

PATENT SPECIFICATION

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(54) HIGH PROTEIN PRODUCTS, E.G. BEVERAGES

(71) We, SANDOZ LTD., of 35 Lichtstrasse, 4002 Basle, Switzerland, a Swiss Body Corporate, 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:—

This invention relates to high-protein beverages, and isolates prepared therefrom.

The invention provides a high-protein product, e.g. a beverage derived from a high-protein flour characterised in that

- (a) the lipoxxygenase enzyme present is 95 to 100% deactivated,
- (b) the trypsin inhibitor and urease enzyme are substantially 100% deactivated,
- (c) the carbohydrate content is less than 20% by weight of solids present in the product and
- (d) the lysine content is in excess of 90% of that of the original high-protein flour.

The lipoxxygenase enzyme is preferably 99.5 to 100% deactivated. The carbohydrate content is desirably less than 10%, more preferably less than 5% by weight, of the total solids present in the product. The lysine content is preferably greater than 95% of that of the original high-protein flour.

The invention thereby provides low-fat or full-fat high-protein product which in the term of beverages that have the properties of bland flavour, oxidative stability, nonflatulence, good suspension and good mouthfeel. In addition, protein isolates are obtainable therefrom in high yields.

For the purposes of this specification, the term "low-fat" is used to indicate that a product contains less than 2%, preferably less than 0.5%, by weight of free fat.

The term "full-fat" is used to indicate that 60 to 90% by weight of the naturally occurring fat in a material is recovered in a product prepared from that material.

The invention also provides a process for producing a high-protein product, e.g. a beverage from an aqueous suspension of a high-protein flour comprising

- i) deactivating lipoxxygenase enzyme, pre-

sent in the flour, to an extent of 95 to 100%,

- ii) reducing carbohydrate to a content of less than 20% by weight of solids present in the high-protein product, and
- iii) deactivating trypsin inhibitor and urease enzyme, present in the flour, to an extent of substantially 100% under conditions such that the lysine content remains in excess of 90% of that of the original high-protein flour.

A high-protein beverage, for example a low-fat or full-fat beverage, may be obtained by the above process and dried by conventional techniques to yield the corresponding protein isolate.

Naturally, the fat content of the protein isolate may depend simply on the fat content of the high-protein flour from which the isolate is obtained. For example, a low-fat protein isolate may be obtained from a low-fat high-protein flour. On the other hand, it will be appreciated that the fat content of the protein isolate may be varied. For example, a low-fat protein isolate may be obtained from a full-fat protein flour by extracting fat from clarified or unclarified full-fat high-protein beverages or from the full fat high-protein isolate.

The invention particularly provides a process for producing a high-protein product, which comprises,

- a) heating a suspension of a high-protein flour in an amount of water which is from 6 to 12 times the weight of flour present, at a pH of 3.3 to 4.8 and at a temperature of from 150° to 212°F over a period of time substantially to complete deactivation of lipoxxygenase enzyme present in the high-protein flour;
- b) cooling the suspension to a temperature of from 50° to 100°F, at a pH of 3.3 to 4.8 and maintaining the suspension at that temperature for a period of time to precipitate lipid-protein present in the flour;
- c) separating the precipitated lipid-protein;
- d) suspending the precipitated lipid-protein in an amount of water which is from 4 to

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- 12 times the weight of flour originally present in step a), at a pH of 8.0 to 9.5; heating the suspension of step d) to a temperature of from 180°—212°F over a period of 1 to 5 minutes; and
- e) cooling the suspension of step e) to a temperature of from 50° to 100°F and adjusting the pH to 6.0 to 7.5.

Preferably, the suspension of step f) is clarified.

The high-protein flours used as starting materials in the process of the invention may be derived from any whole, dehulled low-fat or full-fat oil seed, wheat germ or corn germ, either raw or cooked, and having nitrogen solubility index (NSI) values in water ranging from 15 to 98%. The oilseeds include soybeans, peanuts, cotton seeds, rape seeds, sesame, sunflower seeds, safflower seeds and the like, especially soybeans and peanuts.

To obtain a soybean product having optimum nutritional value and consumer acceptability, it is preferred that the starting material be prepared in the following manner:

- i) crack and dehull whole raw soybeans; ii) lightly cook the dehulled cracked beans in dry heat to a temperature of 150°F; iii) flake and pin mill to a mesh size such that 95 to 100% of the product will pass through a 100-mesh screen.

When peanuts are used, it is preferred that the peanuts be chopped into small pieces using a food chopper and then dispersed in water at a pH of from 2.0 to 4.5. The water-peanut mixture is then colloid milled to obtain the starting material for use in step a) of the instant process.

Flavour and shelf stability are imparted to the final product by the deactivation of the lipoxigenase enzymes in the protein which catalyse oxidation of fats, thereby causing rancidity. In the preferred manner of carrying out the process, the flour is dispersed in water which is carefully monitored to maintain the pH between 2.0 to 3.5. The weight of water is 6 to 12, preferably 8 to 10 times the weight of the flour used. After dispersion and some deactivation of the lipoxigenase enzyme, the pH is raised to 3.3 to 4.8, preferably as close to 3.5 as possible. The pH adjustments may be carried out using any acceptable mineral acid, but hydrochloric acid and especially sulphuric acid are preferred. The dispersion is then heated at a temperature of from 150 to 212°F, preferably 180° to 212°F, especially 205° to 212°F, for a period of time substantially to deactivate the lipoxigenase enzyme, i.e. to an extent of 95 to 100%, preferably 99.5 to 100%. In the process, 1 to 20 minutes, under preferred conditions 5 to 15 minutes, are normally sufficient to effect the deactivation.

In step b), after completion of the deactivation step, the mixture is cooled to 50° to 100°F, preferably 60° to 75°F, while carefully maintaining the pH at 3.3 to 4.8, preferably

as close to 3.5 as possible. Maximum precipitation of the lipid-protein curd is normally ensured by stirring for 5 to 40 minutes, under preferred conditions 10 to 15 minutes.

In step c), the separation of the lipid-protein curd from the liquid whey fraction may be accomplished by any suitable method such as filtration or centrifugation. Centrifugation is preferred because of its efficiency and shorter operation times. It has been found that separation may be affected in the range of 1000 to 16,000, preferably 1500 to 10,000 times the force of gravity. The lipid-protein curd, in the form of a centrifuge cake, is then desirably washed two or more times with water at the same pH at which the curd was precipitated. At this point carbohydrates, which give rise to the flatulent properties in high-protein beverages and isolates, have been solubilised and removed in the whey fraction. It is desirable that the carbohydrate content be less than 20%, preferably less than 10%, and more preferably less than 5% on the weight of dried product.

To provide a product having a modified bland flavour, the cake, at this point, may be resuspended in an aqueous alcohol, e.g. 50% w/w aqueous ethyl or isopropyl alcohol, centrifuged and washed from two to three times with aqueous alcohol and/or water.

In step d), the washed cake is resuspended in 4 to 12 parts by weight of water, preferably 4 to 5 parts when the final product is to be spray dried, and 7 to 8 parts when the final product is a protein beverage, per part by weight of the high-protein flour of step a), at a pH of 8.0 to 9.5, preferably as close to 9.0 as possible. The pH may be adjusted and controlled using bases such as sodium hydroxide, ammonium hydroxide and especially potassium hydroxide.

In step e), the mixture is heated, preferably rather rapidly, to a temperature of about 180 to 212°F, preferably 205° to 212°F, for a period of from 1 minute to 5 minutes, preferably about 1 minute, substantially to deactivate the trypsin inhibitor and urease enzyme present in the flour. The period of heating is critical since undesirable viscosity increases taste deterioration and loss of lysine content in the protein begin to develop if the heating is continued for more than 1 to 2 minutes, although an acceptable product may be obtainable after a heating period of up about 5 minutes. The available lysine content should be in excess of 90% and preferably greater than 95% of the lysine content of the original high-protein flour. With soybean, this means that the lysine content of the final product obtainable by this invention is greater than 5.5% and normally greater than 6.5% based on the total weight of protein in the final product.

In step f), cooling to 50 to 100°F, preferably 60 to 75°F is carried out, preferably rather rapidly. Although not critical, it is preferred, at this time, that the mixture be sub-

jected to colloid milling in a colloid mill, preferably having maximum plate clearances of about 0.001 inch and then homogenised in a high-pressure homogeniser under a pressure of preferably from 8 to 10,000 psig preferably 3000 to 10,000 psig. This optional step decreases the amount of solids removed from the soy milk in the clarification step, improves mouthfeel and reduces sedimentation on standing. After the cooling, or after colloid milling and homogenisation, the pH of the suspension is reduced to 6.0 to 7.5, preferably as close to 7 as possible, with a mineral acid, e.g. sulphuric acid.

There is then preferably carried out a clarification step, preferably in a centrifuge as described above for separation of the lipid-protein curd. This removes any agglomerated particles that have resisted complete dispersion, leaving a stable, bland, non-flatulent high-protein beverage having a mouthfeel similar to that of cow's milk.

In the production of defatted protein isolates from full-fat flour it is preferred that the mixture of step f) not be subjected to colloid milling, homogenisation or the clarification step. After the completion of step f), fat may be removed by liquid-liquid extraction using a suitable water-immiscible solvent, for example, pentane or hexane, and the defatted product dried by conventional techniques, e.g. spray drying. Preferably, however, the water is first removed by means such as evaporation, spray drying or freeze drying and the fat removed from the dried product by solvent extraction with suitable solvents, for example, pentane, hexane, methanol, ethanol or isopropanol. Defatted protein isolates may be obtained in total yields of up to 95% of the original protein by this method. By using a gas-liquid chromatographic (GLC) procedure (see Example 1, *infra*), it was found that the hexane defatted isolates contained small amounts of bound lipids (fats). Three commercial soy-protein isolates analysed in the same manner as the instant products contained 1% to 2% bound lipids, while the instant products contained from 2% to 5%. However, products containing as much as 90% protein may be obtained in substantially fat-free form by extracting the full-fat products with polar solvents such as aqueous alcohols.

The final protein beverage of the instant invention may be dried by conventional techniques, such as evaporation, spray drying or freeze drying, to obtain a dried low-fat or full-fat protein isolate.

Additives such as fats, vitamins, minerals, sweeteners, and flavourings can be added to the high-protein beverage to improve taste and provide for various nutritional needs. When extra fat is added, it is preferred that the fat be added to the suspension as the suspension is being fed to the colloid mill mentioned above as an optional stage in step f). The added fat

may be any liquid oil, preferably a hydrogenated oil, such as coconut oil, soybean oil or cottonseed oil. The total fat content is generally maintained at or below 4% by weight in the final high-protein beverage.

The following examples illustrate the invention.

EXAMPLE 1.

Step A. Preparation of raw preheated full-fat soyflour.

Field-dried soybeans are subjected to a single break (one pass) cracking on corrugated rolls (10 cor./inch, 0.040-inch clearance). The cracked soybeans are then passed over a two-deck screen shaker [1/8 inch round hole top screen and a No. 14 bottom screen (U.S. Standard) i.e. a screen having 14 meshes per inch] with dehulling aspiration on the soybeans as they enter the top screen and leave the No. 14 screen. The dehulled soybeans are then dry heat-treated to a temperature of 150°F by passing through a screw paddle conveyor heated by jacketed steam and having an overall retention time of about 5 minutes. The hot dehulled soybeans are passed through flaking rolls, cooled and ground [99% through a 100-mesh screen (U.S. Standard) i.e. a screen having 100 meshes per inch] in a wide-chamber air-swept pin or stud mill. The resulting flour has an NSI value of 97.

Step B: Preparation of soy milk.

500 grams of soyflour prepared as described above (39.5% protein, 22.0% fat and 4.8% moisture, by weight) are dispersed in 4000 milliliters of water to which has previously been added sufficient concentrated sulphuric acid to give a pH of 3.5 in the dispersion. The mixture is heated with sparge steam to 206° to 210°F and stirred at that temperature for 10 minutes. The mixture is cooled to 70° to 75°F and stirred for an additional 15 minutes. During the above treatment the pH is carefully maintained at 3.5 by the addition of sulphuric acid. The mixture is then fed over a 5 to 10 minute period to the bowl of a perforated basket centrifuge running at 3800 r.p.m. (1500 times the force of gravity). The perforated basket is covered with a cotton duck cloth. The resulting lipid-protein curd is washed twice with 500 ml portions of water having a pH of 3.5 and spun dry for 5 minutes. The liquid whey is recycled through the centrifuge and the curds are combined. The wet curd is reslurried in 4000 cc of water and the suspension adjusted to a pH of 9 with 10% potassium hydroxide solution. The alkaline mixture is quickly heated in 2 to 30 minutes to 205°F using open sparge steam and held at 205°F for 1 minute. The mixture is cooled in 2 to 3 minutes to 70° to 75°F and is fed successively to a Manton-Gaulin colloid mill having a plate clearance of 0.001 inch and then to a Manton-Gaulin single-stage homogeniser at

8000 to 10,000 p.s.i.g. The pH of the resulting milk is adjusted to 7.2 and the milk is then centrifuged to remove undispersed particles as a cake and to clarify the product, such milk and cake being referred to as the products of clarification centrifugation.

The oilseed-protein beverage was analysed by the methods described below and the results obtained are tabulated in Table 1 along with results obtained from examples 2 to 7.

Methods of analysis

The solids content of the milk samples are determined by the official method of the Association of Official Agricultural Chemists, (AOAC), Methods of Analysis, 9th Edition, Washington, D.C., (1960). Protein, fat, ash, crude fiber, and moisture content are run on a freeze-dried milk and whey samples obtained in manner known *per se* and nitrogen-free extract (NFE) is calculated by subtracting the foregoing total from 100% [American Association of Cereal Chemists, AACC, Cereal Laboratory Methods, 7th Edition, The Association, St. Paul, Minnesota (1962)]. Urease activity is determined on freeze-dried milk samples that were defatted and then determined by the AACC method.

Nitrogen solubility index (NSI) for the

measurement of water-soluble protein is measured on the defatted spray dried milk samples by the method of Smith *et al.*, Cereal Chem. 43 (2), 261 (1966) effected at a pH of 7.2. The degree of lipoxigenase inactivation is run on spray dried defatted milk solids by a modification of the method of Smith, Arch. Biochem. Biophys. 19:133 (1948).

Trypsin inhibitor (TI) activity is determined on a freeze-dried and defatted milk samples by a gelatin digestion procedure in which trypsin is added to a buffer solution of gelatin in the presence of TI. The reaction is stopped with neutral formaldehyde solution and the free carboxyl groups are titrated with 0.1N sodium hydroxide solution.

Available lysine is determined on defatted products according to the method of Rao *et al.*, Anal. Chem. 35: 1927 (1963). The Viscosities of soy milks are measured with a Brookfield Model LVT viscometer using a No. 1 spindle at 60 r.p.m.

Free lipids are determined on a freeze-dried samples by pentane-hexane extraction (AACC, *supra*) and bound lipids were run on the pentane-hexane extraction residue using GLC method of L.T. Black *et al.*, Cereal Chem. 44: 152-160 (1967).

TABLE 1

Analysis	Examples						
	1	2	3	4	5	6	7
Solids, % recovered in							
Milk ¹	69.9	71.7	61.7	58.8	57.5	61.1	74.8
Whey ²	22.0	28.4	27.4	30.6	30.2	24.8	25.1
Cake ¹	8.6	2.7	7.1	10.9	6.1	15.7	7.3
Protein, % recovered in							
Milk ¹	95.2	90.6	92.6	84.0	86.5	92.1	93.3
Whey ²	8.1	9.3	10.1	17.7	18.7	10.1	14.7
Cake ¹	3.5	1.5	5.1	5.6	1.5	11.6	4.6
Fat, % recovered in							
Milk ^{1,4}	83.0	71.6	69.1	66.5	69.6	65.5	92.4 ⁷
Whey ²	3.1	26.0	13.2	31.0	15.0	17.6	9.4
Cake ¹	0.9	0.3	0.9	1.0	1.0	8.9	1.9

TABLE 1 (Continued)

Analysis	Examples						
	1	2	3	4	5	6	7
Milk ¹							
Milk composition, %							
Solid	6.0	6.8	5.6	4.9	5.9	6.0	8.9
Protein	3.4	3.6	3.5	2.9	3.7	3.7	3.9
Fat	1.8	1.6	1.5	1.3	1.7	1.5	4.1
Viscosity, cp.	7.1	18.0	8.2	6.5	12.5	8.6	9.2
Lipox., % deact.	100	100	100	99.7	99.6	...	100
TI, % deact.	100	100	100	100	100	...	100
Available lysine, % ³	6.6	6.5	6.7	6.3	6.6	...	6.4
Urease activity	0	0	0	0	0	...	0
Whey							
Composition, %							
Solid	2.3	2.2	2.6	3.1	3.3	2.9	2.1
Protein	0.4	0.6	0.4	0.7	0.8	0.5	0.5
Fat	0.1	0.5	0.3	0.6	0.4	0.5	0.3
Freeze-dried milk							
Composition, %							
Protein	56.4	53.5	62.5	59.3	56.7	59.6	44.3
Fat ⁴	28.1	23.8	26.8	27.0	28.9	25.6	46.0
Ash	3.2	3.6	3.1	3.1	1.8	3.0	2.2
Crude fiber	0.1	2.5	0.7	0.3	1.8	0.3	1.3
Moisture	7.5	0	2.9	6.1	2.9	3.2	2.4
NFE ⁵	4.7	16.6	4.0	4.2	7.9	8.3	3.8
Isolated protein ⁶	87.6	70.2	88.9	88.6	83.1	83.7	85.6

1 Products of clarification centrifugation

2 Products of separation centrifugation

3 % of total protein

4 Total lipids — includes free plus bound forms

5 Nitrogen free extract (carbohydrates)

6 Moisture-free, fat-free basis

7 Includes added fat

EXAMPLES 2, to 7.

The oilseed protein beverages of examples 2 to 7 are prepared by the methods described in Example 1 with the following exceptions (described with reference to the steps a) to f) hereinbefore set out):

EXAMPLE 2.

In step a), the soyflour starting material is slurried in 5000 cc of water at a pH of 3.5.

In step d), the alkaline suspension is heated at a pH of 9 at a temperature of 206—210°F for 5 minutes, then colloid milled and homogenised without cooling.

EXAMPLE 3.

In step a), the starting material used is a commercially prepared full-fat soyflour [Nutrisoy 220 (Registered Trademark), Archer Daniels Midland Co.] having approximately the same amounts of protein, fat, and moisture as the flour described in Example 1 and an NSI value of 18.

In step c), centrifuged lipid-protein curd is washed twice with water having a pH of 3.5.

In step e) the suspension is colloid milled and homogenised without cooling and is then cooled to room temperature after the homogenisation step.

EXAMPLE 4.

In step a) the starting material is extruded full-fat soyflour, prepared by the method of Mustakes *et al.*, Food Technol. 24, 1290 (1970), having an NSI value of 16.3. The amounts of protein, fat, and moisture are approximately the same as in the flour described in Example 1.

EXAMPLE 5.

In step a) the starting material is a raw full-fat soyflour, prepared in a manner similar to that described in Example 1, without dry heat treatment and having an NSI value of about 97. The amounts of protein, fat, and moisture are approximately the same as in the flour described in Example 1.

In step e) the heating is carried out at a temperature of 205°F for 5 minutes.

EXAMPLE 6.

In the example, the colloid milling and homogenisation steps are eliminated, and the suspension is cooled, adjusted to a pH of 7.0 and centrifuged immediately after the 1 minute heating period of step e).

EXAMPLE 7.

The spin-dried lipid-protein curd of step b), plus the cake obtained from the recycled whey are resuspended in 3,500 cc of tap water. The suspension is adjusted to a pH of 9.0, cooked for 1 minute at 205°F and then cooled to 150°F. 100 grams of hydrogenated soybean

oil are added to the suspension as the suspension is fed to the colloid mill. The milled suspension is then adjusted to a pH of 7.2, homogenised and centrifuged.

EXAMPLE 8.

A soy milk product is prepared as described in Example 6, freeze-dried, and extracted with pentane-hexane as described in the AACC reference. The defatted product is then analysed for free fat, bound fat, and protein and the results obtained are shown in Table 2.

Table 2.

Protein isolate	Free fat. %	Bound fat. %	Protein ¹ . %
Example 8	0.4	2.3	89.4

¹Moisture-free, fat-free basis.

EXAMPLE 9.

A raw full-fat soyflour is prepared in essentially the same manner as that described in Step A of Example 1; and is then extracted with hexane to give, after drying, a defatted soyflour starting material, with a NSI of 86.9% and a protein content of 53.9%. The low-fat soyflour is then treated in the same manner as the full-fat soyflour of example 1 to give a low-fat protein isolate as the final product after drying.

EXAMPLE 10.

The process of example 1 is carried out using, as the starting material, blanched Spanish peanuts containing, by weight, 20.0% protein, 46.1% fat, 4.5% moisture, 2.5% ash and 3.2% crude fibre. To prepare the suspension for step a), the full-fat peanuts are cut into small pieces by processing them twice through a centrifuged food chopper machine, suspending the chopped nuts in water at a pH of 3.5 and then colloid milling. The product obtained is a full-fat protein beverage, similar to that obtained in Example 1.

EXAMPLE 11.

The soyflour starting material, prepared as in step A of example 1, is suspended in 4000 cc of water at a pH of 2.0 under controlled conditions which maintain the slurry at a pH of 2.0. Control is effected by slowly adding the soyflour to water at pH 2.0 and simultaneously adding sulphuric acid to counteract the buffering effect of the soyflour, thereby maintaining the pH at 2.0. After stirring for 15 minutes, potassium hydroxide is added to raise the pH of the suspension to 3.5. The mixture is cooked at a temperature of 200°—212°F for 10 minutes and further processed as described in Example 1 to yield a bland full-fat protein beverage.

**WHAT WE CLAIM IS:—**

1. A process for producing a high-protein product from an aqueous suspension of a high-protein flour comprising,
 - i) deactivating lipoxigenase enzyme, present in the flour, to an extent of 95 to 100%;
 - ii) reducing carbohydrate to a content of less than 20% by weight of solids present in the high-protein product; and
 - iii) deactivating trypsin inhibitor and urease enzyme, present in the flour, to an extent of substantially 100% under conditions such that the lysine content remains in excess of 90% of that of the original high-protein flour.
2. A process according to Claim 1, wherein a high-protein product is produced by a process comprising,
 - a) heating a suspension of a high-protein flour in an amount of water which is from 6 to 12 times the weight of flour present, at a pH of 3.3 to 4.8 and at a temperature of from 150° to 212°F over a period of time substantially to complete deactivation of lipoxigenase enzyme present in the high-protein flour;
 - b) cooling the suspension to a temperature of from 50° to 100°F, at a pH of 3.5 to 4.8 and maintaining the suspension at that temperature for a period of time to precipitate lipid-protein present in the flour;
 - c) separating the precipitated lipid-protein;
 - d) suspending the precipitated lipid-protein in an amount of water which is from 4 to 12 times the weight of flour originally present in step a), at a pH of 8.0 to 9.5;
 - e) heating the suspension of step d) to a temperature of from 180°—212°F over a period of 1 to 5 minutes; and
 - f) cooling the suspension of step e) to a temperature of from 50° to 100°F and adjusting the pH to 6.0 to 7.5.
3. A process according to Claim 2, wherein a low-fat or full-fat high protein flour is employed in step a).
4. A process according to either Claim 2 or Claim 3, wherein the suspension of step f) is clarified.
5. A process according to any one of Claims 2 to 4, wherein the amount of water present in step a) is from 8 to 10 times the weight of flour present.
6. A process according to any one of Claims 2 to 5, wherein the temperature in step a) is from 180° to 212°F.
7. A process according to any one of Claims 2 to 6, wherein the temperature in step a) is from 205° to 212°F.
8. A process according to any one of Claims 2 to 7, wherein the period of time in step a) is from 1 to 20 minutes.
9. A process according to any one of Claims 2 to 8, wherein the period of time in step a) is from 5 to 15 minutes.
10. A process according to any one of Claims 2 to 9, wherein the pH in step a) is 3.5.
11. A process according to any one of Claims 2 to 10, wherein the temperature in step b) is from 60° to 75°F.
12. A process according to any one of Claims 2 to 11, wherein the period of time in step b) is from 5 to 40 minutes.
13. A process according to any one of Claims 2 to 12, wherein the period of time in step b) is from 10 to 15 minutes.
14. A process according to any one of Claims 2 to 13, wherein the pH in step b) is 3.5.
15. A process according to any one of Claims 2 to 14, wherein step c) is effected by centrifugation.
16. A process according to any one of Claims 2 to 14, wherein step c) is effected by filtration.
17. A process according to any one of Claims 2 to 16, wherein the amount of water in step d) is from 4 to 8 times the weight of flour present in step a).
18. A process according to any one of Claims 2 to 17, wherein the pH in step d) is 9.0.
19. A process according to any one of Claims 2 to 18, wherein the temperature in step e) is from 205° to 212°F.
20. A process according to any one of Claims 2 to 19, wherein the period of time in step e) is 1 to 2 minutes.
21. A process according to any one of Claims 2 to 20, wherein the period of time in step e) is 1 minute.
22. A process according to any one of Claims 2 to 21, wherein the temperature in step f) is from 60° to 75°F.
23. A process according to any one of Claims 2 to 22, wherein the pH in step f) is 7.0.
24. A process according to any one of Claims 2 to 23, wherein hydrogenated oil is added either after step e) or step f), to give the product an oil content of 4% by weight.
25. A process according to any one of Claims 2 to 24, wherein the suspension of step e) is further processed by subjecting said suspension to colloid milling in a colloid mill, having a maximum plate clearance of about 0.001 inch, followed by homogenisation under a pressure of from 3000 to 10,000 p.s.i.g.
26. A process according to any preceding Claim, wherein the high-protein flour is initially suspended in water at a pH of 2.0 to 3.5.
27. A process for producing a high-protein isolate which comprises removing water from a high protein product when produced by a process as claimed in any preceding Claim.
28. A process for producing a defatted high-protein isolate, comprising effecting steps a) 130



* C L M S *

- to f) of the process as claimed in any one of Claims 2 to 26, with a full-fat high-protein flour and extracting fat from the suspension of step f) with a water immiscible solvent to yield a defatted suspension which is subsequently dried.
29. A process for producing a defatted high-protein isolate, comprising effecting steps a) to f) of the process as claimed in any one of Claims 2 to 26, with a full-fat high-protein flour and removing water from the suspension of step f) to yield a material from which fat is removed with a solvent.
30. A process according to any one of Claims 1 to 26, wherein the high-protein flour is a full-fat oilseed flour.
31. A process according to Claim 30, wherein the full-fat oilseed flour is full-fat soy-flour.
32. A process according to Claim 31, wherein the soyflour in step a) is prepared by
- cracking and dehulling whole raw soy-beans,
 - lightly cooking the dehulled cracked beans in dry heat at a temperature of 150°;
 - flaking the cooked dehulled cracked beans; and pin milling the flakes so that 95. to 100% of the milled product will pass through a 100-mesh screen.
33. A process for the production of a high-protein product substantially as herein described with reference to any one of the Examples.
34. A high-protein product whenever produced by a process according to any one of Claims 1 to 33.
35. A high-protein product derived from a high-protein flour characterised in that
- the lipoxxygenase enzyme present is 95 to 100% deactivated,
 - the trypsin inhibitor and urease enzyme are substantially 100% deactivated.
 - the carbohydrate content is less than 20% by weight of solids present in the product and
 - the lysine content is in excess of 90% of that of the original high-protein flour.
36. A product according to Claim 35, wherein the amount of carbohydrate is less than 10% by weight of solids present in the product.
37. A product according to Claim 35, wherein the amount of carbohydrate is less than 5% by weight of solids present in the product.
38. A product according to any one of Claims 35 to 37, wherein the lipoxxygenase enzyme is 99.5 to 100% deactivated.
39. A product according to any one of Claims 35 to 38, wherein the lysine content is in excess of 95% of that of the original high-protein flour.
40. A product according to any one of Claims 35 to 39, in the form of a beverage.
41. A product according to any one of Claims 35 to 39, in the form of an isolate.
42. A low-fat or full-fat high-protein product according to any one of Claims 35 to 41.
43. A product according to any one of Claims 35 to 39, substantially as herein described.
44. A process for producing a full-fat oilseed-protein beverage comprising
- heating a suspension of a full-fat oilseed flour in an amount of water which is from 8 to 10 times the weight of flour present, at a pH of 3.5 to 4.5 and at a temperature of from 150° to 212°F over a period of time substantially to complete deactivation of lipoxxygenase enzyme present in the full-fat oilseed flour;
 - cooling the suspension to a temperature of from 50° to 75°F at a pH of 3.5 to 4.5 and maintaining the suspension at that temperature for a period of time to precipitate lipid-protein present in the flour;
 - separating the precipitated lipid-protein;
 - suspending the precipitated lipid-protein in an amount of water which is from 7 to 10 times the weight of oilseed flour originally present in step a), at a pH of 9.0;
 - heating the suspension of step d) to a temperature of from 205° to 212°F over a period of 1 to 5 minutes;
 - cooling the suspension of step e) to a temperature of from 70° to 75°F and adjusting the pH to 7.0 and
 - clarifying the suspension of step f).

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