SPECIFICATION

# LOW CALORIE FERMENTED MILK AND METHOD FOR PRODUCING SAME

[Technical Field]

[0001]

The present invention relates to a low calorie fermented milk and a method for producing same.

[Background Art]

[0002]

Fermented milk is a widely-consumed health food, and in recent years the demand for low calorie fermented milk has been increasing. However, fermented milk with a low milk fat content tends to have impaired flavor and texture compared with normal fermented milk. A method for improving the milk fat feel of low fat fermented milk by deoxygenating starting milk has already been disclosed (Patent Document 1).

[0003]

On the other hand, since fermented milk undergoes water separation (whey off) during refrigerated storage, etc., there is a problem in terms of product quality. Because of this, in order to suppress water separation of fermented milk, a stabilizer such as gelatin is generally added and, other than that, methods in which milk protein or whey protein concentrate, etc. is added are also known (Patent Documents 2 to 4). In addition, Patent Document 5 discloses a method for producing fermented milk involving lactose

degradation and deoxygenation; this is a method for maintaining the flavor, etc. of fermented milk, and there is no mention of suppressing water separation of fermented milk.

[Prior Art Documents]

[Patent Documents]

[0004]

[Patent Document 1] Japanese Patent No. 3968108

[Patent Document 2] JP, B, H03-52940

[Patent Document 3] JP, A, H03-19838

[Patent Document 4] Japanese Patent No. 2966330

[Patent Document 5] WO2010/098086

[Summary of the Invention]

[Problems to be Solved by the Invention]

[0005]

In fermented milk having a low milk fat content, it is particularly easy for water separation to occur, and adding a general milk protein or concentrate of whey protein (whey protein concentrate (WPC), whey protein isolate (WPI)) might degrade the flavor, etc. of the fermented milk. Furthermore, adding a stabilizer such as gelatin also impairs the natural flavor or texture of normal fermented milk.

[0006]

Therefore, it is an object of the present invention to solve the above-mentioned problems of the conventional art in a method for producing fermented milk using starting milk having a low milk

fat content, to suppress water separation without adding a stabilizer, and to provide a low calorie fermented milk having good flavor and a method for producing same.

[Means for Solving the Problems]

[0007]

While carrying out an intensive investigation in order to solve the above-mentioned problems, the present inventors have found that water separation of fermented milk having a low milk fat content is greatly suppressed by decreasing the dissolved oxygen concentration of starting milk and degrading lactose in starting milk by means of a lactase. Furthermore, it has been found that blending α-lactalbumin (α-La) and/or β-lactoglobulin (β-Lg) at a predetermined proportion enables water separation to be further suppressed and fermented milk with a firm curd to be obtained, and as a result of further research the present invention has been accomplished.

[0008]

That is, the present invention relates to a low calorie fermented milk and a method for producing same as follows.

[1] A method for producing fermented milk having a low fat content, the method including decreasing the dissolved oxygen concentration of a starting milk at the time of starting fermentation and adding a lactase to the starting milk before starting fermentation.

[2] The method according to [1], wherein the fermented milk having a low fat content has a milk fat content of 0.01 to 2 wt%.

[3] The method according to [1] or [2], wherein the dissolved oxygen concentration of the starting milk at the time of starting fermentation is no greater than 5 ppm.

[4] The method according to any one of [1] to [3], wherein the starting milk contains a high concentration of α-lactalbumin or β-lactoglobulin.

[5] The method according to [4], wherein the concentration of α-lactalbumin or β-lactoglobulin is 0.5 to 1.5 wt% in the starting milk.

[6] The method according to any one of [1] to [5], wherein the starting milk has a total protein content of 3 to 6 wt% and/or a total solids content of 8 to 11 wt%.

[7] The method according to any one of [1] to [6], wherein lactose degradation is carried out during fermentation.

[8] The method according to any one of [1] to [7], wherein the percentage lactose degradation is 75% to 90%.

[9] The method according to any one of [1] to [8], wherein a stabilizer is not added.

[10] Fermented milk produced by the method according to any one of [1] to [10].

[11] Fermented milk having a percentage centrifugal water separation of 50% to 10%, a hardness of 30 to 70 g, and a total calories of no greater than 50 kcal/100 g and not containing a stabilizer.

[12] The fermented milk according to [11], wherein it has a milk fat content of 0.01 to 2 wt%, a total protein content of 3 to 6

wt%, and a total solids content of 8 to 11 wt%.

[13] The fermented milk according to [11] or [12], wherein it has a lactose content of 0.01 to 1 wt%.

[Effects of the Invention]

[0009]

The method for producing fermented milk of the present invention can suppress water separation of fermented milk without adding (blending) a stabilizer, etc. even when using a starting milk for which the total solids content and milk fat content are low. Furthermore, blending α-lactalbumin and/or β-lactoglobulin at a predetermined proportion further suppresses water separation and enables fermented milk with a firm curd to be obtained. Because of this, the fermented milk of the present invention has excellent storage stability and is suitable for long distance transport.

[0010]

Since the method for producing fermented milk of the present invention degrades lactose in starting milk by means of a lactase, not only is sweetness imparted to fermented milk but also the fermentation step is stabilized. Because of this, the flavor and quality of the fermented milk can also be maintained, and a low calorie fermented milk for which water separation is suppressed can be provided in a stable manner. Moreover, in accordance with a production method in which fermentation is carried out while the dissolved oxygen concentration of a starting milk is decreased, the milk fat-derived flavor and texture of normal fermented milk

can be obtained even by the use of a starting milk having low fat content.

[0011]

Furthermore, in the method for producing fermented milk of the present invention, since the α-lactalbumin content or the β-lactoglobulin content in the total starting milk protein is high, unlike a case in which a general milk protein or concentrate of whey protein (WPC, WPI), etc. is added, there is little effect on the flavor of the fermented milk, such as an off-flavor. By the use of a WPC that has a higher α-lactalbumin content or β-lactoglobulin content than a general concentrate of whey protein (WPC, WPI), even if it is a WPC having a protein content of for example no greater than 80%, blending it into a starting milk enables fermented milk with a firm curd to be produced stably while using a concentrate of whey protein as a milk component in the product description.

[0012]

Therefore, the method for producing fermented milk of the present invention can efficiently improve the quality of fermented milk having a low milk fat content, and can provide a low calorie fermented milk that has a good flavor, a low total solids content, and a low fat content.

[Modes for Carrying Out the Invention]

[0013]

The method for producing fermented milk of the present

invention includes a step of decreasing the dissolved oxygen concentration in a starting milk (deoxygenation step) and a step of degrading lactose in the starting milk by means of a lactase (lactose degradation step), the starting milk preferably containing α-lactalbumin (α-La) and/or β-lactoglobulin (β-Lg) at a predetermined proportion.

[0014]

The 'fermented milk' referred to in the present specification includes the 'fermented milk' defined under the Ministerial Ordinance on Milk and Milk Products Concerning Compositional Standards, etc. (Milk, etc. Ministerial Ordinance). For example, the fermented milk is one obtained by fermenting milk such as raw milk, cow's milk, special milk, raw goat's milk, pasteurized goat's milk, raw sheep's milk, composition modified milk, low fat milk, skimmed milk, or processed milk, or milk, etc. containing an equal or greater amount of milk solids-not-fat, with a lactic acid bacterium or a yeast and then forming a paste or liquid, or the frozen product. They include various types of yoghurt, but in the present specification it is typically a set type yoghurt.

[0015]

In general, a set type yoghurt such as a plain yoghurt is produced by charging a container with a starting milk and subsequently effecting fermentation (after-fermentation). On the other hand, a soft yoghurt or a drinking yoghurt is produced by subjecting fermented milk that has been fermented to atomization or homogenization and then charging a container therewith

(pre-fermentation).

[0016]

Starting milk

The 'starting milk' is a starting material for fermented milk such as a yoghurt, and is also called yoghurt mix or fermented milk mix. In the present invention, a known starting milk may be used as appropriate. The starting milk includes that prior to pasteurization and that after pasteurization. Specific materials (starting materials) of the starting milk may include water, raw milk, pasteurized milk, skimmed milk, whole milk powder, skimmed milk powder, buttermilk, butter, cream, etc.

[0017]

The production method of the present invention may be applied to the production of a regular fermented milk, but is particularly suitable for producing a low calorie fermented milk, and the starting milk used in this case is preferably a low-fat milk and, in order to obtain an appropriate hardness (curd tension), preferably has a predetermined total protein content. The low calorie fermented milk of the present invention is mainly due to the low total solids content and the low fat content.

The starting milk used in the production method of the present invention is not particularly limited but preferably has the following components. In the present specification, % means wt% (w/w).

[0018]

The milk fat content of the starting milk is desirably no

greater than 3%, preferably 0.01% to 2%, more preferably 0.05% to 1%, and yet more preferably 0.1% to 0.5%.

The total solids content of the starting milk is desirably no greater than 11%, preferably 8% to 11%, more preferably 8.5% to 10.5%, and yet more preferably 9% to 10.2%.

The total protein content of the starting milk is desirably 3% to 6%, more preferably 3.5% to 5.5%, and yet more preferably 4% to 5%.

The lactose content of the starting milk is desirably 5% to 8%, more preferably 5.5% to 7.5%, and yet more preferably 6% to 7%.

[0019]

Whey protein may be added to (blended with) the starting milk used in the production method of the present invention, and a whey protein concentrate having a high α-lactalbumin content or β-lactoglobulin content is preferably used.

The 'concentrate of whey protein' used in the present specification includes a whey protein concentrate (Whey Protein Concentrate: 'WPC') obtained by concentrating the main protein, etc. of whey by an ultrafiltration (Ultrafiltration: UF) method, etc. followed by drying; defatted WPC (low fat high protein) obtained by removing fat from whey by a microfiltration (Microfiltration: MF) method or a centrifuging method and then concentrating by an UF method, followed by drying; a whey protein isolate (Whey Protein Isolate: 'WPI') obtained by selectively fractionating the main protein, etc. of whey by an ion-exchange

resin method, a gel filtration method, etc., followed by drying; desalted whey obtained by desalting by a nanofiltration (Nanofiltration: NF) method, an electrodialysis method, etc., followed by drying; and mineral concentrated whey obtained by precipitating a whey-derived mineral component, followed by concentration by a centrifuging method, etc. The main 'whey protein' includes α-lactalbumin (α-La), β-lactoglobulin (β-Lg), etc.

[0020]

In the present invention, it is preferable to use a whey protein concentrate (WPC) or whey protein isolate (WPI) having a high α-lactalbumin content or β-lactoglobulin content, and it is more preferable to use a whey protein concentrate (WPC) having a high α-lactalbumin content or β-lactoglobulin content. A plurality of types thereof may be used at the same time.

[0021]

α-Lactalbumin, a whey protein having a high α-lactalbumin content, β-lactoglobulin, and a whey protein having a high β-lactoglobulin content may be obtained by for example a method involving selective separation from whey. Such separation methods include techniques such as an ion-exchange chromatographic method, hydrophobic chromatography, a gel filtration method, an ultrafiltration method, an isoelectric focusing method, a method involving coprecipitaton by means of a polyelectrolyte polymer, a salting-out method, and a temperature treatment separation method, and are also disclosed by JP, A, H07-203863, JP, A,

S61-268138, JP, A, S63-39545, etc.

[0022]

Furthermore, α-lactalbumin (α-La) and β-lactoglobulin (β-Lg) themselves are commercially available, and WPCs and WPIs having a high content thereof are also commercially sold or manufactured. For example, α-La rich WPC (Domo), β-Lg rich WPC (Domo), α-La rich WPC (Davisco), β-Lg rich WPC (Davisco), α-La rich WPC (Leprino Foods), β-Lg rich WPC (Leprino Foods), ALACEN WPI 895 (Fonterra), etc. may be used. Here, those having an α-lactalbumin content of preferably 60% to 100%, and more preferably 80% to 95% or a β-lactoglobulin content of preferably 65% to 100%, and more preferably 80% to 95%, in the total protein of WPC and WPI, such as α-La rich WPC or β-Lg rich WPC may be used suitably. Furthermore, α-lactalbumin and β-lactoglobulin themselves or a combination of these WPCs and WPIs may also be used.

Those having in the total solids content of WPC and WPI a protein content of preferably 30% to 95%, more preferably 35% to 80%, and yet more preferably 65% to 75%, such as α-La rich WPC or β-Lg rich WPC, may also be suitably used.

[0023]

In the method for producing fermented milk of the present invention, the starting milk preferably contains a high concentration of α-lactalbumin or β-lactoglobulin.

α-Lactalbumin is desirably contained at a proportion of at least 7% in the total protein of the starting milk, preferably 12% to 40%, and more preferably 17% to 25%. Further, of the entire

starting milk, it is desirably contained at a proportion of at least 0.3%, preferably 0.5% to 1.5%, and more preferably 0.7% to 1%.

β-Lactoglobulin is desirably contained at a proportion of at least 10% in the total protein of the starting milk, preferably 12% to 40%, and more preferably 15% to 25%. Further, of the entire starting milk, it is desirably contained at a proportion of at least 0.4%, preferably 0.5% to 1.5%, and more preferably 0.6% to 1%.

[0024]

In the method for producing fermented milk of the present invention, the starting milk preferably contains α-La rich WPC or β-Lg rich WPC.

The amount of α-La rich WPC blended with the starting milk depends on the content of α-La in the α-La rich WPC, but it is desirably contained at a proportion of at least 0.5% of the entire starting milk, preferably 0.6% to 2%, and more preferably 0.75% to 1.5%.

The amount of β-Lg rich WPC blended with the starting milk depends on the content of β-Lg in the β-Lg rich WPC, but it is desirably contained at a proportion of at least 0.55% of the entire starting milk, preferably 0.65% to 2%, and more preferably 0.8% to 1.5%.

[0025]

When the concentration of α-lactalbumin or β-lactoglobulin is in a preferred range, an effect in suppressing water separation can be expected. When these concentrations become higher, the hardness tends to increase. When in these preferred ranges,

off-flavors hardly ever occur.

The term 'water separation' used in the present specification includes a phenomenon in which the whey liquid separates, and can be measured as for example the percentage centrifugal water separation obtained by centrifugation.

[0026]

The starting milk is homogenized, pasteurized, and then cooled to a predetermined temperature (to the level of the fermentation temperature). Subsequently, it is inoculated with a starter; in the case of pre-fermentation, it is charged into a tank, etc. and fermentation is started, and in the case of after-fermentation, it is charged into an individual serving container for distribution, etc. and fermentation is started.

Furthermore, a stabilizer, etc. may be added, but since in the method for producing fermented milk of the present invention fermented milk that has a firm curd and is resistant to water separation can be obtained without adding a stabilizer, etc., it is preferable not to add a stabilizer. The 'stabilizer' referred to in the present specification means a stabilizer that is generally used in fermented milk, such as gelatin or a viscosity-increasing polysaccharide such as pectin, agar, starch, carboxymethylcellulose, carrageenan, or xanthan gum.

[0027]

Deoxygenation step

The deoxygenation step is a step for removing oxygen present in a starting milk. As a method for lowering the dissolved oxygen

concentration in a starting milk, for example, a method involving gas replacement with an inert gas, a membrane separation method using a deoxygenation membrane, a method involving degassing at low pressure or under vacuum, etc. may be used. With regard to the deoxygenation step, deoxygenation may be carried out until the amount of oxygen dissolved in the starting milk (dissolved oxygen concentration, DO) attains a degree of for example no greater than 5 ppm, preferably no greater than 3 ppm, and more preferably no greater than 2 ppm.

[0028]

The lower the dissolved oxygen concentration of the starting milk at the time of starting fermentation the better. For example, when the temperature of the starting milk is on the order of 40°C, it is preferably no greater than 5 ppm, and more preferably no greater than 3 ppm. Decreasing the dissolved oxygen concentration allows the fermentation time to be reduced, and even when the fermentation temperature is lowered, fermentation can be carried out by setting the fermentation time so as to be in a relatively short time range of 3 to 7 hours. These deoxygenation steps are also described in Japanese Patent Nos. 3666871, 3644505, and 3968108.

[0029]

The deoxygenation step may be carried out before starting fermentation such as during a stage of preparing a starting milk, after carrying out homogenization and pasteurization, or after adding a starter. However, since it is important to maintain a

state in which the dissolved oxygen concentration is decreased at the time of starting fermentation, it is desirable that the deoxygenation step is carried out immediately before, immediately after, or at the same time as adding a starter.

[0030]

When gas replacement with an inert gas (inert gas replacement) is carried out, nitrogen gas, which is an inert gas normally used for food, may typically be used. Other than nitrogen gas, a rare gas such as helium, neon, argon, or xenon may be used as the inert gas. As a method for replacing dissolved oxygen with an inert gas, a known method may be used such as a method in which the inert gas is directly bubbled into a mix, a method in which a static mixer is used, or one in which the gas and a mix are charged together into a mixer and stirred. Inert gas replacement can be carried out after adding a starter, and there are few restrictions for the step compared with a method involving membrane separation, etc.

[0031]

When a membrane separation method using a deoxygenation membrane (deoxygenation membrane gas replacement) is carried out, as the deoxygenation membrane, a hollow fiber membrane (MHF304KM, Mitsubishi Rayon Co., Ltd.), etc. may be used. For a method of using such a deoxygenation membrane, a conventional method of use may be referred to, and deoxygenation membrane gas replacement can be applied to a starting milk and carried out before adding a starter.

Furthermore, instead of mixing with an inert gas or using a deoxygenation membrane, oxygen dissolved in a starting milk may be removed by degassing. A device for such degassing is disclosed in JP, A, 2002-370006 or JP, A, 2005-304390.

[0032]

Fermentation step

In order to subject the starting milk having a decreased dissolved oxygen concentration to lactic acid fermentation, the starting milk is blended (mixed) with a starter and fermented. As these starters, known starters may be used as appropriate, and a lactic acid bacterium starter can be cited as a preferred example. As the lactic acid bacterium starter, as well as *Lactobacillus bulgaricus* (*L. bulgaricus*), *Streptococcus thermophilus* (*S. thermophilus*), *Lactobacillus lactis* (*L. lactis*), *Lactobacillus gasseri* (*L. gasseri*), or *Bifidobacterium* (*Bifidobacterium*), one or more types from lactic acid bacteria, bifidobacteria, and yeasts generally used in the production of fermented milk may be used.

[0033]

Among these starters, a starter using as a base a mixed starter of *Lactobacillus bulgaricus* (*L. bulgaricus*) and *Streptococcus thermophilus* (*S. thermophilus*), which is standardized by the Codex Standard as a yoghurt starter, is preferable. Using this yoghurt starter as a base, another lactic acid bacterium or bifidobacterium such as *Lactobacillus gasseri* (*L. gasseri*) or *Bifidobacterium* (*Bifidobacterium*) may be added (blended) according to the fermented milk that is to be obtained

in practice. As the amount of starter added, for example, a quantity that is employed in a known method for producing fermented milk may be employed. Addition (inoculation) of a starter may be carried out in accordance with a known method generally used in the production of fermented milk.

[0034]

Furthermore, in the present invention, fermentation may be carried out by decreasing the amount of starter added from the normal amount of starter added. The normal amount of starter added, which is a standard for the amount of starter added, is the amount of starter added when fermentation that gives a lactic acidity of 0.7% is carried out using a starting milk (yoghurt mix) that has not been subjected to a deoxygenation step (treatment of decreasing dissolved oxygen concentration) at a fermentation temperature of 43°C for a fermentation time of 3 hours, and this quantity represents 100%. Specifically, under normal fermentation conditions, the amount of starter added is on the order of 2% relative to the total amount of starting milk, whereas the amount of starter added in the present invention is 0.5% to 1.0% relative to the total amount of a starting milk, this being on the order of 25% to 50% of the normal amount of starter added.

[0035]

Lactose degradation step

The lactose degradation step is a step in which lactose is degraded by means of a lactase (lactase). In principle, a lactase may be added at any stage of the production process. For example,

from the viewpoint of reducing the risk of bacterial contamination, a starting milk is put into a low temperature state, lactose is degraded, and then subjected to thermal pasteurization so as to deactivate the enzyme, and after that fermentation may proceed. Alternatively, after a starting milk is subjected to thermal pasteurization, it is mixed (blended) with a starter and a lactase, and fermentation may proceed in a state in which the enzyme still has activity. Fermentation of the starting milk proceeds, lactose is degraded into lactic acid to thus form an acid and decrease the pH value, and accompanying this the enzyme may be deactivated. By carrying out such a treatment, the percentage lactose degradation can be enhanced effectively.

[0036]

When fermentation is carried out by mixing a starting milk with a starter and a lactase, it becomes unnecessary to make an enzyme reaction progress before subjecting the starting milk to thermal pasteurization, the process for producing fermented milk can be simplified, and the natural flavor of normal fermented milk can be exploited as much as possible. Furthermore, since the percentage lactose degradation can be enhanced effectively by carrying out such a treatment, it becomes unnecessary to continue to individually control the percentage lactose degradation and the degree of fermentation (change in acidity), and product control becomes very easy.

[0037]

Therefore, in the present invention, it is preferable for a

lactase to be added to (blended with) the starting milk together with a starter, but there are no particular limitations, and the lactase may be added to the starting milk before adding a starter or may be added to the starting milk at the same time as adding a starter or after adding a starter. When a starting milk with which a lactase and a starter have been mixed is used, lactose in the starting milk is degraded as the fermentation step progresses. Moreover, a lactase may be added to a starting milk before the deoxygenation step or may be added to a starting milk after the deoxygenation step. Such a lactose degradation step is also disclosed in WO2010/098086.

[0038]

The lactase of the present invention is preferably an enzyme for which the optimum pH for activity is in a neutral region, that is deactivated in an acidic region, and that can degrade lactose in its active state. As the lactase, those derived from a bacterium or a yeast can be cited as examples. For example, the optimum pH for activity may be 6.3 to 7.5 and the deactivation pH may be 6 to 4. The lactase is preferably a *Kluyveromyces lactis* -derived lactase or a *Kluyveromyces fragilis*-derived lactase. The *Kluyveromyces lactis*-derived lactase includes *Kluyveromyces lactis* itself and a lactase derived from *Kluyveromyces lactis*. Lactases are commercially available, and examples of commercial lactases include Lactase F (Amano Enzyme Inc.), Lactoless L-3 (Daiwa Fine Chemicals Co., Ltd.), Lactoless L-10 (Daiwa Fine Chemicals Co., Ltd.), and Lactase (GODO-YNL, Godo Shusei Co.,

Ltd.).

[0039]

The percentage lactose degradation may be at least 65%, preferably 75% to 90%, and more preferably 80% to 90%, but is not limited thereto. Furthermore, a lactase may be added to a starting milk in an amount corresponding to at least 5 U/g, preferably 7 to 20 U/g, and more preferably 10 to 15 U/g. When the percentage lactose degradation is low, there is a tendency for the effects of the present invention, such as the effect in improving the percentage water separation, to be insufficient.

[0040]

Fermentation conditions and lactose degradation conditions

Fermentation conditions such as fermentation temperature and fermentation time are generally adjusted while taking into consideration the type of lactic acid bacterium added to a starting milk, the fermented milk flavor that is actually required, etc., but the temperature within a fermentation chamber (fermentation temperature) is maintained at on the order of 30°C to 50°C.

In the method for producing fermented milk of the present invention, fermentation can be carried out at a relatively low temperature, and fermentation can be carried out at preferably 30°C to 39°C, more preferably 32°C to 38°C, and yet more preferably 34°C to 37°C.

[0041]

On the other hand, when a starter is used in an amount that is on the order of 25% to 50% (that is, 0.5% to 1.0% relative to

the total amount of a starting milk) of the normal amount of starter added, fermentation may be carried out at 38°C to 46°C, which is of the same order as the normal fermentation temperature, preferably 38°C to 45°C, and more preferably 39°C to 43°C.

When this method is employed, since fermentation can be carried out at a normally employed fermentation temperature, in addition to ease of control of the temperature within a fermentation chamber as for a normal product, there is the advantage that the risk of proliferation of saprophytic bacteria can be reduced.

[0042]

The fermentation time may be the time taken until the lactic acidity of fermented milk reaches on the order of 0.7%. In the production method of the present invention, the fermentation time is preferably 3 to 7 hours, and more preferably 3 to 5 hours. In this process, the lactic acidity may be determined by titration using NaOH and a phenolphthalein indicator, etc.

[0043]

Furthermore, when lactose in a starting milk is degraded before fermentation, lactose degradation may be carried out at 0°C to 55°C, at which a lactase maintains its activity, preferably 30°C to 50°C, and more preferably 35°C to 45°C. With regard to conditions for lactose degradation, the purpose can be attained by maintaining the temperature at 35°C to 45°C for at least 1 hour, which is a temperature suitable for a general lactase.

[0044]

Fermented milk

The fermented milk obtained by the production method of the present invention has a firm curd even though it has a low total solids content and a low fat content, and is resistant to water separation. Adjustment of components such as the milk fat content or the protein content of the fermented milk may be achieved by adjustment of the blending proportions of skimmed milk powder, whey protein, etc. in the starting milk. The fermented milk of the present invention preferably has the following properties, but is not particularly limited thereto.

[0045]

The percentage centrifugal water separation of the fermented milk of the present invention is desirably no greater than 60%, preferably 50% to 10%, and more preferably 40% to 15%.

The hardness of the fermented milk of the present invention is desirably at least 30 g, preferably 30 to 70 g, and more preferably 40 to 60 g.

The total calories (kcal/100 g) of the fermented milk of the present invention is desirably no greater than 50 kcal/100 g, preferably 15 to 45 kcal/100 g, and more preferably 20 to 40 kcal/100 g.

The term 'low calorie' used in the present specification includes 50 kcal/100 g or less. Therefore, the low calorie fermented milk of the present invention has 50 kcal/100 g or less, 45 kcal/100 g or less, or 40 kcal/100 g or less.

[0046]

The percentage centrifugal water separation may be determined by measuring the proportion (wt%) of the supernatant (whey) separated by centrifugation of fermented milk. For example, it can be obtained by carrying out centrifugation at 3000 rpm (2150×g) for 10 minutes at room temperature. The hardness (curd tension: CT) may be measured by for example standard equipment such as a Neo Curdmeter ME305 (i-Techno Engineering), and the total calories may be determined by a standard method from the numerical value of each nutritional component.

[0047]

The milk fat content of the fermented milk of the present invention is desirably no greater than 3%, preferably no greater than 2%, more preferably no greater than 1%, and most preferably less than 0.5%. A preferred range is 0.01% to 2%, more preferably 0.05% to 1%, and yet more preferably 0.1% to 0.5%.

The total solids content of the fermented milk of the present invention is desirably no greater than 11%, preferably no greater than 10.5%, more preferably no greater than 10.2%, and most preferably no greater than 10%. A preferred range is 8% to 11%, more preferably 8.5% to 10.5%, and yet more preferably 9% to 10.2%.

The total protein content of the fermented milk of the present invention is desirably 3% to 6%, more preferably 3.5% to 5.5%, and yet more preferably 4% to 5%.

The lactose content of the fermented milk of the present invention is desirably 0.01% to 1%, more preferably 0.05% to 0.8%, and yet more preferably 0.1% to 0.5%.

The pH of the fermented milk of the present invention is desirably 4 to 5, more preferably 4.3 to 4.8, and yet more preferably 4.5 to 4.7.

[0048]

The fermented milk of the present invention preferably has a high α-lactalbumin content or β-lactoglobulin content, and these protein contents can be obtained by adjusting the α-lactalbumin content and/or β-lactoglobulin content in a starting milk.

[0049]

α-Lactalbumin is desirably contained at a proportion of at least 7% of the total protein of the fermented milk, preferably 12% to 40%, and more preferably 17% to 25%. It is desirably contained at a proportion of at least 0.3% of the entire fermented milk, preferably 0.5% to 1.5%, and more preferably 0.7% to 1%.

β-Lactoglobulin is desirably contained at a proportion of at least 10% of the total protein of the fermented milk, preferably 12% to 40%, and more preferably 15% to 25%. It is desirably contained at a proportion of at least 0.4% of the entire fermented milk, preferably 0.5% to 1.5%, and more preferably 0.6% to 1%.

[0050]

The fermented milk of the present invention preferably does not contain a stabilizer. It is also preferable for a sweetener, etc. not to be added, but it may be added before fermentation or after fermentation as necessary.

[0051]

The present invention is explained in detail by way of the

following Examples, but the present invention should not be construed as being limited to these Examples.

[Examples]

[0052]

The starting materials used were as follows.

Skimmed milk powder (Meiji Co., Ltd.), WPC34 (Leprino Foods), and β-Lg rich WPC75 (Leprino Foods) were used. With regard to β-Lg rich WPC75, the main protein component is β-Lg; β-Lg is contained at about 80% of the protein, and a whey protein such as α-La is contained at about 20%.

As the lactase, Lactase (GODO-YNL, 10000 U/g, Godo Shusei Co., Ltd.) was used.

As the lactic acid bacterium starter, *Lactobacillus bulgaricus* and *Streptococcus thermophilus* that had been separated from Meiji Bulgaria yoghurt (Meiji Co., Ltd.) were used.

Curd tension was measured using a Neo Curdmeter ME305 (i-Techno Engineering).

[0053]

Example 1

The starting milk used for the production of fermented milk was prepared by mixing skimmed milk powder: 90.7 g, WPC34: 13.5 g, and tap water: 895.8 g.

The starting milk thus obtained was heated (pasteurized) at 95°C for 5 minutes and then cooled to about 38°C. After the starting milk was cooled, lactase (GODO-YNL, Godo Shusei Co., Ltd.) was

added at 0.1 wt%, and it was inoculated with a lactic acid bacterium starter (separated from Meiji Bulgaria yoghurt, Meiji Co., Ltd.) at 2 wt%. Subsequently, nitrogen gas was blown in through a pipe to thus adjust the dissolved oxygen so as to be no greater than 4 ppm. In addition, an enzyme reaction may be carried out by adding a lactase before pasteurizing the starting milk, to thus degrade lactose, and lactic acid fermentation may then be carried out.

[0054]

Subsequently, the starting milk containing the lactase and the lactic acid bacterium starter was filled in a cup container (capacity: 100 g, made of plastic), and fermented by keeping it stand in a fermentation chamber (38°C) until the lactic acidity attained 0.7%. Subsequently, it was cooled in a refrigeration chamber (no higher than 10°C), thus producing a set type yoghurt (fermented milk).

The fermented milk thus obtained (total solids content: 10.0 wt%, fat content: 0.1 wt%, 40 kcal/100 g) had a hardness (curd tension) of 35 g and a percentage centrifugal water separation (3000 rpm (2150×g), for 10 minutes, room temperature) of 35%.

[0055]

Example 2

The starting milk used for the production of fermented milk was prepared by mixing skimmed milk powder: 86.3g, β-Lg rich WPC75: 4.4g, WPC34: 13.5g, and tap water: 874.8 g.

The starting milk thus obtained was heated (pasteurized) at 95°C for 5 minutes and then cooled to about 38°C. After the starting

milk was cooled, lactase (GODO-YNL, Godo Shusei Co., Ltd.) was added at 0.1 wt%, and it was inoculated with a lactic acid bacterium starter (separated from Meiji Bulgaria yoghurt, Meiji Co., Ltd.) at 2 wt%. Subsequently, nitrogen gas was blown in through a pipe to thus adjust the dissolved oxygen so as to be no greater than 4 ppm. In addition, an enzyme reaction may be carried out by adding a lactase before pasteurizing the starting milk, to thus degrade lactose, and lactic acid fermentation may then be carried out.

[0056]

Subsequently, the starting milk containing the lactase and the lactic acid bacterium starter was filled in a cup container (capacity: 100 g, made of plastic) and fermented by keeping it stand in a fermentation chamber (38°C) until the lactic acidity attained 0.7%. Subsequently, it was cooled in a refrigeration chamber (no higher than 10°C), thus producing a set type yoghurt (fermented milk).

The fermented milk thus obtained (total solids content: 10.0 wt%, fat content: 0.1 wt%, 40 kcal/100 g) had a hardness (curd tension) of 50 g and a percentage centrifugal water separation (3000 rpm (2150×g), for 10 minutes, room temperature) of 25%.

[0057]

Moreover, this fermented milk (total solids content: 10.0 wt%, fat content: 0.1 wt%, 40 kcal/100 g) was produced in an actual production process (factory), 700 cup containers (capacity: 450 g, made of paper) were charged therewith and transported by a refrigerated vehicle (lorry) across 1300 km, and it was confirmed

that the curd was not broken and there was only a small amount of water separation (whey off), which was the same as or less than that of a commercial product (total solids content: 12.5 wt%, fat content: 3.0 wt%).

[0058]

The above results show that the fermented milk of the present invention is fermented milk that not only inhibits water separation but also has a stable quality in which the curd is not broken even by impact due to long distance transport. The results also show that by adjusting the concentration of β-lactoglobulin the percentage centrifugal water separation is further improved.

[0059]

Comparative Example 1

The starting milk used for production of fermented milk was prepared by mixing skimmed milk powder: 90.7 g, WPC34: 13.5 g, and tap water: 895.8 g.

The starting milk thus obtained was heated (pasteurized) at 95°C for 5 minutes and then cooled to about 43°C. After the starting milk was cooled, it was inoculated with a lactic acid bacterium starter (separated from Meiji Bulgaria yoghurt, Meiji Co., Ltd.) at 2 wt%.

[0060]

Subsequently, the starting milk containing the lactic acid bacterium starter was filled in a cup container (capacity: 100 g, made of plastic) and fermented by keeping it stand in a fermentation chamber (43°C) until the lactic acidity attained 0.7%.

Subsequently, it was cooled in a refrigeration chamber (no higher than 10°C), thus producing a set type yoghurt (fermented milk) (control product).

The fermented milk thus obtained (total solids content: 10.0 wt%, fat content: 0.1 wt%, 40 kcal/100 g) had a hardness (curd tension) of 50 g and the percentage centrifugal water separation (3000 rpm (2150×g), for 10 minutes, room temperature) of 65%.

[0061]

From the above results, the method for producing fermented milk of the present invention greatly improves by at least 45% the percentage water separation of a low fat content fermented milk without a stabilizer being added, and further improves it by at least 60% by the concentration of β-lactoglobulin being adjusted.

[Industrial Applicability]

[0062]

The present invention relates to low calorie fermented milk and a method for producing same, and can provide fermented milk that prevents curd from being broken even due to impact during transport and suppresses the occurrence of water separation.

## CLAIMS

[Claim 1]

A method for producing fermented milk having a low fat content, the method comprising decreasing the dissolved oxygen concentration of a starting milk at the time of starting fermentation and adding a lactase to the starting milk before starting fermentation.

[Claim 2]

The method according to Claim 1, wherein the fermented milk having a low fat content has a milk fat content of 0.01 to 2 wt%.

[Claim 3]

The method according to Claim 1 or 2, wherein the dissolved oxygen concentration of the starting milk at the time of starting fermentation is no greater than 5 ppm.

[Claim 4]

The method according to any one of Claims 1 to 3, wherein the starting milk contains a high concentration of α-lactalbumin or β-lactoglobulin.

[Claim 5]

The method according to Claim 4, wherein the concentration of α-lactalbumin or β-lactoglobulin is 0.5 to 1.5 wt% in the

starting milk.

[Claim 6]

The method according to any one of Claims 1 to 5, wherein the starting milk has a total protein content of 3 to 6 wt% and/or a total solids content of 8 to 11 wt%.

[Claim 7]

The method according to any one of Claims 1 to 6, wherein lactose degradation is carried out during fermentation.

[Claim 8]

The method according to any one of Claims 1 to 7, wherein the percentage lactose degradation is 75% to 90%.

[Claim 9]

The method according to any one of Claims 1 to 8, wherein a stabilizer is not added.

[Claim 10]

Fermented milk produced by the method according to any one of Claims 1 to 9.

[Claim 11]

Fermented milk having a percentage centrifugal water separation of 50% to 10%, a hardness of 30 to 70 g, and a total

calories of no greater than 50 kcal/100 g and not containing a stabilizer.

[Claim 12]

The fermented milk according to Claim 11, wherein it has a milk fat content of 0.01 to 2 wt%, a total protein content of 3 to 6 wt%, and a total solids content of 8 to 11 wt%.

[Claim 13]

The fermented milk according to Claim 11 or 12, wherein it has a lactose content of 0.01 to 1 wt%.