

PROCESS FOR PRODUCING NUTRIENT COMPOSITION

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This patent application is based upon and claims
5 the benefit of priority from the prior Japanese Patent Application
No. 2011-270610, filed on December 9, 2011, the entire
disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

10 [0002] Technical Field

The present invention relates to a process for
producing a nutrient composition containing a protein and a
mineral.

[0003] Background Art

15 Since persons who suffer from lowered mastication
and swallowing abilities, such as aged persons (persons having a
difficulty in swallowing), and patients before and after surgery
cannot take various nutrients necessary for bodies (proteins,
saccharides, lipids, minerals, vitamins, water and the like) from
20 foods, liquid diets, medical diets, and enteral nutrients are
administered as foods or medicines through oral intake or enteral
(tube feeding) administration. Further, in recent years, nutritional
supplementary beverages and foods that can easily supplement
necessary nutrients have spread among highly health-oriented
25 people.

[0004] Among the nutrients, nutrient compositions
containing proteins and minerals at high concentrations have a
good nutritional balance and, thus, are desired in clinical practice,
as well as in many other fields.

30 [0005] Regarding such nutrient compositions containing
proteins and minerals at high concentrations, for example,
Japanese Patent No. 4344943 (Patent document 1) discloses a
process for producing an acidic gel composition containing a whey
protein and calcium at high concentrations. In these nutrient
35 compositions, however, minerals other than calcium are not
contained at high concentrations.

[0006] As reported also in International Publication WO 2008/136420 (Patent document 2), whey proteins, due to their property, gelation or aggregation is likely to occur when whey proteins are present at a high concentration in a high-temperature aqueous solution.

[0007] Further, it is reported that, when minerals are added to an aqueous solution containing proteins at a high concentration, proteins are destabilized due to salting-out of minerals, leading to increased viscosity of the aqueous solution or occurrence of aggregation or precipitates (see Japanese Patent Application Laid-Open No. 2008-301723).

PRIOR ART DOCUMENTS

Patent Documents

[0008] Patent document 1: Japanese Patent No. 4344943
Patent document 2: International Publication WO 2008/136420

SUMMARY OF THE INVENTION

[0009] In such a state that whey proteins are present at a high concentration in an aqueous solution, gelation or aggregation is likely to occur, and, when minerals are further added in this state, the tendency towards gelation or aggregation is increased. In fact, the present inventors have found that, when a mineral powder is added to an aqueous concentrated protein solution containing a whey protein at a high concentration, the addition of the mineral to the solution leads to increased viscosity and gelation, requires a considerable time for mixing of the mineral even under a high stirring force, and results in partial heterogeneous mixing. Further, due to an excessively increased viscosity, the mixed solution cannot maintain a constant fluidity, sometimes leading to the application of an excessive load to equipments such as liquid feed pumps and stirring apparatuses in production lines. For this reason, in order to homogeneously mix the mineral into the aqueous concentrated protein solution and, to maintain the fluidity of the mixed solution in the production produces, a method should

be adopted in which a plurality of minerals are previously dissolved in water and the resultant aqueous mineral solution is then added.

[0010] This method, however, is disadvantageous in that, when the production volume is large as in plants, a tank or a line is
5 necessary for previously preparing and storing an aqueous solution containing a plurality of minerals dissolved therein, resulting in complicated production process and increased cost. Further, the protein in the aqueous concentrated protein solution is further diluted by water contained in the aqueous solution containing the
10 minerals dissolved, and, thus, this method is inefficient for the production of a nutrient composition containing a protein at a high concentration.

[0011] The present inventors have now unexpectedly found that the viscosity and state of the mixed solution after the
15 introduction of minerals vary depending upon the type of the mineral to be introduced first and a combination of minerals introduced into the aqueous concentrated protein solution containing the whey protein. Also, the present inventors have found that, when any one mineral that is converted to divalent ions
20 in an aqueous solution is first introduced in a powder or aqueous solution form solely or in a powder form mixed with one or more other minerals, a rapid increase in viscosity and gelation after the introduction of the minerals can be prevented without the use of the aqueous solution containing minerals dissolved therein,
25 contributing to the success of the production of a nutrient composition with minerals homogeneously mixed therein. The present invention has been made based on such findings.

[0012] Thus, an object of the present invention is to provide a process for producing a nutrient composition that contains a
30 protein and minerals at a high concentration, the minerals being homogeneously mixed therein, in a simple, efficient, and low-cost manner.

[0013] According to an aspect of the present invention, there is provided a process for producing a nutritional
35 composition comprising a protein and a mineral group including

two or more minerals selected from sodium, potassium, iron, calcium, and magnesium, the process comprising:

introducing

5 a) a powder or an aqueous solution of any one mineral that is converted to divalent ions in an aqueous solution, or

10 b) a mineral powder mixture containing any one mineral that is converted to divalent ions in an aqueous solution, and one or more other minerals included in the mineral group, into

an aqueous concentrated protein solution containing a whey protein in an amount of 2 to 12 g/100 ml in terms of the amount of a protein derived from the whey protein, and mixing them together, and,

15 when any remaining mineral species are present in the mineral group, introducing a powder of the remaining mineral species into the resultant mixed solution simultaneously or successively, and mixing them together.

[0014] In the process for producing a nutrient composition
20 in one preferred embodiment of the present invention, the aqueous concentrated protein solution, the mixed solution obtained by introducing the mineral powder or aqueous solution of a) or the mineral powder mixture of b) into the aqueous concentrated protein solution, and the mixed solution obtained
25 by introducing the remaining mineral into the mixed solution have a fluidity high enough for mechanical stirring.

[0015] In the process for producing a nutrient composition in one preferred embodiment of the present invention, the aqueous concentrated protein solution, the mixed solution
30 obtained by introducing the powder of a) or the powder mixture of b) into the aqueous concentrated protein solution, and the mixed solution obtained by introducing the remaining mineral into the mixed solution have a viscosity of 1 to 7000 mPa·s (as measured with a Brookfield viscometer under conditions of 20°C
35 and 12 rpm).

[0016] In the process for producing a nutrient composition in one preferred embodiment of the present invention, the aqueous concentrated protein solution further comprises a saccharide and the concentration of the saccharide in the aqueous concentrated protein solution is not more than 50 g/100 ml.

[0017] In the process for producing a nutrient composition in one preferred embodiment of the present invention, the mineral that is converted to divalent ions in the aqueous solution is calcium or magnesium.

[0018] In the process for producing a nutrient composition in one preferred embodiment of the present invention, the aqueous concentrated protein solution has pH 2.5 to 8.

[0019] The nutritional composition produced by the process according to the present invention in one preferred embodiment of the present invention further comprises one or more additional minerals selected from zinc, copper, manganese, selenium, molybdenum, and chromium.

[0020] The nutritional composition produced by the process according to the present invention in one preferred embodiment of the present invention further comprises a lipid.

[0021] The nutritional composition produced by the process according to the present invention in one preferred embodiment of the present invention has a heat quantity of 0.5 to 2.5 kcal/ml.

[0022] The nutritional composition produced by the process according to the present invention in another embodiment of the present invention is a food composition or a pharmaceutical composition.

[0023] The nutritional composition produced by the process according to the present invention in still another embodiment of the present invention is a liquid food, a medical food, an enteral nutrient, a special-use food, or a food and drink for nutritional supplementation.

[0024] The nutritional composition produced by the process according to the present invention in a preferred embodiment of

the present invention is a food for people with difficulty in swallowing.

[0025] According to another aspect of the present invention, there is provided a nutritional composition produced by the process according to the present invention.

[0026] The present invention can provide a process for producing a nutrient composition that contains a protein and minerals at a high concentration, the minerals being homogeneously mixed therein, in a simple, efficient, and low-cost manner. Further, the process according to the present invention can prevent an excessive increase in viscosity in the production of the nutrient composition, and, thus, the nutrient composition can be produced without applying an excessive load to equipments such as liquid feed pumps and stirring apparatuses in production lines. Furthermore, the process according to the present invention can eliminate the need to provide a tank for the preparation and storage of an aqueous solution containing a plurality of minerals dissolved therein and thus can be applied even in a small-scale plant.

DETAILED DESCRIPTION OF THE INVENTION

[0027] The process for producing a nutrient composition according to the present invention, as described above, is a process for producing a nutritional composition comprising a protein and a mineral group including two or more minerals selected from sodium, potassium, iron, calcium, and magnesium, the process comprising:

introducing

a) a powder or an aqueous solution of any one mineral that is converted to divalent ions in an aqueous solution, or

b) a mineral powder mixture containing any one mineral that is converted to divalent ions in an aqueous solution, and one or more other minerals included in the mineral group, into

an aqueous concentrated protein solution

containing a whey protein in an amount of 2 to 12 g/100 ml in terms of the amount of a protein derived from the whey protein, and mixing them together, and,

when any remaining mineral species are present in the mineral group, introducing a powder of the remaining mineral species into the resultant mixed solution simultaneously or successively, and mixing them together.

[0028] The nutrient composition produced by the process according to the present invention comprises a protein and a mineral group. Further, the nutrient composition produced by the process according to the present invention may if necessary further comprise one or more ingredients selected from saccharides, lipids, additional minerals, dietary fiber, and other ingredients.

[0029] Protein

The protein used in the present invention contains at least a protein derived from whey proteins.

[0030] The term "mass of protein" as used herein means the amount of protein as an amino acid polymer contained in various proteins such as whey proteins and other proteins that will be described later. The mass of the protein may be, for example, calculated based on publicly known information or alternatively may be calculated after the measurement by a Kjeldahl method, a Lowry method or other conventional methods. For example, for the Kjeldahl method, the mass of the protein can be calculated by measuring nitrogen contained in various proteins and multiplying the measured value by a nitrogen-protein conversion factor (usually 6.25). For example, for a whey protein having a protein content of 90% by weight, the mass of the protein contained per g of the whey protein is 0.9 g.

[0031] The "whey protein" as used herein includes undiluted solutions, concentrates, isolates, dried products, frozen products, hydrolyzates of whey, and reducing solutions of whey powders and the like. Whey proteins usable herein include whey protein isolates (WPIs), whey protein concentrates (WPCs), sweet wheys, acidic wheys, demineralized wheys, α -La (lactalbumin), and β -Lg (lactoglobulin). They may be used any combination thereof.

They may be commercially available products. The proportions of major ingredients of wheys are, for example, typically as follows. For WPC, for example, the solid content is 95.5%, and, in this case, the protein content, the lactose content, and the ash content are 76.0%, 12.0%, and 2.5%, respectively. For WPI, for example, the solid content is 94.1%, and, in this case, the protein content, the lactose content, and the ash content are 90.0%, 1.7%, and 1.8%, respectively. For the sweet whey powder, for example, the solid content is 97.0%, and, in this case, the protein content, the lactose content, and the ash content are 12.0%, 75.5%, and 8.5%, respectively. For the demineralized whey powder, for example, the solid content is 98.1%, and, in this case, the protein content, the lactose content, and the ash content are 11.8%, 79.7%, and 5.6%, respectively. For the nonfat dry milk, for example, the solid content is 95.5%, and, in this case, the protein content, the lactose content, and the ash content are 34.0%, 53.5%, and 8.0%, respectively. The proportions of these major ingredients may vary, for example, depending upon materials, products, and preparation methods for wheys.

[0032] Preferably, the whey protein used herein is a whey protein concentrate (WPC), a whey protein isolate (WPI), a sweet whey powder, an acidic whey powder, a demineralized whey powder, or a mixture thereof, more preferably WPI, still more preferably acidic WPI or neutral WPI. The term "acidic WPI" means a whey that is acidic (pH below 6) in an aqueous solution, and the term "neutral WPI" means a whey that is neutral (pH 6 to 8) in an aqueous solution.

[0033] The term "aqueous concentrated protein solution" as used herein means an aqueous solution that is obtained by adding a protein and the like in water and mixing them together and contains at least a whey protein in an aqueous solution. Specifically, the aqueous concentrated protein solution is in such a state that a whey protein is homogeneously dissolved and/or dispersed. Here homogeneous dispersion refers to dispersion on such a level that lumps of the whey protein are absent.

[0034] In the preparation of the aqueous concentrated protein solution, the temperature at which the whey protein is added to and mixed with water is preferably 50 to 80°C, more preferably 50 to 70°C, still more preferably 50 to 65°C, further preferably 56 to 65°C.

[0035] The concentration of the whey protein in the aqueous concentrated protein solution is such a concentration that the amount of the protein derived from the whey protein is 2 to 12 g/100 ml, preferably 4 to 12 g/100 ml, more preferably 6 to 12 g/100 ml, still more preferably 8 to 12 g/100 ml.

[0036] The pH value of the aqueous concentrated protein solution is preferably 2.5 to 8, more preferably 3 to 6.

[0037] In one embodiment of the present invention, the protein used in the present invention may further contain other protein-derived proteins in addition to the whey protein.

[0038] Other proteins mean proteins other than the whey protein. Any proteins that are usable in foods and pharmaceutical applications may be used as other proteins without particular limitation. Specific examples of such proteins include milk proteins (casein, casein sodium, α -casein, β -casein, κ -casein, MPC (milk protein concentrate), nonfat dry milk, whole milk powder, partially defatted milk, condensed milk and the like), soybean proteins (glycinin, β -conglycinin and the like), wheat proteins (gluten, gluazine, glutelin and the like), animal meat proteins (muscular structure proteins, myosin, actin and the like), fish meat (muscle fiber proteins, actomyosin, myosin, actin and the like), egg proteins (ovalbumin, egg yolk lipoprotein and the like), pig skin proteins (gelatin and the like), collagen, or hydrolyzates of these proteins. They may be used either solely or any combination thereof.

[0039] Other proteins may be added to the aqueous concentrated protein solution before the introduction of the mineral group as long as the viscosity of the aqueous concentrated protein solution and properties of the mixed solution after the addition of minerals that are converted to divalent ions in an aqueous solution are not substantially affected. Alternatively, other proteins may

be added after mixing of the aqueous concentrated protein solution with the mineral group as long as properties of the nutritional composition are not substantially affected. Preferably, other proteins are added to the aqueous concentrated protein solution.

5 [0040] The concentration of other proteins in the aqueous concentrated protein solution is not particularly limited as long as minerals introduced into the aqueous solution can be homogeneously stirred. Specifically, the concentration of other
10 proteins may be properly regulated, for example, by heat quantity, viscosity, pH, ionic strength, temperature, type and content of proteins, type and content of other ingredients of the nutritional composition to be prepared, and homogenization treatment pressure.

[0041] Mineral group

15 Minerals that are mainly used in the present invention are selected from sodium, potassium, iron, calcium, and magnesium.

[0042] In the present invention, the mineral group means a group of minerals that contains two or more of the above minerals,
20 and one or more of them being converted to divalent ions in the aqueous solution.

[0043] In the present invention, minerals that are converted to divalent ions mean, among the group of minerals, minerals selected from iron, calcium, and magnesium. Minerals that are
25 converted to divalent ions in the aqueous solution prevent an increase in viscosity and gelation of the mixed solution that occur when the mineral group is added to the aqueous concentrated protein solution. The mineral that are converted to divalent ions in the aqueous solution are preferably calcium or magnesium.

30 [0044] Minerals used in the present invention may exist in any form such as salts of organic acids (gluconates, citrates, tartrates, malates and the like), inorganic salts (chloride salts, hydroxide salts, sulfates, nitrates, phosphates and the like), carbonates, mineral yeasts (zinc yeast, selenium yeast, chromium
35 yeast, manganese yeast and the like), foods containing many minerals (casein calcium, casein sodium, casein sodium calcium,

bittern, egg shell calcium, seashell calcium, coral calcium, nonfat dry milks, seaweeds, fishes and seafoods, dolomite and the like).

[0045] In the present invention, the powder means an aggregate of a number of fine particles of solid. In the present invention, the powder may be mainly composed of contemplated ingredients or alternatively may contain other ingredients such as excipients and the like. Further, in the present invention, the mineral powder means that the mineral is in a powder form.

[0046] In the present invention, an aqueous mineral solution means an aqueous solution of minerals dissolved or dispersed in water or a mixed solvent composed of water and an organic solvent. The organic solvent used in the present invention is not particularly limited as long as the organic solvent can be used in food and pharmaceutical applications. Examples thereof include ethanol.

[0047] In the present invention, the mineral powder mixture means a mixture of two or more minerals in a powder form. Specifically, the mineral powder mixture may be a powder obtained by previously mixing two or more mineral powders. The mixing methods include, for example, a method using a mixer for powder and granular materials, for example, blenders, or a method in which powders are filled into bags or other vessels before manual mixing. Alternatively, the mineral powder mixture may be one obtained by mixing two or more solid or particulate minerals and then grinding a mixture to a powder. Further, the mineral powder mixture may be crystals obtained by evaporating water from an aqueous solution containing two or more minerals.

[0048] The temperature at which a mineral group is introduced into an aqueous concentrated protein solution is preferably 50 to 80°C, more preferably 50 to 70°C, still more preferably 50 to 65°C, further preferably 56°C to 65°C.

[0049] The pH value of the mixed solution after the introduction of the mineral group into the aqueous concentrated protein solution varies depending upon the type and concentration of the protein and the minerals included in the mineral group and is preferably 2.5 to 8.

- [0050] The concentration of calcium, magnesium, iron, sodium, or potassium in the aqueous concentrated protein solution can be properly regulated, for example, by pH, ionic strength, temperature, type of minerals, type and content of the protein, and type and content of other ingredients of the nutritional composition to be prepared. For example, for calcium, the concentration is preferably 10 to 230 mg/100 ml, more preferably 100 to 200 mg/100 ml, still more preferably 100 to 160 mg/100 ml, in terms of mineral. For magnesium, the concentration is preferably 10 to 124 mg/100 ml, more preferably 30 to 100 mg/100 ml, still more preferably 30 to 60 mg/100 ml, in terms of mineral. For sodium, the concentration is preferably 15 to 400 mg/100 ml, more preferably 60 to 300 mg/100 ml, still more preferably 100 to 200 mg/100 ml, in terms of mineral. For potassium, the concentration is preferably 15 to 350 mg/100 ml, more preferably 30 to 340 mg/100 ml, still more preferably 80 to 330 mg/100 ml, 100 to 200 mg/100 ml, in terms of mineral. Here the converted mineral amount means a value obtained by calculating the amount of only the mineral from the molecular weight of a salt containing the mineral. The converted mineral content based on the amount of protein contained in the whey protein (whey protein-derived protein) is a value obtained by multiplying the converted mineral amount based on the amount of the protein contained in the whey protein by 100.
- [0051] In the aqueous concentrated protein solution, the concentration of the mineral converted to divalent ions in an aqueous solution varies depending upon the concentration of the protein contained in the whey protein contained in the aqueous concentrated protein solution and the type and concentration of the mineral converted to monovalent ions in the aqueous solution among minerals constituting the mineral group. Specifically, in the aqueous concentrated protein solution, the content of the mineral converted to divalent ions in the aqueous solution based on the amount of the protein derived from the whey protein in the aqueous concentrated protein solution can be properly regulated as long as an increase in viscosity can be suppressed as desired. In

the aqueous concentrated protein solution, the content of the mineral converted to divalent ions in the aqueous solution (converted mineral content) is preferably not less than 0.2% by weight, more preferably not less than 0.5% by weight, still more preferably not less than 0.6% by weight, further preferably not less than 0.7% by weight, based on the amount of the protein derived from the whey protein. Here the content is a content when the mineral converted to divalent ions in the aqueous solution is first introduced. Accordingly, when two or more minerals converted to divalent ions in the aqueous solution are mixed together, the total content of two or more minerals may be the above value or more. The upper limit of the content can be properly regulated, for example, by pH, ionic strength, temperature, type and content of minerals, type and content of other ingredients of the nutritional composition to be prepared.

[0052] The nutritional composition produced according to the present invention may be enriched in calcium or contain more calcium. Here according to the Nutrition Labelling Standards that is a public notice by Ministry of Health, Labour and Welfare in accordance with the provisions of Article 31 Paragraph 1 of the Health Promotion Act, the use of wording such as "high" calcium content or "more" calcium is required to satisfy any one of the following calcium content requirements: not less than 210 mg/100 g, not less than 105 mg/100 ml, or not less than 70 mg/100 kcal. Further, the use of wording containing "enriched," "containing" or the like is required to satisfy any one of the following calcium content requirements: not less than 105 mg/100 g, not less than 53 mg/100 ml, or not less than 35 mg/100 kcal. Accordingly, specifically, the concentration of calcium contained in the nutritional composition produced by the process according to the present invention may satisfy any one of not less than 210 mg/100 g, not less than 105 mg/100 ml, not less than 70 mg/100 kcal, not less than 105 mg/100 g, not less than 53 mg/100 ml, or not less than 35 mg/100 kcal, in terms of mineral.

[0053] The nutritional composition produced according to the present invention may be enriched in magnesium or contain

more magnesium. Here according to the Nutrition Labelling Standards, the use of wording such as "high" magnesium content or "more" magnesium is required to satisfy any one of the following magnesium content requirements: not less than 75 mg/100 g, not less than 38 mg/100 ml, or not less than 25 mg/100 kcal. Further, the use of wording containing "enriched," "containing" or the like is required to satisfy any one of the following magnesium content requirements: not less than 38 mg/100 g, not less than 19 mg/100 ml, or not less than 13 mg/100 kcal. Accordingly, specifically, the concentration of magnesium contained in the nutritional composition produced by the process according to the present invention may satisfy any one of not less than 75 mg/100 g, not less than 38 mg/100 ml, not less than 25 mg/100 kcal, not less than 38 mg/100 g, not less than 19 mg/100 ml, or not less than 13 mg/100 kcal, in terms of mineral.

[0054] The nutritional composition produced according to the present invention may be enriched in iron or contain more iron. Here according to the Nutrition Labelling Standards, the use of wording such as "high" iron content or "more" iron is required to satisfy any one of the following iron content requirements: not less than 2.25 mg/100 g, not less than 1.13 mg/100 ml, or not less than 0.75 mg/100 kcal. Further, the use of wording containing "enriched," "containing" or the like is required to satisfy any one of the following iron content requirements: not less than 1.13 mg/100 g, not less than 0.56 mg/100 ml, or not less than 0.38 mg/100 kcal. Accordingly, specifically, the concentration of iron contained in the nutritional composition produced by the process according to the present invention may satisfy any one of not less than 2.25 mg/100 g, not less than 1.13 mg/100 ml, not less than 0.75 mg/100 kcal, not less than 1.13 mg/100 g, not less than 0.56 mg/100 ml, or not less than 0.38 mg/100kcal, in terms of mineral.

[0055] Saccharide

In one preferred embodiment of the present invention, the nutritional composition produced by the process according to the present invention may further contain a saccharide.

[0056] Any saccharide usable in food and pharmaceutical applications may be used as the saccharide in the present invention without particular limitation. Specific examples of such saccharides include polysaccharides such as starches, dextrans, 5 celluloses, glucomannans, glucans, soluble starches, British starches, oxidized starches, starch esters, and starch ethers; chitins, fructo-oligosaccharides, galacto-oligosaccharides, mannan-oligosaccharides, low-molecular polysaccharides, low-molecular dextrans, low-molecular celluloses, low-molecular 10 glucomannans, isomaltuloses, trehaloses, sucroses, maltoses, glucoses, and sugar alcohols (xylitols and the like). They may be used either solely or in any combination thereof. The saccharide is preferably dextrin or sucrose.

[0057] The DE value of the dextrin used herein is preferably 15 10 to 50, more preferably 15 to 40, still more preferably 15 to 30.

[0058] Saccharides may derive from any of plants, animals, microorganism and the like, or alternatively may be chemically synthesized. For example, saccharides derived from plants (potatoes, rices, sweet potatoes, corns, wheats, beans (horsebeans, 20 mug beans, azuki beans and the like), cassavas and the like), animals (crustacea, insects, shells and the like), microorganisms (mushrooms, fungi and the like) and the like may be used as such or after partial or whole degradation, modification, or other treatments by methods such as enzyme reactions, reactions using 25 microorganisms, heat treatment, and chemical reactions.

[0059] The saccharide may be added to the aqueous concentrated protein solution before the introduction of the mineral group or alternatively may be added after mixing of the aqueous concentrated protein solution with the mineral group.

30 [0060] The concentration of the saccharide in the nutritional composition can be properly regulated, for example, by heat quantity, viscosity, pH, ionic strength, temperature, type and content of the protein, type and content of other ingredients, homogenization treatment pressure and the like of the nutritional 35 composition to be prepared.

[0061] The concentration of the saccharide in the aqueous concentrated protein solution is preferably not more than 50 g/100 ml, more preferably not more than 10 to 30 g/100 ml.

[0062] Lipid

5 In one embodiment of the present invention, the nutritional composition produced by the process according to the present invention may further contain a lipid.

[0063] Any lipid that is usable in food and pharmaceutical applications may be used in the present invention without
10 particular limitation. Specific examples of such lipids include vegetable fats and oils such as soybean oils, corn oils, cotton seed oils, perilla oils, coconut oils, rape-seed oils, sunflower oils, olive oils, safflower oils, and soybean lecithin; animal fats and oils such as beef tallows, prepared lards, chicken oils, milk fats, fish oils,
15 milk phospholipids, and egg-yolk lecithins; synthetic triglycerides, or fractionated oils, hydrogenated oils, and transesterified oils thereof. They may be used either solely or in any combination thereof. Preferred lipids are vegetable fats and oils.

20 [0064] Preferably, the lipid is added after mixing of the aqueous concentrated protein solution with the mineral group. In this case, a method may be adopted in which water and an emulsifier are added to the lipid to prepare an emulsion that is mixed into a mixture of the protein with the mineral group.

25 [0065] The concentration of the lipid in the nutritional composition can be properly regulated, for example, by heat quantity, viscosity, pH, ionic strength, temperature, type and content of the protein, type and content of other ingredients, homogenization treatment pressure and the like of the nutritional
30 composition to be prepared. The concentration is preferably not more than 4 g/100 ml/100 kcal, more preferably not more than 3 g/100 ml/100 kcal.

[0066] Additional minerals

35 In one more preferred embodiment of the present invention, the nutritional composition produced by the process

according to the present invention may further contain additional minerals.

[0067] Additional minerals useable in the present invention include minerals commonly used as very small amounts of minerals for nutritional supplementation. Additional minerals may be selected, for example, from zinc, copper, manganese, selenium, molybdenum, and chromium. Additional minerals are preferably selected from zinc, copper, and selenium.

[0068] Additional minerals may be added after mixing of the aqueous concentrated protein solution with the mineral group. Additional minerals may be added by portions (for example, not more than 2 mg/100 ml, preferably not more than 1.8 mg/100 ml, in terms of mineral, per additional mineral) solely or in a combination of a plurality thereof to the aqueous concentrated protein solution before the introduction of the mineral group, as long as the viscosity of the aqueous concentrated protein solution and properties of the mixed solution after the addition of minerals that are converted to divalent ions in the aqueous solution are not substantially affected.

[0069] The concentration of the additional mineral in the nutritional composition can be properly regulated, for example, by heat quantity, viscosity, pH, ionic strength, temperature, type and content of the protein, type and content of other ingredients, homogenization treatment pressure and the introduction step of the nutritional composition to be prepared.

[0070] Dietary fiber

In one more preferred embodiment of the present invention, the nutritional composition produced by the process according to the present invention further contains dietary fibers.

[0071] The dietary fiber as used herein means substances contained in a food and non-hydrolyzable with digestive enzymes of humans and is classified according to affinity for water into water-soluble dietary fibers and insoluble dietary fibers. Examples of dietary fibers usable in the present invention include indigestible oligosaccharides, lactulose, lactitol, raffinose, pectin (protopectin, pectinic acid, or pectic acid), enzymatically hydrolyzed guar gum,

tamarind seed gum, polymeric water-soluble dietary fibers, soybean thickening polysaccharides, devil's-tongue (konjac) glucomannan, alginic acid, low-molecular alginic acid, psyllium, gum arabic, seaweed saccharides (celluloses, lignin-like substances, agar, carageenans, alginic acid, fukoidan, and laminarin), microorganism gums (Welan gum, curdlan, xanthan gum, gellan gum, dextran, pullulan, and rhamosan gum), and other gums (locust bean gum, tamarind gum, tara gum, gum karaya, gum tragacanth), low-molecular water-soluble dietary fibers, polydextrose, indigestible dextrin, maltitol, celluloses, hemicelluloses, holocelluloses, matrix polysaccharides, minor cereal brans such as soybean brans, wheat brans, barley brans, corn brans, oat brans, rye brans, pearl barley brans, rice brans, common millets, millets, barnyard millets, and sorghums, pseudo cereal brans such as Pulse (legume) brans and buckwheats, sesame brans, and bean-curd refuses. Further, products obtained by chemical and microbiological modification or partial degradation or purification, or dietary fibers that are easy to eat and have been chemically and microbiologically synthesized may be used.

[0072] Dietary fibers may be added to the aqueous concentrated protein solution before the introduction of the mineral group, or alternatively may be added after mixing of the aqueous concentrated protein solution with the mineral group. Preferably, dietary fibers are added to the aqueous concentrated protein solution.

[0073] The concentration of dietary fibers in the nutritional composition can be properly regulated, for example, by heat quantity, viscosity, pH, ionic strength, temperature, type of the protein, type and content of other ingredients, homogenization treatment pressure and the like of the nutritional composition to be prepared. The concentration of the dietary fibers in the nutritional composition is preferably 0 to 3 g/100 ml, more preferably 1 to 2.5 g/100 ml. The concentration is also preferably 0 to 3 g/100 kcal, more preferably 1 to 2.5 g/100 kcal.

[0074] The nutritional composition produced according to the present invention may be enriched in dietary fibers or contain more dietary fibers. Here according to the Nutrition Labelling Standards that is a public notice by Ministry of Health, Labour and Welfare in accordance with the provisions of Article 31 Paragraph 1 of the Health Promotion Act, the use of wording such as "high" dietary fiber content or "more" dietary fibers is required to satisfy any one of the following dietary fiber content requirements: not less than 6 g/100 g, not less than 3 g/100 ml, or not less than 3 g/100 kcal. Further, the use of wording containing "enriched," "containing" or the like is required to satisfy any one of the following dietary fiber content requirements: not less than 3 g/100 g, not less than 1.5 g/100 ml, or not less than 1.5 g/100 kcal. Accordingly, specifically, the concentration of dietary fibers contained in the nutritional composition produced by the process according to the present invention may satisfy any one of not less than 6 g/100 g, not less than 3 g/100 ml, not less than 3 g/100 kcal, not less than 3 g/100 g, not less than 1.5 g/100 ml, or not less than 1.5 g/100 kcal.

20 [0075] Other ingredients

In a preferred embodiment of the present invention, the nutritional composition produced by the process according to the present invention may further contain other ingredients in addition to the above proteins, mineral groups, lipids, saccharides, additional minerals, and dietary fibers.

[0076] Examples of other ingredients include vitamins, organic acids, organic bases, fruit juices, flavors, emulsifiers, thickening agents, or stabilizers. Here vitamins include, for example, vitamin A, carotenes, vitamin Bs, vitamin C, vitamin Ds, vitamin E, vitamin Ks, vitamin P, vitamin Q, vitamin U, niacin, nicotinic acid, pantothenic acid, biotin, inositol, choline, folic acid, and L-carnitine. Organic acids include, for example, malic acid, citric acid, lactic acid, tartaric acid, and erythorbic acid. Organic bases include, for example, histidine.

35 [0077] Other ingredients include materials having the effect of reducing stool odor (for example, champignon extract: 5 mg to

500 mg (0.005% to 0.5%)), carotenoid preparations (for example, preparations containing α -carotene, β -carotene, lycopene, lutein or the like), antioxidants (for example, catechin or polyphenol), and various milk-derived ingredients (for example, butters, whey (milk serum) minerals, creams, wheys, nonprotein nitrogens, sialic acid, phospholipids, or lactose).

[0078] Further, when the nutritional composition according to the present invention is used in pharmaceutical applications, examples of other ingredients include auxiliary active ingredients that are usable in combination with, such as crude drugs, nucleic acids, peptides, and antibiotics.

[0079] These other ingredients may be used either solely or in a combination of two or more. Further, these other ingredients may be synthetic products or foods containing a large amount of these other ingredients.

[0080] Other ingredients may be added to the aqueous concentrated protein solution before the introduction of the mineral group, or alternatively other ingredients may be added after mixing of the aqueous concentrated protein solution with the mineral group. Preferably, other ingredients are added after mixing of the aqueous concentrated protein solution with the mineral group. Here when a plurality of other ingredients are used, they may be added simultaneously or separately.

[0081] Production process

As described above, the process for producing a nutritional composition according to the present invention is a process for producing a nutritional composition comprising a protein and a mineral group including two or more minerals selected from sodium, potassium, iron, calcium, and magnesium, the process comprising:

introducing

a) a powder or an aqueous solution of any one mineral that is converted to divalent ions in an aqueous solution, or

b) a mineral powder mixture containing any one mineral that is converted to divalent ions in an aqueous solution,

and one or more other minerals included in the mineral group, into

an aqueous concentrated protein solution containing a whey protein in an amount of 2 to 12 g/100 ml in terms of the amount of a protein derived from the whey protein, and mixing them together, and,

when any remaining mineral species are present in the mineral group, introducing a powder of the remaining mineral species into the resultant aqueous concentrated protein solution simultaneously or successively, and mixing them together. The process will be described in each of embodiments where minerals are introduced.

[0082] In the present invention, the introduction and mixing of minerals (mineral powders, aqueous mineral solutions, or mineral powder mixture) mean dissolution of introduced minerals in the mixed solution or stirring of introduced materials in the mixed solution until homogeneous dispersion is achieved. In the mixed solution after the mixing, the whole or a part of the minerals may not be dissolved as long as the minerals are homogeneously dispersed. Homogeneous dispersion refers to dispersion on such a level that, when mineral powders are introduced, lumps of powders are absent.

[0083] Further, in the present invention, simultaneous introduction means that all the minerals are introduced at one time, or, after the introduction of a mineral, a next mineral is introduced before the mineral is homogeneously dispersed. Successive introduction means that, after homogeneous dispersion of a mineral, a next mineral is introduced.

[0084] First embodiment

The process for producing a nutritional composition in the first embodiment of the present invention is a process for producing a nutritional composition comprising a protein and a mineral group including two or more minerals selected from sodium, potassium, calcium, and magnesium, the process comprising:

introducing

a powder or an aqueous solution of any one mineral that is converted to divalent ions in an aqueous solution, into

an aqueous concentrated protein solution
 5 containing a whey protein in an amount of 2 to 12 g/100 ml in terms of the amount of a protein derived from the whey protein, and mixing them together, and,

when any remaining mineral species are present in the mineral group, introducing a powder of the remaining
 10 mineral species into the resultant aqueous concentrated protein solution simultaneously or successively, and mixing them together.

[0085] The remaining mineral species in the mineral group mean minerals other than any one mineral converted to divalent
 15 ions in the aqueous solution in the mineral group. For example, when the mineral group consists of sodium, potassium, calcium, and magnesium and calcium is first added as a mineral converted to divalent ions to the aqueous concentrated protein solution, the remaining mineral species are sodium, potassium, and magnesium.
 20 A method may be adopted in which, after calcium is mixed into the aqueous concentrated protein solution, powders of the respective mineral species are introduced or mixed therein either simultaneously or successively.

[0086] Second embodiment

25 The process for producing a nutritional composition in the second embodiment of the present invention is a process for producing a nutritional composition comprising a protein and a mineral group including two or more minerals selected from sodium, potassium, calcium, and magnesium, the process
 30 comprising:

introducing

a mineral powder mixture containing any one mineral that is converted to divalent ions in an aqueous solution and one or more other minerals included in the mineral group, into

35 an aqueous concentrated protein solution containing a whey protein in an amount of 2 to 12 g/100 ml in terms of the

amount of a protein derived from the whey protein, and mixing them together, and,

when any remaining mineral species are present in the mineral group, introducing a powder of the remaining mineral species into the resultant aqueous concentrated protein solution simultaneously or successively, and mixing them together.

[0087] Here one or more other minerals included in the mineral group mean minerals other than any one mineral, in the mineral group, that is converted to divalent ions in the aqueous solution and is included in the mineral powder mixture. The remaining mineral species in the mineral group mean minerals other than any one mineral converted to divalent ions in the aqueous solution and one or more other minerals in the mineral group. For example, when the mineral group consists of sodium, potassium, calcium, and magnesium and calcium and sodium are brought to a mineral powder mixture, one or more other minerals are sodium, the remaining mineral species are potassium and magnesium. A method may be adopted in which, after the mineral powder mixture is mixed into the aqueous concentrated protein solution, powders of the respective mineral species are introduced or mixed thereinto either simultaneously or successively. Further, for example, when the mineral group consists of sodium, potassium, calcium, and magnesium and all the minerals are used as a mineral powder mixture, one or more other minerals are sodium, potassium, calcium, or magnesium, the remaining mineral species are absent.

[0088] As described in Examples 1 to 3 that will be described later, when the minerals constituting the mineral group are mixed into the aqueous concentrated protein solution at one time or separately from each other in a plurality of times according to the first or second embodiment, the viscosity of each of the mixed solutions varies and the fluidity of the mixed solutions varies.

[0089] In one embodiment of the present invention, preferably, the fluidity of an aqueous concentrated protein solution

before the introduction of the mineral group (including the fluidity in preparing the aqueous concentrated protein solution), and a mixed solution obtained by introducing a powder or an aqueous solution of any one mineral converted to divalent ions in the aqueous solution or the mineral powder mixture into the aqueous concentrated protein solution, and a mixed solution obtained by introducing the remaining mineral(s) into the mixed solution is high enough to be mechanically stirrable at a temperature at which the mineral group is introduced into an aqueous concentrated protein solution. Here "mechanically stirrable" means that, in the field of foods and pharmaceutical preparations, stirring is possible with apparatuses such as stirring apparatuses commonly used in liquid stirring without applying an excessive load to apparatuses. When the liquid has a fluidity high enough to be mechanically stirrable, the application of excessive load to other apparatuses that require the liquid to have a certain level of fluidity, such as liquid feed pumps, can be avoided.

[0090] The fluidity high enough to be mechanically stirrable at a temperature at which the mineral group is introduced and mixed into the aqueous concentrated protein solution may be determined, for example, using a viscosity as an index. Accordingly, in one preferred embodiment of the present invention, the viscosity of the aqueous concentrated protein solution before the introduction of the mineral group, and the viscosity of a mixed solution obtained by introducing a powder or an aqueous solution of any one mineral converted to divalent ions in the aqueous solution or the mineral powder mixture into the aqueous concentrated protein solution, and the viscosity of a mixed solution obtained by introducing the remaining mineral(s) into the mixed solution are 1 to 7000 mPa·s, preferably 1 to 5000 mPa·s, more preferably 1 to 2500 mPa·s, still more preferably 1 to 1500 mPa·s, further more preferably 1 to 500mPa·s, as measured under conditions of 20°C and 12 rpm (Brookfield viscometer), and are 1 to 1500 mPa·s, preferably 1 to 1000 mPa·s, more preferably 1 to 500 mPa·s, still more preferably 1 to 300 mPa·s, further more preferably 1 to 100 mPa·s, as measured under conditions of 50°C

and 12 rpm (Brookfield viscometer). On the other hand, the fluidity that suffers from the difficulty of mechanical stirring at a temperature at which the mineral group is introduced and mixed into the aqueous concentrated protein solution is, for example, such that the viscosity of the aqueous concentrated protein solution before the introduction of the mineral group, and the viscosity of a mixed solution obtained by introducing a powder of any one mineral converted to divalent ions in the aqueous solution or the mineral powder mixture into the aqueous concentrated protein solution, and the viscosity of a mixed solution obtained by introducing the remaining mineral(s) into the mixed solution are, more than 7000 mPa·s (20°C, 12 rpm, Brookfield viscometer), or more than 1500 mPa·s (50°C, 12 rpm, Brookfield viscometer).

[0091] In one embodiment of the present invention, a mixed solution that is a mixture composed of a protein, a mineral group, and optionally one or more ingredients selected from saccharides, lipids, additional minerals, dietary fibers, and other ingredients and is produced according to the first or second embodiment as such may be used as the nutritional composition, or alternatively may be diluted at any dilution ratio to prepare a desired nutritional composition (having desired heat quantity, viscosity, and concentration). Further, the mixed solution may be homogenized after high temperature sterilization or may be sterilized at an elevated temperature after homogenization.

[0092] Any conditions for heating in the high-temperature sterilization may be adopted without particular limitation as long as heat sterilization conditions are commonly used in the field of foods and pharmaceutical preparations. For conditions for heating in high-temperature sterilization in an acidic solution, a method may be adopted in which sterilization is carried out at a temperature of 90 to 100°C for 30 to 60 sec followed by hot pack filling (hot filling). For conditions for heating in high-temperature sterilization in a neutral solution, a method may be adopted in which high-temperature sterilization is carried out under conventional conditions, for example, under conditions of 120 to 130°C and 5 to 10 sec.

[0093] In the high-temperature sterilization, a pressure may optionally be applied to the mixed solution. Apparatuses for high-temperature sterilization include, for example, plate-type heat exchangers, tube-type heat exchangers, steam injection-type sterilizers, steam infusion-type sterilizers, and electrical heating-type sterilizers.

[0094] For example, a homogenizer may be used for the homogenization. Here conditions for operation of the homogenization can be properly regulated, for example, by a production scale and the type and content of a protein, a mineral group, and other ingredients in the nutritional composition to be prepared. For example, when the temperature and the flow rate are about 40 to 80°C and 10 to 2000 L/h, respectively, the pressure may be, for example, 10 to 100 MPa, 10 to 50 MPa, or 15 to 30 MPa. If necessary, homogenization treatment may be carried out in a plurality of times under varied operation conditions.

[0095] Nutritional composition

As described above, the nutritional composition produced by the process according to the present invention comprises a protein and a mineral group containing two or more minerals selected from sodium, potassium, iron, calcium, and magnesium. The nutritional composition according to the present invention may if necessary further comprise one or more ingredients selected from saccharides, lipids, additional minerals, dietary fibers, and other ingredients.

[0096] The nutritional composition according to the present invention may if necessary further contain additional additives, for example, thickening agents/gelling agents, stabilizers, preservatives, wetting agents, emulsifiers, sweetening agents, colorants, antioxidants, and pH adjusters.

[0097] Here the thickening agent/gelling agent can impart viscosity to the nutritional composition of the present invention to regulate properties as desired to a liquid, semi-solid, solid, or gel form. Examples of thickening agents/gelling agents usable in the present invention include guar gums, tara gums, locust bean gums, tamarind seed gums, psyllium seed gums, gum arabic, gum karaya,

agars, carageenans, curdlans, xanthan gums, gellan gums, pectin, celluloses, chitins, chitosans, or sobean polysaccharides. In the nutritional composition of the present invention, the thickening agent/gelling agent can be used in any type, proportion, and
5 mixing amount.

[0098] The nutritional composition of the present invention mainly aims at nutritional supplementation. In a preferred embodiment, the nutritional composition is provided as a food composition or a pharmaceutical composition. The nutritional
10 composition of the present invention may be administered as such may be given solely through oral or enteral (tube) administration, or alternatively may be given as a mixture with a commercially available food or pharmaceutical preparation at any ratio through oral or enteral administration.

[0099] In one embodiment of the present invention, the nutritional composition of the present invention is a liquid food, a medical food, an enteral nutrient, a special-use food, or a food and drink for nutritional supplementation. Further, in one preferred embodiment of the present invention, the nutritional
20 composition of the present invention is a food for people with difficulty in swallowing. Here the nutritional composition of the present invention may be, for example, in a liquid, thick liquid, thick suspension, gel, paste, or semi-solid form.

[0100] The liquid food refers to a food or a pharmaceutical preparation having a fluidity high enough to be swallowed by patients and the like without mastication, for example, a food that has a water content of 60 to 85% by weight and exhibits a fluidity high enough to be passed through a feeding tube. This fluidity satisfies, for example, a requirement of a falling speed of 100 ml/hr or more under conditions of a temperature of 25°C and a fall of 60
30 cm.

[0101] The medical food is a food or a pharmaceutical preparation, the intake of which is recommended for patients from the viewpoint of treatment or prevention used in medical fronts.
35 The enteral nutrient refers to nutritional supplements to be fed through a tube.

[0102] The special-use food refers to "foods that have been permitted to be labelled as a food for special use" indicating that the food is suitable for growth and maintenance and restoration of health of object persons for which medical and nutritional considerations are necessary, such as infants, parturients/nursing women, and sick persons. Foods for persons with difficulty in swallowing and foods for specified health use are included in the special-use food. In one preferred embodiment of the present invention, the special-use food is a food for persons with difficulty in swallowing.

[0103] Foods and drinks for nutritional supplementation include health foods, functional foods, and foods on which a disease risk presentation label is attached, and, further, foods classified into foods for sick persons.

[0104] In one embodiment of the present invention, the nutritional composition of the present invention may be a nutritional supplement, a nutritional balance adjustor, a mineral supplement, a mineral balance adjustor, a hydration adjustor, an osmotic pressure balance adjustor and the like that aims at nutritional functional use, that is, the effect of maintaining and promoting health by nutritional ingredients. Further, the nutritional composition according to the present invention may be an oral ingestion agent, a tube-feeding nutrient, an enteral nutrient, or an agent for persons with difficulty in swallowing according to the mode of use.

[0105] The pH value of the nutritional composition according to the present invention is preferably 2.5 to 8, more preferably 3 to 6. In general, nutritional foods or pharmaceutical preparations, the pH value of which has been brought to an acidic level, advantageously have good storage stability as products and, when used as enteral nutrients, are less likely to cause aggregation of protein ingredients by a gastric juice that occurs when the nutrient is administered into the stomach through a tube, as compared with neutral nutritional foods and can suppress clogging of the tube.

[0106] The pH value of the nutritional composition can be adjusted by pH adjustors. Any pH adjustor that can adjust pH to the above-defined range and is usable in foods and pharmaceutical preparations can be used without particular limitation. Typical examples thereof include sodium hydroxide, potassium hydroxide, sodium hydrogencarbonate, and sodium carbonate. They may be used solely or in a combination of two or more.

[0107] The heat quantity (or energy value) of the nutritional composition according to the present invention can be properly regulated by ingredients contained in the nutritional composition. The heat quantity of the nutritional composition is preferably 50 to 250 kcal/100 ml, more preferably 100 to 200 kcal/100 ml.

[0108] The amount of energy occupied by individual ingredients of the nutritional composition is preferably 2 to 24 kcal/100 ml or 2 to 24 kcal/100 kcal for protein, 0 to 96 kcal/100 ml or 0 to 96 kcal/100 kcal for saccharides, and 0 to 36 kcal/100 ml or 0 to 36 kcal/100 kcal for lipid.

EXAMPLES

[0109] The present invention is further illustrated by the following Examples that are not intended as a limitation of the invention.

[0110] Example 1

A mixed solution was produced according to a formulation specified in Table 1 below. Specifically, an acidic whey protein isolate (WPI) (protein content: 90% by weight), a dextrin having a DE value of 20 to 40, an indigestible dextrin, a sweetening agent and a foam inhibitor, and zinc gluconate, copper gluconate, and a selenium yeast were added to and mixed with water having a temperature of 60°C. A powder of one of minerals (calcium lactate(Ca), sodium chloride(Na), magnesium sulfate heptahydrate(Mg), and potassium chloride (K)) or a powder of a mixture obtained by homogeneously premixing two or more of the minerals was introduced into the resultant aqueous concentrated protein solution having a temperature of 50 to 70°C at a mixing ratio specified in Table 1, and they were mixed while stirring to a

homogeneous state to prepare a mixed solution. pH of the mixed solution, when the minerals were introduced, underwent a change and was in the range of 2.5 to 5.

[0111] The converted mineral amount means a value
 5 obtained by calculating the amount of only the mineral from the molecular weight of a salt containing the mineral. The converted mineral content based on the amount of protein contained in the whey protein is a value obtained by multiplying the converted mineral amount based on the amount of the protein contained in
 10 the mixed whey protein (acidic WPI) by 100. Specifically, the converted mineral content based on the amount of protein contained in the whey protein can be calculated by (converted mineral amount/amount of protein contained in whey protein) × 100, that is, {converted mineral amount/(mixed amount of whey
 15 protein × content of protein in whey protein)} × 100.

[0112] [Table 1]

Table 1: Recipe for mixed solution

				Recipe (g/100 mL)	Converted mineral amount (mg/100 mL)	Converted mineral content based on amount of protein contained in whey protein (wt%)
Aqueous concentrated protein solution	Water content	Water		80.992		
	Solid Content	Protein	Acidic WPI (protein content: 90%)	9.719		
		Saccharide	Dextrin	14.471		
		Vegetable fiber	Indigestible dextrin	1.296		
		Additives	Sweetening agent	0.026		
			Foam inhibitor	0.130		
		Additional minerals	Zinc gluconate	0.014	1.792	0.020
			Copper gluconate	0.002	0.28	0.003
			Selenium yeast	0.005	0.01	0.0001
Mineral group	Minerals	Calcium lactate	0.996	182.9	2.091	
		Sodium chloride	0.324	127.4	1.456	
		Magnesium sulfate heptahydrate	0.663	65.4	0.748	
		Potassium chloride	0.324	169.9	1.942	
Total solid content				28.008	(Specific gravity: 1.09)	
Total of final product				109.000		
Volume of final product (mL)				100.000		
Heat quantity of final product (kcal)				98.054		

[0113] The viscosity of the mixed solution thus obtained was measured with a Brookfield viscometer ("TVB-10," manufactured by Toki Sangyo Co., Ltd.) under conditions of a water temperature of 20°C and 12 rpm. The state of the solution, for example, whether the solution is in a gel or liquid form was determined visually or based on the result of a procedure consisting of scooping up the solution with a spoon and dropping the solution. The term "gel form" as used herein means a solution having such properties that the viscosity and the structure (three-dimensional structure) are as observed in jam and the fluidity is poor; the term "thick liquid" means a solution having such properties that the solution is viscous but does not have a clear three-dimensional structure and, at a temperature at which the mineral group is

introduced into and mixed with an aqueous concentrated protein solution, has a fluidity high enough for mechanical stirring; and the term "liquid" means a solution having such properties that the solution is neither viscous nor has a three-dimensional structure and, at a temperature at which the mineral group is introduced into and mixed with an aqueous concentrated protein solution, has a fluidity high enough for mechanical stirring. The results are shown in Table 2.

[0114] [Table 2]

10 Table 2: Viscosity and properties of mixed solution

Type of introduced mineral		Viscosity mPa·s	State
No mineral (aqueous concentrated protein solution)		110	Liquid
Single mineral powder	K (potassium chloride)	12610	Gel
	Na (sodium chloride)	16740	Gel
	Ca (calcium lactate)	1460	Thick liquid
	Mg (magnesium sulfate heptahydrate)	6380	Thick liquid
	K + Na	7790	Gel
Mineral powder mixture	K + Ca	142	Liquid
	K + Mg	322	Liquid
	Na + Ca	115	Liquid
	Na + Mg	150	Liquid
	Ca + Mg	100	Liquid
	K + Na + Ca	133	Liquid
	K + Na + Mg	166	Liquid
	K + Ca + Mg	77	Liquid
	Na + Ca + Mg	100	Liquid
	K + Na + Ca + Mg	64	Liquid

[0115] Example 2

15 A mixed solution was produced according to a formulation specified in Table 3 below. The mixed solution was produced in the same manner as in Example 1. The viscosity and properties of the mixed solution thus obtained were as shown in Table 4.

[0116] [Table 3]

Table 3: Recipe for mixed solution

				Recipe (g/100 mL)	Converted mineral amount (mg/100 mL)	Converted mineral content based on amount of protein contained in whey protein (wt%)
Aqueous concentrated protein solution	Water content	Water		80.94		
		Protein	Acidic WPI	9.00		
		Saccharide	Dextrin	13.00		
	Additive	Foam inhibitor	0.06			
Mineral group	Solid content	Minerals	Calcium lactate	1.00	183.7	2.267
			Sodium chloride	0.30	118.0	1.456
			Magnesium sulfate heptahydrate	0.60	59.2	0.731
			Potassium chloride	0.30	157.3	1.941
Total solid content				24.26	(Specific gravity: 1.05)	
Total of final product				105.20		
Volume of final product (mL)				100.00		
Heat quantity of final product (kcal)				88.00		

[0117] [Table 4]

5 Table 4: Viscosity and properties of mixed solution

Type of introduced mineral		Viscosity mPa·s	State
No mineral (aqueous concentrated protein solution)		24.4	Liquid
Single mineral powder	K (potassium chloride)	2070	Thick liquid
	Na (sodium chloride)	3040	Thick liquid
	Ca (calcium lactate)	308	Liquid
	Mg (magnesium sulfate heptahydrate)	590	Liquid
Mineral powder mixture	K + Na	2190	Thick liquid
	K + Ca	433	Liquid
	K + Mg	68	Liquid
	Na + Ca	81	Liquid
	Na + Mg	98	Liquid
	Ca + Mg	77	Liquid
	K + Na + Ca	45	Liquid
	K + Na + Mg	174	Liquid
	K + Ca + Mg	33	Liquid
	Na + Ca + Mg	137	Liquid
	K + Na + Ca + Mg	55	Liquid

[0118] Example 3

A mixed solution was produced according to a formulation specified in Table 5 below. Specifically, an acidic whey

protein isolate (WPI), a dextrin, and a foam inhibitor as described in Example 1 were added to and mixed with water having a temperature of 70°C to a homogeneous state. The aqueous concentrated protein solution thus obtained had pH 3.25 to 3.3.

- 5 Powders of minerals (calcium lactate, sodium chloride, magnesium heptahydrate, and potassium chloride) in respective mixing amounts specified in Table 5 were introduced one by one in an order specified in Table 6 into the resultant protein mixed solution having a temperature of 50 to 70°C. The second or later mineral
10 was introduced after the previously introduced mineral was mixed in the solution to a homogeneous state. The mixed solution was obtained by introducing and mixing all the minerals in the specified order.

[0119] [Table 5]

- 15 Table 5: Recipe for mixed solution

				Recipe (g/100 mL)	Converted mineral amount (mg/100 mL)	Converted mineral content based on amount of protein contained in whey protein (wt%)
Aqueous concentrated protein solution	Water content	Water		75.14		
		Protein	Acidic WPI	12.00		
		Saccharide	Dextrin	24.00		
		Additive	Foam inhibitor	0.06		
Mineral group	Solid content	Minerals	Calcium lactate	1.00	183.7	1.701
			Sodium chloride	0.30	118.0	1.093
			Magnesium sulfate heptahydrate	0.60	59.2	0.548
			Potassium chloride	0.30	157.3	1.456

- [0120] The viscosity of the mixed solution thus obtained was measured with a Brookfield viscometer under conditions of a water temperature of 20°C and 12 rpm in the same manner as in
20 Example 1. The state of the solution was determined visually and based on the result of a procedure consisting of scooping up the solution with a spoon and dropping the solution. The results are shown in Table 6.

[0121] [Table 6]

Table 6: Order of introduction of minerals and viscosity and properties of mixed solution

Order of introduction (Order: from left to right)	Combination of minerals introduced					Viscosity after introduction and mixing of the ingredients (mPa.s)	State
		First ingre-dient	Second ingre-dient	Third ingre-dient	Fourth ingre-dient		
No mineral	Aqueous concentrated protein solution	-	-	-	-	1030	Thick liquid
Na	Aqueous concentrated protein solution	Na	-	-	-	11800	Gel
K → Ca → Na → Mg	Aqueous concentrated protein solution	K	-	-	-	16400	Gel
	Aqueous concentrated protein solution	K	Ca	-	-	235	Liquid
	Aqueous concentrated protein solution	K	Ca	Na	-	99	Liquid
	Aqueous concentrated protein solution	K	Ca	Na	Mg	101	Liquid
K → Na → Ca → Mg	Aqueous concentrated protein solution	K	-	-	-	16400	Gel
	Aqueous concentrated protein solution	K	Na	-	-	3020	Thick liquid
	Aqueous concentrated protein solution	K	Na	Ca	-	112	Liquid
	Aqueous concentrated protein solution	K	Na	Ca	Mg	104	Liquid
Ca → Na → K → Mg	Aqueous concentrated protein solution	Ca	-	-	-	1930	Thick liquid
	Aqueous concentrated protein solution	Ca	Na	-	-	119	Liquid
	Aqueous concentrated protein solution	Ca	Na	K	-	135	Liquid
	Aqueous concentrated protein solution	Ca	Na	K	Mg	370	Liquid
Ca → Na	Aqueous	Ca	-	-	-	1930	Thick

→ Mg → K	concentrated protein solution						liquid
	Aqueous concentrated protein solution	Ca	Na	-	-	119	Liquid
	Aqueous concentrated protein solution	Ca	Na	Mg	-	157	Liquid
	Aqueous concentrated protein solution	Ca	Na	Mg	K	171	Liquid
Ca → K → Mg → Na	Aqueous concentrated protein solution	Ca	-	-	-	1930	Thick liquid
	Aqueous concentrated protein solution	Ca	K	-	-	128	Liquid
	Aqueous concentrated protein solution	Ca	K	Mg	-	222	Liquid
	Aqueous concentrated protein solution	Ca	K	Mg	Na	157	Liquid
Ca → K → Na → Mg	Aqueous concentrated protein solution	Ca	-	-	-	1930	Thick liquid
	Aqueous concentrated protein solution	Ca	K	-	-	128	Liquid
	Aqueous concentrated protein solution	Ca	K	Na	-	127	Liquid
	Aqueous concentrated protein solution	Ca	K	Na	Mg	144	Liquid
Ca → Mg → K → Na	Aqueous concentrated protein solution	Ca	-	-	-	1930	Thick liquid
	Aqueous concentrated protein solution	Ca	Mg	-	-	369	Liquid
	Aqueous concentrated protein solution	Ca	Mg	K	-	129	Liquid
	Aqueous concentrated protein solution	Ca	Mg	K	Na	236	Liquid
Ca → Mg → Na → K	Aqueous concentrated protein solution	Ca	-	-	-	1930	Thick liquid
	Aqueous concentrated	Ca	Mg	-	-	369	Liquid

	protein solution						
	Aqueous concentrated protein solution	Ca	Mg	Na	-	129	Liquid
	Aqueous concentrated protein solution	Ca	Mg	Na	K	357	Liquid
Mg → Na → K → Ca	Aqueous concentrated protein solution	Mg	-	-	-	2072	Thick liquid
	Aqueous concentrated protein solution	Mg	Na	-	-	398	Liquid
	Aqueous concentrated protein solution	Mg	Na	K	-	289	Liquid
	Aqueous concentrated protein solution	Mg	Na	K	Ca	195	Liquid
Mg → Ca → K → Na	Aqueous concentrated protein solution	Mg	-	-	-	2072	Thick liquid
	Aqueous concentrated protein solution	Mg	Ca	-	-	219	Liquid
	Aqueous concentrated protein solution	Mg	Ca	K	-	166	Liquid
	Aqueous concentrated protein solution	Mg	Ca	K	Na	147	Liquid

- [0122] In the conditions of the aqueous concentrated protein solution specified in Table 5, when the concentration of the whey protein (acidic WPI) was 14 to 20 g/100 ml, before the introduction of the mineral group, the aqueous concentrated protein solution gelled, making it impossible to conduct homogeneous stirring even after the addition of the mineral group.

[0123] Example 4: Production of liquid nutrient composition

- A liquid nutrient composition was produced according to the following procedure.

[0124] (1) Preparation of water-soluble mixed solution

In a wear-soluble tank, acidic WPI, dextrin and indigestible dextrin, sweetening agent and foam inhibitor, zinc gluconate, copper gluconate, and selenium yeast as described in

Example 1 were added according to a formulation shown in Table 7 below to hot water having a temperature of 70°C before mixing to a homogeneous state. The aqueous concentrated protein solution thus obtained had pH 3.25 to 3.3.

5 [0125] The minerals were introduced by the following two methods.

1. Mineral powders were introduced one by one into the protein mixed solution in the order of calcium lactate, magnesium sulfate heptahydrate, sodium chloride, and potassium chloride.

10 The mineral introduction of the second or later ingredient was carried out after the previously introduced mineral was homogeneously dissolved or dispersed in the mixed solution. A water-soluble mixed solution was obtained by introducing all the minerals in the specified order and mixing the contents. The
15 viscosity was increased by the introduction of the minerals but was less than 7000 mPa·s (20°C, 12rpm, Brookfield viscometer), and the increased viscosity did not pose a production problem.

2. A mixture previously obtained by mixing a powder of calcium lactate and a powder of magnesium sulfate heptahydrate
20 together was introduced into and mixed with the protein mixed solution, and sodium chloride and potassium chloride were introduced one by one in that order. The introduction method was the same as in the above 1. The viscosity was increased by the introduction of the minerals but was less than 7000 mPa·s (20°C,
25 12rpm, Brookfield viscometer), and the increased viscosity did not pose a production problem.

[0126] [Table 7]

Table 7: Recipe for water-soluble mixed solution

	Mixing ratio (g/100 ml)	Mixing amount	Converted mineral amount (mg/100 ml)	Converted mineral content based on amount of protein contained in whey protein (wt%)
Water (temp. 70°C)	30	600 g		
Foam inhibitor	0.06	1.2 g		
Dextrin	12	240 g		
Indigestible dextrin	1.5	30 g		
Sweetening agent	0.012	0.24 g		
Acidic WPI	6	120 g		
Zinc gluconate	0.006	0.12 g	0.768	0.014
Copper gluconate	0.001	0.02 g	0.140	0.003
Selenium yeast	0.002	0.04 g	0.004	0.00007
Calcium lactate	0.6	12 g	110.3	2.042
Magnesium sulfate heptahydrate	0.3	6 g	29.6	0.548
Sodium chloride	0.2	4 g	78.6	1.456
Potassium chloride	0.2	4 g	104.9	1.943
Water (temp. 50°C)	5	100 g		

[0127] (2) Preparation of lipid-soluble mixed solution

- 5 In another tank (a lipid-soluble tank), a lipid-soluble mixed solution was obtained by adding an emulsifier, a granulated sugar, and vegetable fats and oils to water having a temperature of 85 to 90°C according to a formulation specified in Table 8 below and mixing them with stirring to a homogeneous state.

10 [0128] [Table 8]

Table 8: Recipe for lipid-soluble mixed solution

	Mixing ratio (g/100 ml)	Mixing amount
Water (temp. 85-90°C)	20	400 g
Emulsifier	0.03	0.6 g
Granulated sugar	6.3	126 g
Vegetable fats and oils	3.5	70 g
Water (temp. 90°C)	5	100 g

[0129] (3) Production of liquid nutrient composition

- 15 In still another tank (a mixing tank), a water-soluble mixed solution and a lipid-soluble mixed solution were mixed together, and a flavoring agent, citric acid, ferrous sulfate, vitamin mix, and ascorbic acid were added according to a formulation specified in Table 9 at 50 to 60°C to a homogeneous state, followed by mixing while stirring.

[0130] [Table 9]

Table 9:

	Mixing ratio (g/100 ml)	Mixing amount
Flavoring agent	0.1	2 g
Citric acid	0.3	6 g
Ferrous sulfate	0.005	0.1 g
Vitamin mix	0.2	4 g
Ascorbic acid	0.025	0.5 g
Water	10	200 g

[0131] Water was added to the mixing tank to regulate the mixing amounts as specified in Table 10.

[0132] [Table 10]

Table 10: Recipe for liquid nutrient composition

	Mixing ratio, %w/v kg/100 L	Charge amount	Unit
Whey protein (acidic WPI)	6	120	g
Dextrin	12	240	g
Granulated sugar	6.3	126	g
Indigestible dextrin	1.5	30	g
Sweetening agent	0.012	0.24	g
Zinc gluconate	0.006	0.12	g
Copper gluconate	0.001	0.02	g
Selenium yeast	0.002	0.04	g
Potassium chloride	0.2	4	g
Sodium chloride	0.2	4	g
Calcium lactate	0.6	12	g
Magnesium sulfate heptahydrate	0.3	6	g
Ferrous sulfate (MF)	0.005	0.1	g
Citric acid	0.3	6	g
Vegetable fats and oils	3.5	70	g
Emulsifier	0.03	0.6	g
Vitamin mix	0.2	4	g
Ascorbic acid	0.025	0.5	g
Flavoring agent	0.3	6	g
Foam inhibitor	0.06	1.2	g
Water	78.07	1561.35	g
Total (per charge amount)	110	2192	g

[0133] The mixed solution thus obtained was homogenized (homogenizer, first stage 12 MPa, second stage 3 MPa) and was then held at 90°C for 10 min for sterilization. As a result, a liquid nutrient composition was obtained. The specific gravity and

nutrient ingredients of the nutrient composition were determined. The results were as shown in Table 11.

[0134] [Table 11]

5 Table 11: Specific gravity and nutrient ingredients of liquid nutrient composition

	Per 100 ml
Heat quantity	130 kcal
Protein	5.10 g
Fat	3.66 g
Carbohydrate	20.22 g
Vegetable fiber	1.35 g
Water content	79.40 g
Sodium	78 mg
Potassium	105 mg
Calcium	78 mg
Magnesium	29 mg

Specific gravity 1.1

[0135] Example 5: Production of semisolid nutrient composition

10 A semisolid nutrient composition was produced according to the following procedure.

[0136] (1) Preparation of water-soluble mixed solution

A water-soluble mixed solution was prepared according to the method described in Example 4.

15 [0137] (2) Preparation of lipid-soluble mixed solution

20 In a further tank (a lipid-soluble tank), agar, a gelling agent, an emulsifier, a granulated sugar, and vegetable fats and oils were added to water having a temperature of 85 to 90°C according to a formulation specified in Table 12 below, followed by mixing while stirring to a homogeneous state to obtain a lipid-soluble mixed solution.

[0138] [Table 12]

Table 12: Recipe for lipid-soluble mixed solution

	Mixing ratio (g/100 ml)	Mixing amount
Water (temp. 85-90°C)	20	400 g
Agar	0.4	8 g
Gelling agent	0.6	12 g
Emulsifier	0.03	0.6 g
Granulated sugar	6.3	126 g
Vegetable fats and oils	3.5	70 g
Water (temp. 90°C)	5	100 g

[0139] (3) Production of semisolid nutrient composition

- 5 In another tank (a mixing tank), the water-soluble mixed solution and the lipid-soluble mixed solution were further mixed together, and a flavoring agent, citric acid, ferrous sulfate, vitamin mix, and ascorbic acid were added according to a formulation specified in Table 9 and mixed therewith while stirring
- 10 at 50 to 60°C to a homogeneous state .

[0140] Water was added to the mixing tank to regulate the mixing amounts as specified in Table 13.

[0141] [Table 13]

Table 13: Recipe for semi-solid nutrient composition

	Mixing ratio, %w/v	Charge amount	Unit
	kg/100 L	2000	ml
Whey protein (acidic WPI)	6	120	g
Dextrin	12	240	g
Granulated sugar	6.3	126	g
Indigestible dextrin	1.5	30	g
Sweetening agent	0.012	0.24	g
Zinc gluconate	0.006	0.12	g
Copper gluconate	0.001	0.02	g
Selenium yeast	0.002	0.04	g
Potassium chloride	0.2	4	g
Sodium chloride	0.2	4	g
Calcium lactate	0.6	12	g
Magnesium sulfate heptahydrate	0.3	6	g
Ferrous sulfate (MF)	0.005	0.1	g
Citric acid	0.3	6	g
Vegetable fats and oils	3.5	70	g
Emulsifier	0.03	0.6	g
Vitamin mix	0.2	4	g
Ascorbic acid	0.025	0.5	g
Flavoring agent	0.3	6	g
Agar	0.4	8	g
Gelling agent	0.6	12	g
Foam inhibitor	0.06	1.2	g
Water	77.76	1555	g
Total (per charge amount)	110	2200	g

[0142] The mixed solution thus obtained was homogenized (homogenizer, first stage 12 MPa, second stage 3 MPa) and was then held at 90°C for 10 min for sterilization. As a result, a semi-liquid nutrient composition was obtained. The specific gravity and nutrient ingredients of the nutrient composition were determined. The results were as shown in Table 14.

[0143] [Table 14]

Table 14 Specific gravity and nutrient ingredients of semi-solid nutrient

10 composition

	Per 100 ml
Heat quantity	132 kcal
Protein	5.10 g
Fat	3.66 g
Carbohydrate	21.22 g
Vegetable fiber	1.95 g
Water content	79.40 g
Sodium	86 mg
Potassium	107 mg
Calcium	79 mg
Magnesium	29 mg

Specific gravity 1.1

[CLAIMS]

- [1] A process for producing a nutritional composition comprising a protein and a mineral group including two or more minerals selected from sodium, potassium, calcium, and magnesium, the process comprising:

introducing

a) a powder or an aqueous solution of any one mineral that is converted to divalent ions in an aqueous solution, or

b) a mineral powder mixture containing any one mineral that is converted to divalent ions in an aqueous solution, and one or more other minerals included in the mineral group, into

an aqueous concentrated protein solution containing a whey protein in an amount of 2 to 12 g/100 ml in terms of the amount of a protein derived from the whey protein, and mixing them together, and,

when any remaining mineral species are present in the mineral group, introducing a powder of the remaining mineral species into the resultant mixed solution simultaneously or successively, and mixing them together.

- [2] The process according to claim 1, wherein the aqueous concentrated protein solution, the mixed solution obtained by introducing the mineral powder or aqueous solution of a) or the mineral powder mixture of b) into the aqueous concentrated protein solution, and the mixed solution obtained by introducing the remaining mineral into the mixed solution have a fluidity high enough for mechanical stirring.

- [3] The process according to claim 1 or 2, wherein the

aqueous concentrated protein solution, the mixed solution obtained by introducing the powder of a) or the powder mixture of b) into the aqueous concentrated protein solution, and the mixed solution obtained by introducing the remaining mineral into the mixed solution have a viscosity of 1 to 7000 mPa·s (as measured with a Brookfield viscometer under conditions of 20°C and 12 rpm).

- [4] The process according to any one of claims 1 to 3, wherein the aqueous concentrated protein solution further comprises a saccharide and the concentration of the saccharide in the aqueous concentrated protein solution is not more than 50 g/100 ml.
- [5] The process according to any one of claims 1 to 4, wherein the aqueous concentrated protein solution has pH 2.5 to 8.
- [6] The process according to any one of claims 1 to 5, wherein the nutritional composition further comprises one or more additional minerals selected from zinc, copper, manganese, selenium, molybdenum, and chromium.
- [7] The process according to any one of claims 1 to 6, wherein the nutritional composition further comprises a lipid.
- [8] The process according to any one of claims 1 to 7, wherein the nutritional composition has a heat quantity of 0.5 to 2.5 kcal/ml.
- [9] The process according to any one of claims 1 to 8, wherein the nutritional composition is a food composition or a pharmaceutical composition.

- [10] The process according to any one of claims 1 to 8, wherein the nutritional composition is a liquid food, a medical food, an enteral nutrient, a special-use food, or a food and drink for nutritional supplementation.
- [11] The process according to any one of claims 1 to 8, wherein the nutritional composition is a food for people with difficulty in swallowing.
- [12] A nutritional composition produced by a process according to any one of claims 1 to 11.