seen that the application of a vacuum significantly improved firmness of the product.

EXAMPLE 4

Protein granules were produced generally as described in Example 1, using a water temperature of 70°C and a hydration ratio of water to isolate of 3 to 1. The isolate employed was Fujipro 545 (Trade Mark, available from Protein Technologies International, Inc., St. Louis, MO, USA, 63164). The isolate was blended with the water at slow speed for 30 seconds to achieve mixing, followed by high shear chopping for two minutes to form a gel. The gel was formed into granules by chopping on mix speed.

The granules were then used to prepare low fat beef patties at three different levels of addition. The formulations for the beef patties containing the granules are set forth below.

<u>Ingredients</u> <u>(% by weight)</u>	<u>Sample 1</u>	<u>Sample 2</u>	<u>Sample 3</u>
90% Lean Beef	55	40	55
85% Lean Beef	30	40	30
Protein Granules	8	12	11
Water	4.12	6.62	2.87
Beef Flavour (McCormick Beef Flavour #F22072 available from McCormick Stange, Hunt Valley, MD)	0.37	0.38	0.37

Carrageenan (Viscarin SD389 available from Marine Colloids - Division, FMC Corporation Philadelphia, PA)	-	0.5	0.25
Starch	2.0	-	-
Encapsulated Salt (Sodium Chloride 150-85, Van Den Bergh, Lisle, Illinois)	0.5	0.5	0.5

The protein granules are cooled to a temperature of about 20°C before mixing with the meat.

The frozen beef is flaked using a Biro FBC 4800 frozen meat chopper available from (Biro Manufacturing Company, Marblehead, Ohio, USA). The flaked meat, water and granules in the indicated amounts are mixed in a Buffalo Mixer 1/2-5A available from (Hantover Inc., Kansas City, Missouri, USA) for about 1 minute. The remaining ingredients are added to the mixer and blended for an additional 30 seconds. The entire mixture is ground in a meat grinder through a 1/8" (3.2 mm) plate and formed into patties using a Formax F-6 former available from (Formax Inc., Mokena, Illinois). The formed patties are then frozen in a blast freezer at -40°C.

EXAMPLE 5

Protein granules were produced as generally described in Example 1, using a water temperature of 70°C and a hydration ratio of water to isolate of 3.25 to 1. The isolate employed was Supro 500E (available from PTI Inc., St. Louis, Missouri, USA 63164). The isolate was blended with the water at slow speed for 30 seconds followed by high shear chopping for 2 minutes. The granules were formed by chopping on mix speed 1-2 minutes.

The granules produced as described above were then used to prepare a meat analogue simulating a ground meat patty. The formulation for the meat analogue containing the granules are set forth below.

<u>Ingredients</u>	<u>% by Weight</u>
Supro 200 (Protein Technologies International, St. Louis, Missouri, USA)	18.0
Supro 200G, (Protein Technologies International, St. Louis, Missouri, USA)	21.9
Protein Granule	11.0
Water	31.8
Supro 620 (Protein Technologies International, St. Louis, Missouri, USA)	3.8
Wheat Gluten 75 (Fielders Starches, Port Melbourne, Australia)	2.0
Methyl cellulose, (Methocel A4M, Dow Chemical Company, Midland, Michigan, USA)	1.5

Soybean oil	5.2
Salt	1.0
Flavouring (Ogawa Beef Flavour #B18538, Ogawa, Tokyo, Japan)	2.8
Malt Extract (Black Malt, Malt Products Corporation, Maywood, New Jersey, USA)	0.4
Beetjuice concentrate (C670, Quest, Sarasota, Florida, USA)	0.2
Sodium carbonate	0.4

The Supro 200 is mixed with 6% of the water and the sodium carbonate in a Hobart Model A-200-D Mixer (Hobart Manufacturing Co., Troy, Ohio, USA) for two minutes. The Supro 200G and protein granule are added to the mixture and mixed one minute. Forty-seven percent of the water (80°C) is chopped on high speed with the methylcellulose for one minute in a Seydelmann Model K21 (Robert Reiser Co., Inc., Canton, Maryland, USA) bowl cutter. The Supro 620 and 47% of the water as ice is added to the cutter and chopped on high speed for 2 minutes. The soybean oil is added slowly with high speed chopping and chopped for one minute. The gluten, salt, flavouring, malt extract, and beet juice concentrate are added and chopped 1.5 minutes. The mixture is removed from the cutter and added to the mixture in the Hobart mixer and mixed for two minutes. The mixture is formed into patties with a Hollymatic Super Model 54 Food Portioning machine (Hollymatic Corporation, Park Forest, IL, USA). Patties are frozen at -40°C.



CLAIMS

1. A process for producing a hydrated protein granule for use as a meat extender, comprising the steps of hydrating a vegetable protein isolate and blending the isolate to produce a granule, the hydration step being such that the isolate is mixed with water to a ratio of 1 : 2-3.5 parts by weight, the water being at a temperature of at least 50°C, and the blending step being under conditions of shear for a time sufficient to form the granule.
2. A process according to Claim 1, wherein the vegetable protein isolate is a soy protein isolate.
3. A process according to Claim 1 or 2, wherein the water is at a temperature of 50 - 100°C.
4. A process according to Claim 3 wherein the water is at a temperature of 60 - 80°C.
5. A process according to any preceding claim, wherein blending under conditions of shear is carried out for at least one minute.
6. A process according to Claim 5, wherein blending is carried out for 1 - 3 minutes.
7. A process according to any preceding claim, wherein the isolate is hydrated to a ratio of 3 parts by weight of water to 1 part of isolate.
8. A process according to any preceding claim, wherein blending is carried out under a condition of reduced atmospheric pressure.

9. A process according to Claim 8 wherein the reduced atmospheric pressure is 25 inches of mercury (84.7 kPa) or less.

10. A granulated protein product produced by a process according to any preceding Claim.

