

Description

Title of Invention: LIQUID FERMENTED MILK AND METHOD FOR PRODUCING SAME

Technical Field

[0001] The present invention relates to a liquid fermented milk and a method of producing the liquid fermented milk.

Background Art

[0002] In recent years, consumers have become quality-oriented and mild-taste-oriented, and there has been a demand for fermented milk having a weak sour taste and a mild taste.

As an example of methods of producing a fermented milk having a weak sour taste, there has been proposed a method of producing a liquid fermented milk characterized in that the method comprises: culturing lactic acid bacteria, which decrease the pH of a liquid fermented milk in less than 0.3 after storage at 10°C for 14 days, in a fermented milk mix having a weight ratio of solids-not-fat to milk fats of 2 to 6, so that a pH of 4.9 to 5.3 is achieved at the end of fermentation; and liquefying the resultant curd (see Patent Literature 1 listed below).

As another example of methods of producing a fermented milk having a weak sour taste, there has been proposed a method of producing a fermented milk food and beverage containing bacteria of the genus

Bifidobacterium, characterized in that the method comprises: performing fermentation of raw material milk using one kind or two or more kinds of lactic acid bacteria or bacteria of the genus *Bifidobacterium* including at least *Bifidobacterium bifidum*; and adding an alkali salt to the resultant at any timing after the fermentation step, to produce a fermented milk food and beverage having a product pH of 5.4 or more and containing bacteria of the genus *Bifidobacterium* (see Patent Literature 2 listed below).

Citation List

List of Patent Literatures

[0003] [Patent Literature 1] JP 06-14706 A
[Patent Literature 2] JP 2002-204655 A

Summary of the Invention

Problems to be Solved by the Invention

[0004] According to the above-mentioned production method described in Patent Literature 1, it is possible to produce a liquid fermented milk that has good storage stability even at a pH of about 5.0, undergoes less syneresis and precipitation even if a stabilizer such as pectin is not used, has no paste-like feeling and a good texture because no stabilizer such as pectin is used, and has a low acidity and a mild taste because the pH is higher than usual.

However, the inventors of the present invention have made studies on production conditions for the production method described

in Patent Literature 1, and as a result, have obtained the following findings. In the case where a curd of the fermented milk mix is prepared so that the pH exceeds 5.3 at the end of fermentation, precipitates may be formed due to coagulation of components in the liquid fermented milk during storage as a liquid fermented milk that is a final product provided after liquefaction (i.e., homogenization treatment) of the curd, resulting in deteriorated appearance and texture.

An object of the present invention is to provide a liquid fermented milk that has a weak sour taste and a mild taste and has no deterioration in the appearance, flavor, and texture because of forming no precipitates during storage, and to provide a method of producing of the liquid fermented milk.

Means of Solving the Problem

[0005] The inventors of the present invention have made extensive studies to solve the above-mentioned problems, and as a result, have found that, even when the pH of a curd after the end of fermentation is 5.0 to 6.0, which is higher than a usual pH, a liquid fermented milk that has a weak sour taste and a mild taste and forms no or a very small amount of precipitates during its storage can be obtained by performing homogenization treatment at a pressure of 30 to 100 MPa, which is higher than a pressure of 10 to 15 MPa in the conventional art, thus completing the present invention.

[0006] That is, the present invention provides the following [1] to [6].

[1] A method of producing a liquid fermented milk having a pH of 5.0 or more, the method including: (A) a curd preparation step of preparing a curd having a pH of 5.0 to 6.0 by adding lactic acid bacteria to a raw material of a fermented milk and performing fermentation; and (B) a homogenization treatment step of subjecting the curd to homogenization treatment at a pressure of 30 to 100 MPa to provide a liquid fermented milk having a pH of 5.0 to 6.0.

[2] A liquid fermented milk, which is produced by the method of producing a liquid fermented milk according to [1] above.

[3] The liquid fermented milk according to [2] above, having a viscosity of 10 mPa·s or less.

[4] The liquid fermented milk according to [2] or [3] above, having an acidity of 1.0% or less.

[5] The liquid fermented milk according to [2] or [3] above, having an acidity of 0.5% or less.

[6] The liquid fermented milk according to any one of [2] to [5] above, not containing a thickener.

Advantageous Effects of the Invention

[0007] The liquid fermented milk of the present invention can maintain a weak sour taste and a mild (i.e. gentle) taste at a pH of 5.0 or more, because the liquid fermented milk was subjected to the homogenization treatment at the specific pressure and has

a pH of 5.0 to 6.0 after the homogenization treatment. In addition, the liquid fermented milk has a weak sour taste and hence is suitable for preference of health-conscious consumers, because the amount of a sweetener such as sugar that needs to be added to a product having a strong sour taste can be reduced to zero or a small amount.

In addition, the liquid fermented milk of the present invention can maintain a good appearance, flavor, and texture as a liquid fermented milk without causing separation and coagulation of components and formation of precipitates (i.e. solid matter) for a long storage period, because the liquid fermented milk was subjected to the homogenization treatment at a pressure of 30 to 100 MPa.

In addition, the liquid fermented milk of the present invention can give non-paste-like and good feeling on the throat, because it is not necessary to add a thickener such as pectin or carboxymethylcellulose (CMC) to suppress formation of precipitates during storage. In this case, the liquid fermented milk of the present invention is suitable for preference of quality-oriented and additive-free-oriented consumers.

Further, the liquid fermented milk of the present invention can be easily produced with the same number of steps and in the same production time as those of conventional liquid fermented milk.

Embodiments for Carrying Out the Invention

[0008] A method of producing a liquid fermented milk having a pH of 5.0 or more according to the present invention includes:

(A) a curd preparation step of preparing a curd having a pH of 5.0 to 6.0 by adding lactic acid bacteria to a raw material of a fermented milk and performing fermentation; and (B) a homogenization treatment step of subjecting the curd to homogenization treatment at a pressure of 30 to 100 MPa to provide a liquid fermented milk having a pH of 5.0 to 6.0. Each step is described in detail below.

[0009] [Step (A); Curd preparation step]

The step (A) is a step of preparing a curd having a pH of 5.0 to 6.0 by adding lactic acid bacteria to a raw material of a fermented milk and performing fermentation.

The "raw material of a fermented milk" as used herein refers to one containing at least raw material milk.

In this case, examples of the raw material milk include animal milk such as cow's milk, a processed product thereof (e.g. skim milk, skim milk powder, condensed milk, whey, or cream), and plant milk such as soy milk derived from soybeans.

Examples of the raw material of fermented milk include one which is called fermented milk raw material mix.

Fermented milk raw material mix is a mixture including raw material milk and other components, and can be provided by, for example, dissolving raw materials usually used for production of fermented milk such as raw material milk, sugar, a saccharide other than sugar, a high-intensity sweetener, a flavor, and water by heating, and mixing the resultant solution.

It is to be noted that the composition of milk fats,

solids-not-fat (e.g., milk proteins, lactose, and ash), and the like in raw material milk and a processed product of milk may vary depending on, for example, individual differences among animals, environments for breeding, and weather. Therefore, depending on the composition of raw materials actually used, the raw material milk and the processed product of milk may be selected to set an appropriate blending ratio for each case.

The raw material of fermented milk (e.g., animal milk such as cow's milk) may be pasteurized in advance by heating. In this case, examples of a method for pasteurization include ultrahigh temperature pasteurization (UHT), in which pasteurization is performed at 120 to 130°C for several seconds, and high temperature short time pasteurization (HTST), in which pasteurization is performed at 90 to 95°C for tens of minutes.

[0010] The strain of the lactic acid bacteria is not particularly limited as long as it is used for a fermented milk such as yogurt. The strain is not limited by the experimental description in Examples below. In particular, when lactic acid bacteria which cause a less increase in acidity during refrigerated storage are appropriately selected and used, a period for storage of the liquid fermented milk may be extended. For example, in the case where it takes 15 days to reach a pH of 5.0 during refrigerated storage of a liquid fermented milk prepared by the production method of the present invention, the storage period (i.e. a period in which the liquid fermented milk of the present invention can be consumed)

may be set to 15 days. In addition, in the case where it takes 30 days to reach a pH of 5.0 during refrigerated storage of a liquid fermented milk prepared by the production method of the present invention, the storage period may be set to 30 days. That is, as an increase in acidity and/or a decrease in pH in the liquid fermented milk of the present invention during refrigerated storage become smaller, the effect of the present invention can be provided for a longer period after production.

The time to start storage of the liquid fermented milk in this case is a time point at which the liquid temperature of the liquid fermented milk is adjusted to a storage temperature (e.g. 10°C) after the end of the homogenization treatment (in the case where storage temperature is 10°C and the homogenization treatment is performed at 10°C, the time is a time point of the end of the homogenization treatment).

[0011] Whether or not a lactic acid bacterial strain being able to be used in the present invention may be affected by the composition of components in the liquid fermented milk or the like. For example, in the case of using a raw material of a fermented milk having composition of components which hardly causes lowering of pH, the number of kinds of lactic acid bacterial strains which can be used in the present invention is large, because the condition of "pH of a fermented milk during refrigerated storage is 5.0 or more" is easily satisfied.

[0012] The temperature of fermentation is 30 to 48°C, preferably

35 to 48°C, and more preferably 38 to 45°C from the viewpoint of efficiently producing a fermented milk having a good flavor.

From the viewpoint of producing a fermented milk having an after-mentioned pH and a good flavor, the time for fermentation in the case of using, for example, *Lactobacillus bulgaricus* and *Streptococcus thermophilus* is preferably 0.5 to 10 hours, more preferably 1 to 8 hours, still more preferably 1 to 5 hours, and particularly preferably 1 to 3 hours.

The raw material of a fermented milk is coagulated along with the progress of fermentation and becomes a curd (i.e. solid form).

The pH of the curd at the end of fermentation is 5.0 to 6.0, preferably 5.2 to 6.0, more preferably 5.3 to 5.9, and particularly preferably 5.4 to 5.9. When the pH is less than 5.0, the sour taste of the liquid fermented milk may become strong during storage. When the pH exceeds 6.0, it is difficult to produce a fermented milk having a good flavor, or proteins may be coagulated to form precipitates during storage of the liquid fermented milk.

After the end of fermentation, lowering the temperature of the curd to a temperature for the after-mentioned homogenization treatment can be conducted in order to perform the homogenization treatment in the subsequent step (B), or lowering the temperature of the liquid fermented milk after the homogenization treatment to a temperature for storage (e.g., 10°C) can be conducted without lowering the temperature of the curd. As mentioned above, the timing to lower the temperature is not particularly limited.

[0013] [Step (B); Homogenization treatment step]

The step (B) is a step of subjecting the curd obtained by the step (A) to homogenization treatment at a pressure of 30 to 100 MPa to obtain a liquid fermented milk having a pH of 5.0 to 6.0.

The homogenization treatment may be carried out using a homogenizer.

The pressure of the homogenization treatment is 30 to 100 MPa, preferably 40 to 100 MPa, more preferably 50 to 100 MPa, and particularly preferably 60 to 100 MPa. When the pressure is less than 30 MPa, precipitates may be formed during storage of the liquid fermented milk. When the pressure exceeds 100 MPa, it is necessary to use a high-performance apparatus as pressurization means for the homogenization treatment, resulting in low economic efficiency. From the viewpoint of economic efficiency, the upper limit of the pressure is preferably 90 MPa, and more preferably 80 MPa.

The temperature of the homogenization treatment is preferably 5 to 50°C, and more preferably 5 to 45°C. When the temperature is less than 5°C, the degree of temperature to be lowered from the fermentation temperature is large, and hence a load in operation of a cooling apparatus is increased, resulting in low economic efficiency. When the temperature exceeds 50°C, the fermentation may progress remarkably by the end of the homogenization treatment and the pH of the liquid fermented milk is significantly decreased when compared with the pH of the curd, and therefore, there is a need to carry out a cooling step immediately after homogenization.

According to the homogenization treatment, a final product of a liquid fermented milk is provided.

[0014] Physical properties (i.e., values under storage at a predetermined storage temperature such as 10°C) of the liquid fermented milk obtained by the homogenization treatment are as follows. It is to be noted that the following values are preferably satisfied at least at the end of preparation of the liquid fermented milk (i.e. the time point at which the liquid temperature of the liquid fermented milk is adjusted to a storage temperature such as 10°C after the end of the homogenization treatment), and are more preferably satisfied at the end of preparation of the liquid fermented milk and during a predetermined storage period.

The pH of the liquid fermented milk is 5.0 to 6.0, preferably 5.2 to 6.0, more preferably 5.3 to 5.9, and particularly preferably 5.4 to 5.9. When the pH is less than 5.0, the liquid fermented milk may have a strong sour taste and an increased viscosity and may form precipitates during storage. When the pH exceeds 6.0, the flavor as a liquid fermented milk deteriorates.

The viscosity of the liquid fermented milk is preferably 10 mPa·s or less, more preferably 7.5 mPa·s or less, and still more preferably 5 mPa·s or less from the viewpoint of giving good feeling on the throat without paste-like feeling.

The viscosity of the liquid fermented milk can be measured using a Brookfield type viscometer.

[0015] From the viewpoint of giving a weak sour taste and a

mild flavor, the acidity of the liquid fermented milk is preferably 1.0% or less, more preferably 0.8% or less, still more preferably 0.75% or less, and particularly preferably 0.5% or less. The lower limit of the acidity is not particularly limited, and is usually 0.2%.

The acidity of the liquid fermented milk is represented as percent by weight determined by converting acids in the liquid fermented milk into lactic acid. The acidity is measured by the following method, for example. 9 g of a sample is diluted 2-fold with water, and then a phenolphthalein indicator is added. Subsequently, neutralization titration is carried out with a 0.1 N sodium hydroxide solution. Regarding a point that a slightly reddish color does not disappear for 30 seconds as the end point, the amount of lactic acid per 100 g of the sample is determined from the titer at the endpoint, and the resultant value is represented as a percentage.

From the viewpoint of suppressing the formation of precipitates during storage of the liquid fermented milk, the particle size of a component (i.e., casein micelle) in the liquid fermented milk is preferably 5 μm or less, more preferably 3 μm or less, still more preferably 1.5 μm or less, and particularly preferably 1.0 μm or less.

The "particle size" refers to a 50% weight cumulative particle size (i.e. average particle size). The particle size may be determined by measuring a particle size distribution of components

in the liquid fermented milk using, for example, a laser diffraction particle size distribution analyzer (e.g., "SALD-2100" manufactured by Shimazu Corporation).

[0016] The liquid fermented milk of the present invention is, for example, filled into a food container, refrigerated at a predetermined storage temperature (e.g., 10°C or less) in the form of a final product such as drinkable yogurt, and then supplied as a drink.

 The degree of pH to be lowered in the liquid fermented milk during storage of the liquid fermented milk at a predetermined storage temperature (e.g., 10°C) for a predetermined period from the end of preparation is 0.5 or less, preferably 0.4 or less, more preferably 0.3 or less, and particularly preferably 0.2 or less, from the viewpoints of suppressing the formation of precipitates during storage of the liquid fermented milk, suppressing an increase in acidity, and maintaining a mild flavor.

The liquid fermented milk of the present invention preferably does not contain a thickener such as pectin or carboxymethylcellulose (CMC) from the viewpoint of giving no paste-like feeling. It is to be noted that pectin is less useful at a pH of from 5.0 to 6.0, which is the pH of the liquid fermented milk of the present invention, because pectin can exert an effect of suppressing the formation of precipitates in the liquid fermented milk only at a pH of 3.5 to 4.4, which is lower than a pH of 4.6, which is an isoelectric point of milk protein. In addition, carboxymethylcellulose is also

less useful at a pH of from 5.0 to 6.0, which is the pH of the liquid fermented milk of the present invention, because carboxymethyl-cellulose is suitably used at a pH of 4.2 to 4.8.

Examples

[0017] Hereinafter, the present invention is described in detail by way of Examples. However, the present invention is not limited to Examples. It is to be noted that the terms "%" and "part(s)" in Examples and Comparative Example below mean values on a weight basis unless otherwise specified.

[Example 1]

2,496 g of cow's milk, 210 g of skim milk powder, and 96 g of high-fructose syrup were mixed as materials to prepare reconstituted milk containing 8.4% of solids-not-fat, 2.0% of milk fat, 2.0% of high-fructose syrup, and water (i.e. the balance; 87.6%), and the reconstituted milk was pasteurized to prepare a raw material of fermented milk.

Next, *Lactobacillus bulgaricus* and *Streptococcus thermophilus* each isolated from "Meiji Bulgaria Yogurt" (product name: manufactured by Meiji Dairies Corporation) were inoculated as starters into 100 parts of the prepared raw material of fermented milk, and fermentation was performed for 2 hours while maintaining the liquid temperature at 43°C, thereby preparing a curd obtained by fermentation of the raw material of fermented milk. The curd was found to have a pH of 5.62.

After that, the resultant curd was cooled to 10°C.

[0018] Next, the cooled curd was subjected to homogenization treatment using a homogenizer (manufactured by SANWA MACHINE CO., INC.) at a pressure of 60 MPa while maintaining the temperature at 10°C, thereby preparing liquid fermented milk. The resultant liquid fermented milk was found to have a pH of 5.62.

Subsequently, the liquid fermented milk was stored while maintaining the liquid temperature at 10°C. At time points of 1, 4, 8, and 11 days after the start of storage, physical properties including pH, acidity, viscosity, and particle size were measured, and the liquid fermented milk was visually observed to examine whether precipitates had been formed or not and the state of the liquid fermented milk. Table 1 shows the results.

As mentioned above, the acidity was calculated by a method involving adding a phenolphthalein indicator and then performing neutralization titration with a sodium hydroxide solution. The viscosity was measured using a Brookfield type viscometer. The particle size was determined based on a particle size distribution obtained by using a laser diffraction particle size distribution analyzer ("SALD-2100" manufactured by Shimadzu Corporation).

[0019] [Table 1]

	Storage period (day(s))			
	1	4	8	11
pH	5.45	5.24	4.95	4.85
Acidity (%)	0.39	0.46	0.49	0.52
Viscosity (mPa·s)	3.4	3.7	5.7	11.6
Particle size (μm)	0.8	0.8	0.9	12.8
Precipitate	Not formed	Not formed	Not formed	-
State	Liquid	Liquid	Liquid	Solidified

[0020] In Table 1, until the time of "storage at 10°C for 8 days" where the liquid fermented milk had a pH of 4.95, the effect of the present invention was achieved. However, after the time of "storage at 10°C for 11 days" where the liquid fermented milk had a pH of 4.85, the effect of the present invention was not achieved, because the viscosity and particle size increased and the liquid fermented milk was solidified due to coagulation of the milk. Therefore, it was found that the effect of the present invention can be achieved when the pressure for the homogenization treatment is adjusted to 60 MPa and the pH of the liquid fermented milk during refrigerated storage is 5.0 or more.

[0021] [Example 2]

An experiment was carried out in the same manner as in Example 1 except that the pressure for the homogenization treatment was changed from 60 MPa to 30 MPa. As a result, the curd was found to have a pH of 5.62, and the liquid fermented milk was found to have a pH of 5.62. The liquid fermented milk cooled in the same manner as in Example 1 was stored while maintaining the liquid temperature at 10°C. At time points of 1, 3, and 6 days after the start of storage,

physical properties including pH, acidity, viscosity, and particle size were measured, and the liquid fermented milk was visually observed to examine whether precipitates had been formed or not and the state of the liquid fermented milk. Table 2 shows the results.

[0022] [Table 2]

	Storage period (day(s))		
	1	3	6
pH	5.48	5.22	4.80
Acidity (%)	0.40	0.45	0.53
Viscosity (mPa·s)	3.5	2.9	8.0
Particle size (μm)	0.9	0.9	11.8
Precipitate	Not formed	Not formed	-
State	Liquid	Liquid	Solidified

[0023] In Table 2, until the time of "storage at 10°C for 3 days" where the liquid fermented milk had a pH of 5.0 or more, the effect of the present invention was achieved. However, after the time of "storage at 10°C for 6 days" where the liquid fermented milk had a pH of 4.80, the effect of the present invention was not achieved, because the viscosity and particle size increased and the liquid fermented milk was solidified due to coagulation of the milk. Therefore, it was found that the effect of the present invention can be achieved when the pressure for the homogenization treatment is adjusted to 30 MPa, and the pH of the liquid fermented milk during refrigerated storage is 5.0 or more.

[0024] [Comparative Example 1]

An experiment was carried out in the same manner as in Example 1 except that the pressure for the homogenization treatment was changed from 60 MPa to 0 MPa. The liquid fermented milk cooled in

the same manner as in Example 1 was stored while maintaining the liquid temperature at 10°C. At time points of 1, 4, and 5 days after the start of storage, physical properties including pH, acidity, viscosity, and particle size were measured, and the liquid fermented milk was visually observed to examine whether precipitates had been formed or not and the state of the liquid fermented milk. Table 3 shows the results.

[0025] [Table 3]

	Storage period (day(s))		
	1	4	5
pH	5.47	4.94	4.76
Acidity (%)	0.40	0.55	0.58
Viscosity (mPa·s)	4.4	41.9	17.3
Particle size (μm)	0.9	13.6	24.9
Precipitate	Not formed	Formed	-
State	Liquid	Paste-like	Solidified

[0026] In Table 3, even at the time of "storage at 10°C for 4 days" where the liquid fermented milk had a pH of 4.94, the effect of the present invention was not achieved, because the viscosity and particle size increased, the liquid fermented milk was being solidified on the bottom and had a paste-like form, and precipitates were formed. In Example 1, where the pressure for the homogenization treatment was 60 MPa, the effect of the present invention was achieved in the liquid fermented milk having a pH of 4.95. In contrast, in Comparative Example 1, where the pressure for the homogenization treatment was 0 MPa, the effect of the present invention was not achieved. Specifically, after the time of "storage at 10°C for 5 days" where the liquid fermented milk had a pH of 4.76, the effect

of the present invention was not achieved, because the viscosity and particle size increased and the liquid fermented milk was solidified due to coagulation of the milk.

Example 1, Example 2, and Comparative Example 1 demonstrate the following fact. In order to achieve the effect of the present invention, it is necessary to perform homogenization treatment (i.e. liquefaction) of fermented milk at a pressure of 30 MPa or more and to provide liquid fermented milk having a pH of 5.0 or more. It is possible to elongate the storage period by using lactic acid bacteria giving a long period to reach a pH of 5.0 during refrigerated storage.

Claims

1. A method of producing a liquid fermented milk having a pH of 5.4 or more, comprising:

(A) a curd preparation step of preparing a curd having a pH of 5.4 to 6.0 by adding lactic acid bacteria to a raw material, which does not comprise a thickener, of fermented milk and performing fermentation; and

(B) a homogenization treatment step of subjecting the curd to homogenization treatment at a pressure of 30 to 100 MPa to provide a liquid fermented milk having a pH of 5.4 to 6.0.

2. The method of producing a liquid fermented milk according to claim 1, wherein the temperature of the homogenization treatment in step (B) is 5 to 50°C.

3. The method of producing a liquid fermented milk according to claim 1 or 2, wherein the pressure of the homogenization treatment in step (B) is 50 to 100 MPa.

4. The method of producing a liquid fermented milk according to any one of claims 1 to 3, wherein the liquid fermented milk has a viscosity of 10 mPa·s or less.

5. The method of producing a liquid fermented milk according to any one of claims 1 to 4, wherein the liquid fermented milk has an acidity of 1.0% or less.

6. The method of producing a liquid fermented milk according to claim 5, wherein the liquid fermented milk has an acidity of

0.5% or less.