

[Document]**Specification****[Title of Invention]**

Dairy product in which whey is used, and method for manufacturing same

[Technical Field]

[0001]

The present invention relates to milk-related processed foods in which whey is used, and a method for manufacturing the same.

[Background Art]

[0002]

Milk and dairy products are widely favored around the world regardless of age or sex, due to their high nutritional values and good flavors. Milk-related processed foods (dairy products) as represented by yogurt and various types of cheese are fermented milk wherein casein is a major protein source, which is coagulated by lactic acid fermentation, a decrease in pH, and an action of proteolytic enzymes (such as rennet), etc. Other products such as ricotta cheese are also known, in which, other than casein, whey protein is used as a major protein source and is coagulated by heat denaturation.

[0003]

Among the milk and dairy products, in recent years high functionality of whey has attracted particular attention. However, the use of whey is limited to specified food products such as modified milk powder for babies and infants, liquid diet for persons requiring long-term care, and health foods for athletes, as well as pharmaceutical products. To date, as a food product using whey protein, fermented milk obtained as follows

has been known (Patent Document 1): a whey protein is subjected to limited degradation by hydrolytic enzymes, heat treated to make a micellar whey protein, then lactic acid fermented.

[0004]

As other food products using whey, a gelled food using whey protein concentrate (WPC) or whey protein isolate (WPI), which is mixed with other foods such as ice cream, is described in Patent Documents 2 and 3. In Patent documents 4 to 6, a gelled composition with increased stability of texture or gel due to addition of gelatin or poly-L-lysine to whey protein, as well as a manufacturing method thereof have been described.

[Citation List]

Patent Document

[0005]

Patent Document 1: JP B 2683491

Patent Document 2: JP B 2525865

Patent Document 3: JP A H04-187050

Patent Document 4: JP A H06-276953

Patent Document 5: JP A H05-276877

Patent Document 6: JP A H06-276954

[Disclosure of Invention]

[Problems to Be Solved by the Invention]

[0006]

In many of Western-style food (Western food), milk and dairy products are eaten as part of the diet as they are, or as dessert (such as snack). In addition, they are also used as condiments and sauces; however, their use and application in eating situations are generally limited. In Chinese food and Japanese-style food (Japanese food), opportunity of eating milk and dairy products is further limited, and they are only used by

being added to condiments, so that their application range, etc. is severely limited.

[0007]

Furthermore, because food products using conventional fermented milk and whey protein exhibit strong milk smell, their combination with Japanese food is not easy, and their use in Japanese flavors is difficult. Therefore, their application is limited to, for example, mixing with other food products, etc. Accordingly, although milk and dairy products have high nutritional values and functionality, their utilization has been far from sufficient.

Therefore, the present invention aims to provide milk-related processed foods in accord with Chinese and Japanese foods, in particular, milk-related processed foods that can be utilized in both Chinese and Japanese foods, eaten as a main or side dish, as well as a manufacturing method thereof.

[Means for Solving the Problems]

[0008]

The present inventors have devoted themselves to solve the above problems, and found that a novel edible gel can be obtained by using β -lactoglobulin (β -LG) as the main protein source among whey proteins and by gelling the whey protein; after further promotion of the research, the inventors have accomplished the present invention.

[0009]

The present inventors have found that, by comprising a high concentration of β -lactoglobulin in the total protein, milk-related processed foods with clear flavor and smooth texture, with less milk smell can be obtained. Furthermore, by fermenting raw ingredients comprising β -lactoglobulin with a microorganism,

stabilization in the gel formation has been enabled.

[0010]

Namely, the present invention relates to the following edible gel, and the manufacturing method thereof.

[1] An edible gel comprising β -lactoglobulin, wherein the β -lactoglobulin is blended in a proportion of 70-100 wt% in the total protein of raw ingredients.

[2] The edible gel according to [1], wherein the β -lactoglobulin is blended in a proportion of 2-10 wt% in the raw ingredients.

[3] The edible gel according to [1] or [2], wherein the breaking strength is 40-500 g.

[4] The edible gel according to any one of [1]-[3], wherein the pH is 5.0-6.0.

[5] The edible gel according to any one of [1]-[4], which is translucent and/or tasteless and odorless.

[6] A method of manufacturing an edible gel, comprising:
a raw-ingredient blending step, wherein β -lactoglobulin is blended in a proportion of 70-100 wt% in the total protein of raw ingredients,

a heating step after said raw-ingredient blending step,

a fermenting step by a microorganism after said heating step.

[7] The method according to [6], wherein the heating step is carried out at 80-150°C.

[8] The method according to Claim [6] or [7], wherein the fermenting step is lactic acid fermentation, and the gel is formed at pH of 5.0-6.0.

[9] The method according to any one of [6]-[8], wherein in the raw-ingredient blending step, 0.2-1.0 wt% of a whey powder is further blended in the raw ingredients.

[10] The method according to any one of [6]-[9], wherein the fermentation step is carried out by after-fermentation.

[11] An edible gel manufactured by the method according to any one of [6]-[10].

[12] A drink and food product comprising the edible gel according to any one of [1]-[5] and [11].

Advantageous Effects of Invention

[0011]

The present invention enables provision of a novel edible gel with a little sour taste and unpleasant taste, which is almost tasteless and odorless. Since there is only a little milk smell specific to dairy products, the gel can be cooked and ingested without mixing with other foods, so that arrangement not only with Western foods, but also with Chinese and Japanese foods is possible. In particular, it can be ingested deliciously when it is taken together with Japanese condiments such as soy sauce, miso and ponzu sauce.

[0012]

The gel of the present invention does not become brown or cloudy as seen in gels derived from whey protein that is not mainly composed of β -lactoglobulin, and the present gel can be adjusted to be translucent with appropriate transparency, so that color arrangement becomes easy. Moreover, because it has an appropriate breaking strength, not only it can provide favorable texture, but also it can be formed into various shapes. In addition, its pH can be adjusted to be a fairly high value even within the acidic range, so that it can be applied to various ways of eating without restriction of usage for conventional dairy products.

[0013]

For example, for the elderly Japanese who are less familiar with Western food and prefer Japanese food, the present gel enables efficient and effective intake of milk and dairy products with high nutrients and functionality, by arranging a milk-related processed food to have Japanese flavors and by providing it as part of Japanese food. In addition, depending on the contents of a meal, the milk-related processed food of the present invention can be used as a substitute of staple food.

[0014]

Furthermore, the present invention enables efficient intake of whey proteins, in particular β -lactoglobulin, and it is also possible to obtain their nutritional physiological effects.

[0015]

According to the manufacturing method of the present invention, since the present gel hardly aggregates even after heat sterilization, an after-fermentation type manufacturing step may be adopted. In addition, when lactic acid fermentation is adopted in the present invention, formation of a smooth gel is possible by gradual decrease in pH, and refrigeration stability of the gel is increased.

[Brief Description of Drawings]

[0016]

[Fig. 1] Figure 1 is a diagram showing influences of whey powder on fermentability (43°C, 0-6 hours) of edible gel.

[Fig. 2] Figure 2 is a diagram showing influences of whey powder on refrigeration preservability (5°C, 0-16 days) of edible gel.

[Fig. 3] Figure 3 is a photograph showing characteristics of coloring and shaping of edible gel.

[Description of Embodiments]

[0017]

One aspect of the present invention relates to an edible gel of a whey protein, in particular, a whey protein comprising a high concentration of β -lactoglobulin (β -LG), and to a drink and food product comprising the same.

In the present specification, % means weight % (w/w).

[0018]

Edible gel of whey protein and drink and food products comprising the same

The edible gel of the present invention may be a gel comprising a certain amount of protein to maintain the gel, and the amount of total protein comprised in the raw ingredients is 2.5-14%, preferably 3-11%, more preferably 3.5-9%. A solid component other than the whey protein may be contained; however, it is preferable that the proportion (content) of the whey protein is high.

[0019]

"Whey" is a water-soluble component, for example, that remaining when fats, casein, and fat-soluble vitamins are removed from milk; and "whey protein" includes the following: whey protein concentrate (WPC) obtained by concentration of major proteins of a whey with ultrafiltration (UF) method, etc., then drying; defatted WPC (low fat and high protein) obtained by removing fats from a whey with microfiltration (MF) method or centrifugation method, then concentration by UF method and drying; whey protein isolate (WPI) obtained by selective fractionation of major proteins of a whey by ion exchange resin and gel filtration, then drying; desalted whey obtained by desalting a whey with nanofiltration (NF) method or electrodialysis, then drying; mineral-concentrated whey, α -lactalbumin (α -LA) and

β -lactoglobulin (β -LG), etc. obtained by precipitation of mineral components derived from a whey, then concentration by centrifugation.

[0020]

The edible gel of the present invention comprises a high concentration of β -lactoglobulin. When the proportion of casein, α -lactalbumin and peptide in the gel increases, the gel tends to have milk smell and unpleasant taste; when the concentration of β -lactoglobulin increases, the gel tends to have increased transparency and clearer flavor (tasteless and odorless).

The amount of β -lactoglobulin contained in raw ingredients is, preferably 2-10%, more preferably 2.5-8%, and even more preferably 3-7%. In addition, the amount of β -lactoglobulin contained in the total protein of raw ingredients is, preferably 70-100%, more preferably 75-100%, and even more preferably 80-100%.

[0021]

The solid content of the edible gel of the present invention in raw ingredients is, in order to maintain appropriate texture, preferably 3-15%, more preferably 3.5-12%, and even more preferably 4-10%. The ash content contained in raw ingredients is preferably 0.01-1%, more preferably 0.1-0.5%.

[0022]

The edible gel of the present invention may have strength sufficient to maintain the gel form; it has breaking strength of preferably 40-500 g, more preferably 45-400 g, even more preferably 50-300 g. In addition, the gel can have a fairly high pH value even in the acidic range; it has a pH value of preferably 5.0-6.0, more preferably 5.2-6.0, even more preferably 5.5-6.0.

[0023]

The edible gel of the present invention is translucent or white in color, without a milk smell, and is close to tasteless and odorless. The color of the gel of the present invention with suppressed turbidity (cloudiness, etc.) can be measured/evaluated by, for example, L value of color difference (lightness index L^*). Without limitation, the L value of the present invention is preferably 50-70, more preferably 53-68, and even more preferably 55-65.

[0024]

The edible gel of the present invention has various kinds of application, as compared to conventional gel-like foods of whey protein. For example, the edible gel can be mixed with other food, or can be eaten in combination with other food; in addition, the edible gel itself may be eaten as-is or together with condiments, etc. In this case, especially Japanese condiments such as soy sauce, miso and ponzu sauce may be appropriately used. In addition, sweeteners such as sugar and granulated sugar may be added as necessary.

[0025]

Furthermore, its color arrangement is easy, and since it has appropriate breaking strength, the gel may be processed into gel-like foods with various shapes and colors. For example, the gel may be mixed with various kinds of colorant, or eaten in combination with them. The gel may be eaten together with a food containing natural pigments. In this case, the gel may be appropriately used as a colorful decoration.

[0026]

Evaluation of flavors of the edible gel of the present invention and drink and food products comprising the same may be determined by a sensory test, etc. For example, as an analytical

sensory evaluation, discrimination-type tests such as two-point discrimination method, three-point discrimination method, and ranking method may be used. In addition, description-type tests such as scoring method and profiling method may also be used, and quantitative descriptive analysis method (QDA) may also be used for the evaluation.

[0027]

The edible gel of the present invention and drink and food products comprising the same may be manufactured by a manufacturing method of the present invention described below, and by methods described in Examples.

[0028]

One aspect of the present invention relates to a method of manufacturing an edible gel of whey protein, comprising a high concentration of whey protein, in particular β -lactoglobulin (β -LG), and a drink and food product comprising the same. The manufacturing method of the present invention may comprise the following steps, but the invention is not limited thereto.

[0029]

Raw ingredient blending step

In the raw ingredient blending step, raw ingredients of the edible gel of the present invention are blended. In the present invention, major raw ingredients include whey extract such as a whey protein and whey protein concentrate, etc., and preferably, β -lactoglobulin and/or a whey protein comprising a high content of β -lactoglobulin are blended. Multiple kinds of these may be used simultaneously, and they may be appropriately combined depending on the purpose.

[0030]

β -lactoglobulin and a whey protein comprising a high

content of β -lactoglobulin are obtained, for example, by selective separation from whey. Such a separation method includes ion exchange chromatography, gel filtration, ultrafiltration, isoelectric point separation method, coprecipitation with polyelectrolyte, salting-out, separation by temperature treatment, etc., and some are disclosed in JP A S61-268138, JP A S63-39545 and others.

[0031]

In addition, as raw ingredients, β -lactoglobulin itself and/or commercially available WPC and WPI having a high content of β -lactoglobulin may be used. For example, ALACEN WPI 895 (Fonterra) may be used. As a whey protein, those having a β -lactoglobulin content of preferably 70-100%, more preferably 75-100%, and even more preferably 80-100% are used.

[0032]

As other raw ingredients, in addition to water and fermentation starters, whey powder, lactose, α -lactalbumin, casein, etc. may be added without limitation. In addition to these, food products may be added separately from the gel components.

In one embodiment of the present invention, raw ingredients other than water and fermentation starters consist only of components derived from whey.

[0033]

In the manufacturing method of the present invention, the amount of the total protein blended in raw ingredients may be any amount that can maintain a gel; preferably, it is blended in the raw ingredients at 2.5-14%, more preferably 3-11%, and even more preferably 3.5-9%. In addition, solid components other than the whey protein may be contained; however, it is preferable that the

proportion (content) of the whey protein is high.

[0034]

In the manufacturing method of the present invention, the raw ingredients comprise a high concentration of β -lactoglobulin. When the proportion of casein, α -lactalbumin and peptide in the raw ingredients increases, the gel tends to have a milk smell and unpleasant taste; when the concentration of β -lactoglobulin increases, the gel tends to have increased transparency and clear flavor (tasteless and odorless).

The amount of β -lactoglobulin contained in the raw ingredients is, preferably 2-10%, more preferably 2.5-8%, and even more preferably 3-7%. In addition, the amount of β -lactoglobulin contained in the total protein of the raw ingredients is, preferably 70-100%, more preferably 75-100%, and even more preferably 80-100%.

[0035]

In the manufacturing method of the present invention, the solid content in the raw ingredients is preferably 3-15%, more preferably 3.5-12%, and even more preferably 4-10%. When the ash content is low, the gel hardly coagulates after heat treatment; therefore, the ash content contained in the raw ingredients is preferably 0.01-1%, more preferably 0.1-0.5%.

Each of the raw ingredients is mixed, suspended and dissolved.

[0036]

Heating step

In the heating step, a mixture of raw ingredients obtained in the raw ingredient blending step is heat-treated. As a result, not only properties of protein change, but also raw ingredients are sterilized.

In the manufacturing method of the present invention, the temperature in the heating step is such that the gel formation is not suppressed while effects such as sterilization can be obtained; it is preferably 80-150°C, more preferably 80-120°C, even more preferably 80-100°C. The preferable heating time is appropriately determined depending on the heating temperature, and it is preferably 1 second to 5 minutes, more preferably 5 seconds to 5 minutes, even more preferably 1 minute to 5 minutes; but it is not particularly limited thereto. In addition, in the case of high temperature, it may be a time period to reach such temperature.

[0037]

After heat treatment, the mixture is cooled to a level that allows addition of a microorganism required for the fermentation step. It is cooled to preferably 30-50°C, more preferably 35-45°C, even more preferably 40-45°C, but it is not limited thereto.

[0038]

Fermenting step

In the manufacturing method of the present invention, fermentation by a microorganism can be utilized. Fermenting step is preferably carried out by a microorganism that produce acid, and specifically, it is lactic acid fermentation by a lactic acid bacterium.

[0039]

In the manufacturing method of the present invention, fermenting step is initiated by mixing a starter, preferably after heating step. As the starter, starters generally used in the production of fermented milk may be used, and a starter mixture may be used. The microorganism that can be used in the present invention includes a lactic acid bacterium and a bifidobacterium,

and one or more kinds of these may be contained.

[0040]

Examples of lactic acid bacteria of the present invention preferably include, but are not limited to, *Lactobacillus*, *Streptococcus*, *Enterococcus*, *Lactococcus*, *Pediococcus*, and *Leuconostoc*. Preferable examples include *Lactobacillus bulgaricus*, *Lactobacillus acidophilus*, *Lactobacillus gasseri*, *Lactobacillus casei*, *Lactococcus lactis*, *Lactococcus cremoris*, *Streptococcus thermophilus* and the like. *Lactobacillus bulgaricus* and *Streptococcus thermophilus* are preferred.

[0041]

Examples of bifidobacteria of the present invention include, but are not limited to, *Bifidobacterium bifidum*, *Bifidobacterium longum*, *Bifidobacterium Burebe*, *Bifidobacterium infantis*, *Bifidobacterium catenulatum*, *Bifidobacterium adolescentis*, *Bifidobacterium pseudolongum*, etc.

[0042]

The amount of a starter may be an amount that enables fermentation, and is not particularly limited; preferably, the amount is adjusted and added such that the number of the bacterium in the raw ingredients including water becomes approximately 10^5 - 10^7 CFU/mL. Furthermore, the addition of a starter can be performed according to, for example, methods used in producing fermented milk, and frozen concentrates and high density cultures of a microorganism (e.g., a lactic acid bacterium) may be used.

[0043]

In the production method of the present invention, fermentation conditions such as fermentation temperature can be adjusted by considering the kind of the microorganism added to the raw ingredients. For example, when a lactic acid bacterium

is used, the fermentation temperature can be maintained at 30-50°C, preferably at 35-45°C, and more preferably at 40-45°C. Fermentation time may be adjusted in accordance with starters and fermentation temperature, and when the fermentation temperature is 35-45°C, fermentation time is 3-7 hours; when the fermentation temperature is 40-45°C, fermentation time is 3-5 hours.

[0044]

It is preferable that formation of edible gels of the present invention is carried out in a gradual manner; due to gradual decrease in pH by fermentation, a smooth gel can be formed. Moreover, since it can be adjusted to a fairly high pH value even within the acidic range, it is possible to produce a gel with reduced acidity. For example, in the case of lactic acid fermentation, pH of the gel formation process is preferably 5.0-6.0, more preferably 5.2-6.0, and even more preferably 5.5-6.0.

[0045]

In one embodiment of the present invention, a whey powder may be blended in raw ingredients. By the addition of a whey powder, fermentation with a microorganism, in particular with a lactic acid bacterium, can be carried out efficiently even within a short time, and fermentation time and refrigeration preservability can be controlled. Whey powder to be blended may be set as appropriate depending on conditions of fermentation process; it is blended in the raw ingredients at 0.2-1.0%, preferably 0.3-0.7%, and even more preferably 0.35-0.5%.

[0046]

Incidentally, the term "whey powder" used in the present specification encompasses the following: as defined in the Ministerial Ordinance on Milk and Milk products Concerning

Compositional Standards, etc., the product which is obtained from the whey that has been produced either by fermenting milk with lactic acid bacteria, or by the addition of enzymes or acid to milk and then removing almost all the water and reducing to powder.

[0047]

In one embodiment of the present invention, similar to the method of manufacturing hard yogurt, "after-fermentation" may be appropriately used, wherein raw ingredients are filled in a container then fermentation is carried out. Accordingly, it is possible to use a manufacturing process by after-fermentation of fermented milk, as it is. Meanwhile, depending on the purpose, "pre-fermentation" may be used, wherein fermented materials after fermentation are filled in a container.

[0048]

The present invention is described in detail with reference to the following examples; however, the present invention is not limited to each example.

[Example]

[0049]

In the raw materials, in addition to WPC (Hilmar 8800, Hilmar Cheese Company), WPI (Lacprodan DI 9224, Arla Foods) and WPI (ALACEN WPI 895, Fonterra), as well as α -lactalbumin (Davisco Foods International, Inc.) and β -lactoglobulin (Davisco Foods International, Inc.) were used as the whey protein.

[0050]

WPC (Hilmar 8800, Hilmar Cheese Company) has a protein content of 78%, wherein β -lactoglobulin is contained in said protein in a proportion of 23%, and α -lactalbumin is contained in said protein in a proportion of approximately 75%. WPI (Lacprodan DI 9224, Arla Foods) has a protein content of 87%,

wherein β -lactoglobulin is contained in said protein in a proportion of 47%, and α -lactalbumin is contained in said protein in a proportion of approximately 50%. WPI (ALACEN WPI 895, Fonterra) has a protein content of 90%, wherein β -lactoglobulin is contained in said protein in a proportion of 80%, and α -lactalbumin is contained in said protein in a proportion of approximately 20%.

[0051]

In addition, the α -lactalbumin (Davisco Foods International, Inc.) has a protein content of 90% or more, wherein α -lactalbumin and β -lactoglobulin are contained in said protein in a proportion of 90% or more and less than 5%, respectively. The β -lactoglobulin (Davisco Foods International, Inc.) has a protein content of 90% or more, wherein α -lactalbumin and β -lactoglobulin are contained in said protein in a proportion of less than 5% and 90% or more, respectively.

[0052]

As other raw ingredients, lactose (Leprino Foods Company), a whey powder (lactose content of 75-80%; whey powder from Meiji Dairies Corporation) and lactic acid bacteria (*Lactobacillus bulgaricus* and *Streptococcus thermophilus* isolated from Meiji Bulgaria Yogurt, Meiji Dairies Corporation) were used.

[0053] Example 1

Influences of kind of WPC and WPI on the flavor of edible gel

Regarding each of the sample numbers (sample numbers: 1-1, 1-2 and 1-3), milk-related processed foods (edible gels) was produced with the composition of raw ingredients listed in Table 1.

Raw ingredients of each sample (excluding lactic acid bacteria) were prepared in accordance with the composition listed

in Table 1.

[Table 1]

Table 1. Influences of the kind of WPC and WPI on the flavor of the milk-related processed foods

Sample number		(1-1)	(1-2)	(1-3)
WPI (Hilmar 8800)	[kg]	5.77		
WPI (Lacprodan DI 9224)	[kg]		5.17	
WPI (ALACEN WPI 895)	[kg]			5.00
Whey powder	[kg]	0.30	0.30	0.30
Frozen concentrate of lactic acid bacteria	[kg]	0.15	0.15	0.15
Water	[kg]	93.78	94.38	94.55
(Total)	[kg]	100.0	100.0	100.0
Total protein	[wt%]	4.54	4.54	4.54
β -LG concentration	[wt%]	1.04	2.12	3.60
Proportion of β -LG in total protein (percentage)	[wt%]	22.8	46.6	79.3
Clear flavor		×	×	○

[0054]

After preparing and dissolving the raw ingredients (excluding lactic acid bacteria), each of them was heat sterilized at 95°C for 5 minutes. After heating, the raw ingredients were cooled to 40-45°C, to which lactic acid bacteria (*Lactobacillus bulgaricus* and *Streptococcus thermophilus* isolated from Meiji Bulgaria Yogurt, Meiji Dairies Corporation) were added at 10^5 - 10^7 CFU/mL, then they were filled into containers of various shapes. After filling, the containers were transferred to a constant temperature box and fermentation was carried out at 43°C for 3 hours. After fermentation, obtained gels were cooled to 5°C in a refrigerator and stored for more than 7 days.

[0055]

For the gel of each sample number, sensory evaluation (5 expert panels) was performed; as a result, even when the amount of protein of each sample is almost identical, flavor differs depending on the kind of whey protein. Among them, with respect to the gels of sample No. 1-3 that have the highest β -lactoglobulin content, milk smell is suppressed and clear flavor was obtained.

Here, only when all the 5 expert panels gave positive evaluation (clear flavor with suppressed milk smell) in each of the sensory evaluation criteria, "o" mark was given in the table.

[0056] Example 2

Influences of the proportion of β -lactoglobulin (β -LG) in total protein on the flavor of edible gel

Similar to the method of Example 1, regarding each sample number (Sample Nos. 2-1, 2-2, 2-3, 2-4 and 2-5), milk-related processed foods (edible gels) were manufactured in accordance with the composition of raw ingredients listed in Table 2.

[Table 2]

Table 2. Influences of the proportion of β -LG on the flavor of the milk-related processed foods

Sample number		(2-1)	(2-2)	(2-3)	(2-4)	(2-5)
α -lactalbumin (raw ingredient)	[kg]	3.00	2.25	1.50	0.75	0.00
β -lactoglobulin (raw ingredient)	[kg]	0.00	0.75	1.50	2.25	3.00
Whey powder	[kg]	0.30	0.30	0.30	0.30	0.30
Frozen concentrate of lactic acid bacteria	[kg]	0.15	0.15	0.15	0.15	0.15
Water	[kg]	96.55	96.55	96.55	96.55	96.55
(Total)	[kg]	100.0	100.0	100.0	100.0	100.0
Total protein	[wt%]	2.99	2.99	2.99	2.99	2.99
β -LG concentration	[wt%]	0.00	0.75	1.47	2.21	2.93
Proportion of β -LG in total protein (percentage)	[wt%]	0.0	25.0	49.0	74.0	98.0
Clear flavor		×	×	×	o	O
pH		-	5.46	5.30	5.28	5.21
Measured value of color difference	L	-	76.95	71.10	64.50	57.70
	a	-	-1.89	-1.97	-1.90	-1.69
	b	-	-3.43	-5.70	-1.69	-9.69

[0057]

For the gel of each sample number, sensory evaluation (5 expert panels) was performed; as a result, clear flavor was obtained for the gels having 74% or more of the proportion (percentage) of β -lactoglobulin in the total protein of raw ingredients (Sample Nos. 2-4 and 2-5). On the other hand, clear flavor was not obtained for the gels having a low proportion

(percentage) of β -lactoglobulin in the total protein (Sample Nos. 2-1, 2-2 and 2-3). In addition, color differences (L value, a value, b value) of the gels obtained were measured using a spectral colorimeter, color analyzer TC1800J (Tokyo Denshoku Co., Ltd.).

[0058]

Results of further detailed sensory evaluation and visual evaluation are shown in Table 3.

[Table 3]

Table 3. Influences of the proportion of β -LG on visual evaluation and sensory evaluation of the milk-related processed foods

Sample No.	Visual evaluation and sensory evaluation
(2-1)	Cloudy, gel is not formed, unpleasant taste is noticed.
(2-2)	White gel is slightly formed, unpleasant taste is noticed.
(2-3)	White soft gel is formed, unpleasant taste is noticed.
(2-4)	Translucent gel is formed, almost no unpleasant taste is noticed.
(2-5)	Translucent gel is formed, almost tasteless and odorless.

[0059]

Results of the sensory evaluation and visual evaluation show that, as the proportion (percentage) of β -lactoglobulin in the total protein increases, the level of unpleasant taste decreases and the flavor of the gel approaches tasteless and odorless, and furthermore, cloudiness of the gel decreases and translucent gel is formed. On the other hand, as the proportion of α -lactalbumin increases, the gel becomes cloudy and tends to have more unpleasant taste.

[0060] Example 3

Influences of the proportion of β -lactoglobulin (β -LG) in total protein on properties

Similar to the method of Example 1, regarding each sample number (Sample Nos. 3-1, 3-2, 3-3, 3-4 and 3-5), milk-related processed foods (edible gels) were manufactured in accordance

with the composition of raw ingredients listed in Table 4.

[Table 4]

Table 4. Influences of β -LG concentration on the flavor of the milk-related processed foods

Sample number		(3-1)	(3-2)	(3-3)	(3-4)	(3-5)
WPI (ALACEN WPI 895)	[kg]	1.00	3.00	5.00	7.00	9.00
Whey powder	[kg]	0.30	0.30	0.30	0.30	0.30
Frozen concentrate of lactic acid bacteria	[kg]	0.15	0.15	0.15	0.15	0.15
Water	[kg]	98.55	96.55	94.55	92.55	90.55
(Total)	[kg]	100.0	100.0	100.0	100.0	100.0
Total protein concentration	[wt%]	0.94	2.74	4.54	6.34	8.14
β -LG concentration	[wt%]	0.72	2.16	3.60	5.04	6.48
Proportion of β -LG in total protein (percentage)	[wt%]	76.6	78.8	79.3	79.5	79.6
Breaking strength	[g]	0.0	41.0	107.6	216.7	306.1
Clear flavor		x	o	o	o	o

[0061]

For the gel of each sample number, breaking strength test and sensory evaluation (5 expert panels) were performed; as a result, clear flavor was obtained for the gels having 2.16% or more of the β -lactoglobulin concentration in the entire gel (Sample Nos. 3-2, 3-3, 3-4 and 3-5). In addition, these gels have an appropriate hardness of 41.0 g or more.

In the breaking strength test, a texture analyzer TA.XT Plus (Stable Micro Systems, Ltd.) was used and measurement was carried out with P5/S probe.

[0062]

Results of further detailed sensory evaluation and visual evaluation are shown in Table 5.

[Table 5]

Table 5. Influences of β -LG concentration on visual evaluation and sensory evaluation of the milk-related processed foods

Sample No.	Visual evaluation and sensory evaluation
(3-1)	Cloudy, gel is not formed, unpleasant taste is noticed.
(3-2)	Translucent and soft gel is formed, almost tasteless and odorless.
(3-3)	Translucent gel is formed, almost tasteless and odorless.

- | | |
|-------|--|
| (3-4) | Translucent and hard gel is formed, almost no unpleasant taste is noticed. |
| (3-5) | Translucent and hard gel is formed, almost no unpleasant taste is noticed. |
-

[0063]

Results of the sensory evaluation and visual evaluation show that, in agreement with the results of Example 2, as the concentration of β -lactoglobulin in the total protein of raw ingredients increases, the level of unpleasant taste decreases and the flavor of the gel approaches tasteless and odorless, and furthermore, cloudiness of the gel decreases and translucent gel is formed.

[0064] Example 4

Influences of whey powder on the fermentability in formation of edible gel

Similar to the method of Example 1, regarding each sample number (Sample Nos. 4-1, 4-2, 4-3, 4-4, 4-5, 4-6, 4-7, 4-8 and 4-9), milk-related processed foods (edible gels) were manufactured in accordance with the composition of raw ingredients listed in Table 6. In addition, changes in pH with time in each sample were investigated, and results are shown in Table 6 and Fig. 1.

[Table 6]

Table 6. Influences of the concentration (blending) of lactose or whey powder on the fermentability (pH changes over time) of the milk-related processed foods (storage temperature 5 °C)

Sample number	(4-1)	(4-2)	(4-3)	(4-4)	(4-5)	(4-6)	(4-7)	(4-8)	(4-9)
WPI (ALACEN WPI 895)	[kg]	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Whey powder	[kg]	0.00	0.10	0.20	0.30	0.50	1.00	2.00	3.00
Lactose	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Frozen concentrate of lactic acid bacteria	[kg]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Water	[kg]	94.85	94.75	94.65	94.55	94.35	93.85	92.85	91.85
(Total)	[kg]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total protein concentration	[wt%]	4.50	4.51	4.53	4.54	4.57	4.63	4.77	4.90
β -LG concentration	[wt%]	3.60	3.60	3.60	3.60	3.62	3.65	3.70	3.76
Proportion of β -LG in total protein (percentage)	[wt%]	80.0	79.8	79.5	79.3	79.2	78.8	77.6	80.0
Fermentability	0.0 hr.	6.95	6.98	6.96	6.94	6.92	6.88	6.86	6.89
pH[-]	1.0 hr.	6.97	6.90	6.92	6.88	6.85	6.78	6.72	6.85
	2.0 hrs.	6.97	6.70	6.62	6.63	6.53	6.41	6.21	6.85
	3.0 hrs.	6.89	6.41	6.22	6.17	5.96	5.71	5.30	6.42
	3.3 hrs.					5.45			
	3.75 hrs.					5.65			
	4.0 hrs.	6.90	6.31	5.98	5.86		5.10	4.79	6.27
	4.3 hrs.					5.44			
	4.75 hrs.				5.66				
	5.0 hrs.	6.91	6.25	5.84		5.26	4.73	4.60	6.10
	5.5 hrs.				5.52				
	6.0 hrs.	6.98	6.21	5.82		5.06	4.59	4.48	5.99
	7.0 hrs.	6.98			5.31		4.39	4.34	5.87

[0065]

It was shown that, by blending a whey powder in raw ingredients, fermentability of lactic acid fermentation changes and the decreasing rate of pH also changes. Compared to the sample (Sample No. 4-1) in which neither whey powder nor lactose is added, the samples in which whey powder alone is added (Sample Nos. 4-2, 4-3, 4-4, 4-5, 4-6, 4-7 and 4-8; 0-3.0% of whey powder) showed more effective progress of lactic acid fermentation than the sample in which lactose alone is added (Sample No. 4-9; 3.6% lactose). In addition, the fermentability was shown to be dependent on the concentration of a whey powder.

[0066]

Furthermore, influences of blending a whey powder on the refrigeration preservability of gels were investigated; results are shown in Table 7 and Fig. 2.

[Table 7]

Table 7. Influences of the concentration (blending) of lactose or a whey powder on the refrigeration preservability (pH changes over time) of the milk-related processed foods (storage temperature 5 °C)

Sample number	(4-1)	(4-2)	(4-3)	(4-4)	(4-5)	(4-6)	(4-7)	(4-8)	(4-9)
WPI (ALACEN WPI 895)	[kg]	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Whey powder	[kg]	0.00	0.10	0.20	0.30	0.50	1.00	2.00	3.00
Lactose	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Frozen concentrate of lactic acid bacteria	[kg]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Water	[kg]	94.85	94.75	94.65	94.55	94.35	93.85	92.85	91.85
(Total)	[kg]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total protein concentration	[wt%]	4.50	4.51	4.53	4.54	4.57	4.63	4.77	4.90
β -LG concentration	[wt%]	3.60	3.60	3.60	3.60	3.62	3.65	3.70	3.76
Proportion of β -LG in total protein (percentage)	[wt%]	80.0	79.8	79.5	79.3	79.2	78.8	77.6	76.7
Refrigeration preservability	0 day			5.80	5.48	5.79	5.54		5.83
pH[-]	1 day			5.70	5.39	5.60	5.12		5.70
	10 day			5.75	5.37	5.45	4.83		5.39
	16 day			5.70	5.36	5.47	4.76		5.36

[0067]

The results shown in Table 7 and Fig. 2 demonstrate that when a low concentration of whey powder (e.g., 0.3-0.5%) is blended, the decreasing rate of pH under refrigeration storage (0-16 days) can be reduced compared to the case of addition of lactose, and the stability of pH of the gel under refrigeration storage can be adjusted.

[0068] Example 5

Influences of heating temperature on the properties of edible gel

Regarding each sample number (Sample Nos. 5-1, 5-2, 5-3, 5-4, 5-5 and 5-6), dairy products (edible gels) were manufactured with a method similar to that in Example 1 except that samples with the composition listed in Table 8 were heat-sterilized at 50-130°C (for 5 min or the time to reach the temperature).

[Table 8]

Table 8. Influences of heating (sterilization) conditions on the properties of the milk-related processed foods

Sample number		(5-1)	(5-2)	(5-3)	(5-4)	(5-5)	(5-6)
WPI (ALACEN WPI 895)	[kg]	5.00	5.00	5.00	5.00	5.00	5.00
Whey powder	[kg]	0.30	0.30	0.30	0.30	0.30	0.30
Frozen concentrate of lactic acid bacteria	[kg]	0.15	0.15	0.15	0.15	0.15	0.15
Water	[kg]	94.55	94.55	94.55	94.55	94.55	94.55
(Total)	[kg]	100.0	100.0	100.0	100.0	100.0	100.0
Total protein concentration	[wt%]	4.54	4.54	4.54	4.54	4.54	4.54
β -LG concentration	[wt%]	3.60	3.60	3.60	3.60	3.60	3.60
Proportion of β -LG in total protein	[wt%]	79.3	79.3	79.3	79.3	79.3	79.3
Heating temperature	[°C]	50	65	80	95	110	130
Heating time	[min]	5	5	5	5	Until reach the temp.	Time to reach the temp.

Breaking strength	[g]	0	0	48.7	107.6	115.3	102.4
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[0069]

Results of Table 8 show that in the case of heating temperature of 80-130°C (Sample Nos. 5-3, 5-4, 5-5 and 5-6), gels with appropriate hardness were obtained, and the hardest gel was obtained with the heating temperature of 110°C. On the other hand, in the case of insufficient heating temperature (Sample Nos. 5-1 and 5-2), sufficient gel formation was not observed under this condition.

[0070] Example 6

Evaluation of compatibility of edible gel with flavor of Japanese food

Similar to the method of Example 1, regarding each sample number (Sample Nos. 6-1, 6-2, 6-3, and 6-4), milk-related processed foods (edible gels) were manufactured in accordance with the composition of raw ingredients listed in Table 9. Compatibility of flavors with Japanese condiments and food materials was investigated (5 expert panels), and results are shown in Table 9. Here, only when all the 5 expert panels gave positive evaluation (evaluation of good compatibility of flavor) in the sensory evaluation, "o" mark was given in the table.

[Table 9]

Table 9. Evaluation of compatibility of flavor of the milk-related processed foods with Japanese food

Sample number		(6-1)	(6-2)	(6-3)	(6-4)
WPI (ALACN WPI 895)	kg	5.00	5.00	5.00	5.00
Whey powder	kg	0.30	0.30	0.30	0.30
Frozen concentrate of lactic acid bacteria	kg	0.15	0.15	0.15	0.15
Water	kg	94.55	94.55	94.55	94.55
(Total)	kg	100.0	100.0	100.0	100.0
Total protein	wt%	4.54	4.54	4.54	4.54
β-LG concentration	wt%	3.60	3.60	3.60	3.60
Proportion of β-LG in total protein	wt%	79.3	79.3	79.3	79.3

Compatibility of the flavor with Japanese flavors and materials	Soy sauce	o			
	Miso		o		
	Ponzu sauce			o	
	Nori tsukudani				o

[0071]

When the gels were ingested in combination with soy sauce, miso, ponzu sauce (citrus flavored and soy sauce based sauce) or Nori tsukudani (laver simmered in soy sauce, and sugar and/or mirin etc.), their compatibility was good in any cases. In addition, since the gels have appropriate hardness and transparency, it was easy to add various colors and to process them into various shapes (Fig. 3).

[Industrial Applicability]

[0072]

The present invention relates to a dairy product using whey and a manufacturing method thereof, and the present invention contributes to food industries by providing unique dairy products.

[Claims]

1. A gelled food product having a shape made by gelling raw ingredients comprising protein, wherein the raw ingredients comprise:

- whey powder, and
- β -lactoglobulin in a proportion of 70-100 wt% in the total protein,

and wherein gelling is carried out by fermentation with microorganisms.

2. The gelled food product according to Claim 1, wherein the raw ingredients comprise β -lactoglobulin in a proportion of 2-10 wt%.

3. The gelled food product according to Claim 1 or 2, wherein the breaking strength is 40-500 g.

4. The gelled food product according to any one of Claims 1 to 3, wherein the pH is 5.0-6.0.

5. The gelled food product according to any one of Claims 1 to 4, which is translucent and/or tasteless and odorless.

6. The gelled food product according to any one of Claims 1 to 5, wherein the L value is 50-70.

7. The gelled food product according to any one of Claims 1 to 6, wherein the raw ingredients comprise 2.5-14% total protein.

8. The gelled food product according to Claim 1, wherein the raw ingredients comprise whey powder in a proportion of 0.2 to 1.0%.

9. The gelled food product according to any one of Claims 1 to 8, further comprising a Japanese condiment selected from a group consisting of soy sauce, Miso, and Ponzu sauce and/or a sweetener.

10. A method of manufacturing a gelled food product having a shape, comprising:

- a raw-ingredient blending step, of blending raw ingredients comprising whey powder and β -lactoglobulin, wherein the raw materials are blended such that β -lactoglobulin is contained in a proportion of 70-100 wt% in the total protein,
- a heating step after said raw-ingredient blending step, and
- a fermenting step by a microorganism after said heating step.

11. The method according to Claim 10, wherein the heating step is carried out at 80-150°C.

12. The method according to Claim 10 or 11, wherein the fermenting step is lactic acid fermentation, and the gel is formed at pH of 5.0-6.0.

13. The method according to any one of Claims 10 to 12, wherein in the raw-ingredient blending step, 0.2-1.0 wt% of a whey powder is blended.

14. The method according to any one of Claims 10 to 13, wherein the fermenting step is carried out by after-fermentation.

15. The method according to any one of Claims 10 to 14, wherein in the raw-ingredient blending step, the raw ingredients are blended such that β -lactoglobulin is contained in a proportion of 2-10 wt%.

16. The method according to any one of Claims 10 to 15, wherein the microorganism is a lactic acid bacterium.

17. A gelled food product having a shape manufactured by the method according to any one of Claims 10 to 16.

18. A gelled food product having a shape made by gelling raw ingredients comprising protein, wherein the raw ingredients comprise:

- whey powder, and
- β -lactoglobulin in a proportion of 70-100 wt% in the total protein,

and wherein the L value is 50-70.

19. The gelled food product according to Claim 18, wherein the raw ingredients comprise 2.5-14% total protein.

20. The gelled food product according to Claim 18 or 19, further comprising a Japanese condiment selected from a group consisting of soy sauce, Miso, and Ponzu sauce and/or a sweetener.

21. The gelled food product according to any one of Claims 1 to 9 and 17 to 20, which is eaten as-is or with a condiment and/or a sweetener.