

DESCRIPTION

METHOD FOR PRODUCING FERMENTED MILK, AND DAIRY PRODUCT

Technical Field

[0001] The present invention relates to a method for producing fermented milk which can improve taste and quality of fermented milk simply and efficiently, and more particularly, to a method for producing fermented milk which can suppress changes in acidity and pH during refrigerated storage of a fermented milk-containing dairy product such as pre-fermentation type drinkable yogurt, soft stirred type yogurt, and the like.

Background Art

[0002] According to "Ministerial Ordinance Regarding Compositional Standards, etc. of Milk and Dairy Products", fermented milk is defined as a product obtained by subjecting milk or processed milk containing solid non-fat in an amount not less than that of milk to fermentation with a lactic acid bacterium or yeast to form a paste or a liquid, or a frozen product thereof. The fermented milk is broadly classified into: (a) hard yogurt (i.e. solid fermented milk or set type yogurt) obtained mainly by filling its material into a container, and then fermenting and solidifying the material in the container; (b) soft stirred type yogurt (i.e. pasty fermented milk) obtained by fermentation in a large tank or the like, the subsequent curd pulverization, and optional mixing with fruit pulp,

sauce or the like, followed by filling the obtained mixture into a container; and (c) drinkable yogurt (i.e. liquid fermented milk) obtained by fine crushing of hard yogurt or soft stirred type yogurt with a homogenizer or the like to enhance properties as a liquid, optional mixing with fruit pulp, sauce or the like, and the subsequent filling into a container.

[0003] According to the compositional standards of fermented milk defined in Japan, the ratio of solid non-fat (i.e. milk solid non-fat) in fermented milk should be 8% or more, and the number of lactic acid bacteria or yeast per ml should be 10,000,000 or more. Further, according to the international standards of yogurt defined by the Food and Agriculture Organization of the United Nations (FAO)/World Health Organization (WHO), a coagulated dairy product obtained by subjecting milk or a dairy product to lactic acid fermentation through actions of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* is defined as "yogurt".

[0004] The fermented milk such as yogurt contains viable cells of lactic acid bacteria. Hence, when the fermented milk is stored for a long period of time, there arises a problem in that an increase in acidity and a decrease in pH with time occur owing to lactic acid and the like to be generated by the lactic acid bacteria, and changes in taste and quality occur as compared to those immediately after production. In order to alleviate the problem, various methods have been proposed up to now.

[0005] As an example of such methods, there is a proposal

concerning a method for producing yogurt containing viable lactic acidbacteriumcells, comprising a step of adding lactic acid bacteria to a yogurt material composition to control a fermentation degree of milk in the composition to a desired degree, a step of leaving the resultant to stand at a low temperature, a step of heating the lactic acid bacteria under such temperature and time conditions that the temperature is equal to or higher than the limit temperature on high temperature side for growth arrest and that complete killing is not achieved, and a step of cooling the resultant (see Patent Reference 1 described below). In this method for producing yogurt, when the lactic acid bacteria are *Lactobacillus bulgaricus*, the limit temperature on high temperature side for growth arrest is 50 to 55°C, and the conditions for complete killing are, for example, 63°C for 30 minutes.

As another example of such methods, there is a proposal concerning fermented milk containing chitosan which can suppress an increase in acidity (see Patent Reference 2 described below).

Related Art References

List of Patent References

[0006] [Patent Reference 1] JP S50-6745 A

[Patent Reference 2] JP H03-292853 A

Summary of the Invention

Problems to be solved by the invention

[0007] The method of Patent Reference 1 includes a step of treating the lactic acid bacteria under particular heating conditions with regard to temperature and time after a step for fermentation. This method has the following problems. The adjustment of heating conditions is complicated. Also, thermal energy for heating is required excessively. Furthermore, the taste of yogurt may deteriorate under the conditions that the heating temperature is high.

In the method of Patent Reference 2, chitosan is used as an additive for fermented milk. In the conventional art, chitosan is not contained in fermented milk generally. The method of Patent Reference 2 has the following problems. The addition of chitosan degrades marketability. Also, the taste of fermented milk may be changed by the taste of chitosan.

[0008] The object of the present invention is to provide a method for producing fermented milk which does not require any complicated operations such as heating, use of an additive after fermentation, and the like, and which can suppress an increase in acidity and a decrease in pH with time, keep appropriate taste (e.g. sourness) over a long period of time, and maintain satisfactory quality.

Means for Solving the Problems

[0009] The inventors of the present invention have made intensive studies in order to solve the aforementioned problems, and have found that by adding rod-shaped lactic acid bacteria and

coccus-shaped lactic acid bacteria to a raw material of fermented milk and carrying out fermentation at a higher temperature (e.g. 44 to 49°C) than the conventional optimum temperature (i.e. approximately 38 to 43°C) for a fermentation step, an increase in acidity and a decrease in pH in a fermented milk-containing product during refrigerated storage can be suppressed with substantially no increase in fermentation time as compared to the case of carrying out fermentation at the conventional optimum temperature. The inventors have also found that in the case of carrying out fermentation at the fermentation temperature of the present invention (e.g. 44 to 46°C), there is substantially no change in viable cell counts (i.e. the number of viable cells) of rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria as compared to the case of carrying out fermentation at the conventional optimum temperature, and thus a commercial value in the market as a fermented milk-containing dairy product is not impaired. The inventors have also found that in the case of carrying out fermentation at the fermentation temperature of the present invention (e.g. 44 to 50°C), the taste and properties (i.e. quality) of a fermented milk-containing dairy product are maintained at equivalent levels as compared to the case of carrying out fermentation at the conventional optimum temperature, and thus a commercial value in the market is not impaired. Thus, the present invention has been completed.

[0010] That is, the present invention provides the following

items (1) to (8).

(1) A method for producing fermented milk, comprising a fermentation step of adding rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria to a raw material of fermented milk and carrying out fermentation at a fermentation temperature of from 44 to 55°C to yield fermented milk.

(2) The method for producing fermented milk according to the above-mentioned item (1), in which the fermentation temperature is 44 to 49°C.

(3) The method for producing fermented milk according to the above-mentioned item (1) or (2), in which a retention time of the fermentation temperature is 2 to 24 hours.

(4) The method for producing fermented milk according to any one of the above-mentioned items (1) to (3), in which the rod-shaped lactic acid bacteria are *Lactobacillus bulgaricus* and the coccus-shaped lactic acid bacteria are *Streptococcus thermophilus*.

(5) A dairy product, including the fermented milk produced by the method for producing fermented milk according to any one of the above-mentioned items (1) to (4).

(6) The dairy product according to the above-mentioned item (5), in which the dairy product is one selected from a drinkable yogurt (i.e. a yogurt drink) , a soft stirred type yogurt, a lactic acid bacteria beverage (i.e. a lactic fermented milk drink), and a set type yogurt.

(7) The dairy product according to the above-mentioned item (5)

or (6), in which when the dairy product is stored at a temperature of 10°C for 25 days from the completion of preparing the dairy product, the amount of increase in acidity (%) of the dairy product is 0.25% or less.

(8) The dairy product according to any one of the above-mentioned items (5) to (7), in which when the dairy product is stored at a temperature of 10°C for 25 days from the completion of preparing the dairy product, the amount of decrease in pH of the dairy product is 0.28 or less.

[0011] The term of "raw material of fermented milk" to be used in the present invention means a liquid containing a milk constituent such as raw milk, whole milk, skim milk, whey, and the like. The examples of the raw milk include animal milk such as cow's milk. Examples of the components which may constitute the raw material of fermented milk include raw milk, whole milk, skim milk, whey, and other processed products thereof (e.g. whole milk powder, condensed whole milk, skim milk powder, condensed skim milk, condensed milk, whey powder, cream, butter, cheese, and the like). In the case that a solid raw material such as whole milk powder is used, a liquid raw material of fermented milk may be prepared by adding a liquid such as water.

It should be noted that the raw material of fermented milk may be one generally called "yogurt mix" or the like, and may contain, in addition to the milk constituent, for example, a food ingredient or a food additive such as sugar, a saccharide, a sweetener, a

flavoring agent, fruit juice, fruit pulp, a vitamin, a mineral, or the like. Further, a stabilizer such as pectin, a soybean polysaccharide, carboxymethylcellulose (CMC), agar, gelatin or the like may be contained in the raw material of fermented milk as necessary.

[0012] The term of "fermented milk" in the present invention means (a) post-fermentation type yogurt such as set type yogurt (e.g. plain yogurt, hard yogurt, and the like), or (b) one which is an intermediate product after the completion (i.e. end) of the fermentation step and before the addition of an auxiliary raw material to be added after the fermentation step, and which is an intermediate product during the production (in other words, a product in the course of production other than a finished product) of a soft stirred type yogurt, a drinkable yogurt, or a lactic acid bacteria beverage.

Also, "fermented milk" in the present invention contains a milk constituent, and does not have a limitation on the ratio of solid non-fat and the viable cell count. That is, the "fermented milk" in the present invention is not limited to one containing 8% by weight or more of solid non-fat (narrowly-defined "fermented milk" defined by Ministerial Ordinance Regarding Compositional Standards, etc. of Milk and Dairy Products in Japan), and encompasses, for example, one containing at least 3% and less than 8% by weight of solid non-fat (narrowly-defined "dairy product" defined by Ministerial Ordinance Regarding Compositional Standards, etc. of Milk and Dairy Products in Japan) and one containing less than 3%

by weight of solid non-fat. Further, the "fermented milk" in the present invention is not limited to one in which the number of lactic acid bacteria per ml is 10,000,000 or more (narrowly-defined "fermented milk" defined by Ministerial Ordinance Regarding Compositional Standards, etc. of Milk and Dairy Products in Japan), and encompasses one in which the number of lactic acid bacteria per ml is less than 10,000,000.

The examples of "fermented dairy product" include pre-fermentation type yogurt such as soft stirred type yogurt, drinkable yogurt, and the like, and a lactic acid bacteria beverage, which are prepared by mixing an auxiliary raw material such as a sugar solution and the like with fermented milk (e.g. an intermediate product during the production of soft stirred type yogurt or drinkable yogurt) obtained by the method of the present invention. The auxiliary raw material may contain the food ingredient, food additive, stabilizer, or the like to be blended as necessary, which are exemplified in the explanation of the "raw material for fermented milk" described above.

Each of "dairy product" and "fermented dairy product" as used herein is not limited to one containing 3% by weight or more of solid non-fat (narrowly-defined "dairy products" defined by Ministerial Ordinance Regarding Compositional Standards, etc. of Milk and Dairy Products in Japan), and encompass one containing less than 3% by weight of solid non-fat.

"Dairy product" as used herein is a finished product (i.e.

a final product) and encompasses a set type yogurt, a soft stirred type yogurt, a drinkable yogurt, and a lactic acid bacteria beverage. The term of "finished product" means a product ready to be eaten or drunk by a consumer. The term of "finished product" means fermented milk in the case of post-fermentation type yogurt (i.e. set type yogurt), and means a fermented dairy product in the case of soft stirred type yogurt, drinkable yogurt, and a lactic acid bacteria beverage.

[0013] The term of "acidity" as used herein means a value measured by "5 Method for measuring acidity of milk and dairy products" described on page 56 in "Laws and Ordinances Regarding Milk" (Association of Dairy Companies for Hygiene, which is "Nyugyo Dantai Eisei Renraku Kyogikai" in Japanese; March 2004).

The details of this method are as follows. 10 ml of water free of carbon oxide gas is added to 10 ml of a sample to dilute the sample, and 0.5 ml of a phenolphthalein solution is added to the diluted sample as an indicator. The resultant is titrated with a 0.1 mol/L sodium hydroxide solution until the faint pink color persists for 30 seconds. Based on the titration amount, the percentage amount of lactic acid per 100 g of the sample is determined and used as the value of acidity. 1 ml of the 0.1 mol/L sodium hydroxide solution corresponds to 9 mg of lactic acid. The indicator is prepared by dissolving 1 g of phenolphthalein in 50% ethanol solution and adjusting the volume to 100 ml.

Advantageous Effects of the Invention

[0014] According to the present invention, by adding rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria to a raw material of fermented milk and carrying out fermentation at a higher temperature (e.g. 44 to 47°C) than the conventional optimum temperature (about 38 to 43°C) for a fermentation step, an increase in acidity with time in a fermented milk-containing product (i.e. a fermented milk or a fermented dairy product) during refrigerated storage can be suppressed to keep the acidity at an appropriate level as compared to the case of carrying out fermentation at the conventional optimum temperature. Thus, the deterioration in taste of fermented milk due to the excessively strong sourness of the fermented milk can be avoided. In addition, for example, the best-before date of about 14 days in the case of adding rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria to a raw material for fermented milk and carrying out fermentation at the conventional optimum temperature can be extended to about 20 to 30 days by carrying out fermentation at the fermentation temperature of the present invention.

[0015] Further, according to the present invention, in spite of adding rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria to a raw material for fermented milk and carrying out fermentation at a higher temperature (e.g. 44 to 46°C) than the conventional optimum temperature (about 38 to 43°C) for a fermentation step, there is substantially no change in viable cell

counts of rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria as compared to the case of carrying out fermentation at the conventional optimum temperature, and viable cell counts of rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria required for fermented milk can be ensured. Thus, a commercial value in the market as a fermented milk-containing dairy product is not impaired.

In addition, in the case of carrying out fermentation at the fermentation temperature of the present invention (e.g. 44 to 50°C), the taste and properties (i.e. quality) of a fermented milk-containing dairy product as a finished product are maintained at equivalent levels as compared to the case of carrying out fermentation at the conventional optimum temperature, and thus a commercial value in the market as a finished product is not impaired.

[0016] That is, according to the present invention, it is possible to provide the method for producing a fermented milk which does not require any complicated operation such as heating, use of an additive, and the like after a fermentation step and which can suppress an increase in acidity and a decrease in pH with time, keep appropriate taste over a long period of time, and maintain satisfactory quality.

Embodiments for Carrying Out the Invention

[0017] A method for producing a fermented milk according to the present invention includes a fermentation step including adding

rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria to a raw material of the fermented milk and carrying out fermentation at a fermentation temperature of from 44 to 55°C to yield the fermented milk.

In the present invention, the fermentation temperature is set to a higher value (i.e. 44 to 55°C) than the conventional optimum temperature (about 38 to 43°C). Hence, it is possible to suppress an increase in acidity and a decrease in pH in a fermented milk or a fermented dairy product containing the fermented milk. In the present invention, it seems that the vitality (i.e. activity) or cell count of microorganisms such as lactic acid bacteria, bifidobacteria and the like, or various components contained in a raw material of the fermented milk are affected by carrying out fermentation at the high temperature (i.e. 44 to 55°C), and as a result, for example, an increase in acidity during refrigerated storage can be suppressed.

The fermentation temperature in the present invention is a temperature that the lactic acid bacteria in fermented milk are not killed, and is 44 to 55°C, preferably 44 to 50°C, more preferably 44 to 49°C, even more preferably 44 to 48°C, even more preferably 44 to 47°C, even more preferably 45 to 47°C, even more preferably 45 to 46.5°C, most preferably 45 to 46°C.

Further, in the present invention, the difference between the fermentation temperature of the present invention and the upper limit value (i.e. 43°C) of the conventional optimum temperature

range (i.e. 38 to 43°C) is preferably 1 to 15°C, more preferably 2 to 12°C, even more preferably 2 to 10°C, even more preferably 2 to 8°C, even more preferably 2 to 7°C, even more preferably 2 to 6°C, even more preferably 2 to 5°C, most preferably 2 to 4°C.

In the present invention, the retention time of the fermentation temperature is preferably 2 to 24 hours, more preferably 3 to 12 hours, even more preferably 3.5 to 8 hours, most preferably 4 to 6 hours from the viewpoint of providing a fermented milk satisfactory in taste and properties efficiently.

[0018] Through the adoption of the fermentation conditions as described above, microorganisms in fermented milk (e.g. rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria) are not killed to ensure the viable cell counts required for fermented milk similarly to the case of carrying out fermentation at the conventional optimum temperature, and the taste and properties (i.e. quality) of a fermented milk or a fermented dairy product can be maintained at equivalent levels as compared to the case of carrying out fermentation at the conventional optimum temperature. It should be noted that in the case of the commercial-scale (in other words, mass) production of fermented milk, it is difficult to control the fermentation temperature under exactly the same condition, and hence it is recommended to set a fermentation condition on the assumption of upward and downward changes by about 1 to 2°C from a temperature to be set actually.

[0019] Next, lactic acid bacteria for being added and mixed

as a starter in a raw material of fermented milk are described.

Examples of the rod-shaped lactic acid bacteria to be used in the present invention include *Lactobacillus bulgaricus* and *Lactobacillus lactis*.

Examples of the coccus-shaped lactic acid bacteria to be used in the present invention include *Streptococcus thermophilus*.

In the present invention, in addition to the rod-shaped lactic acid bacteria and the coccus-shaped lactic acid bacteria, other microorganisms may also be used. Examples of the other microorganisms include yeast.

A preferred combination of the rod-shaped lactic acid bacteria and the coccus-shaped lactic acid bacteria to be used in the present invention is ,for example, the combination of *Lactobacillus bulgaricus* as the rod-shaped lactic acid bacteria and *Streptococcus thermophilus* as the coccus-shaped lactic acid bacteria. This combination is preferably used in the present invention, because this combination gives distinctive richness and freshness to yogurt to make the consumers to have high preference, and the yogurt obtained by using the combination is approved as "yogurt" in the international standards. That is, from the viewpoint of sufficiently exhibiting the effect of the present invention, it is desired to use at least *Lactobacillus bulgaricus* as the rod-shaped lactic acid bacteria and use at least *Streptococcus thermophilus* as the coccus-shaped lactic acid bacteria. It should be noted that in the present invention, it is not necessary to use a mutant strain having specific

properties as the rod-shaped lactic acid bacteria or coccus-shaped lactic acid bacteria, and a bacterial strain for general use may be used.

[0020] The fermented milk to be obtained in the present invention may be used for the production of a fermented dairy product. In this case, examples of the fermented dairy product include drinkable yogurt, soft stirred type yogurt, and a lactic acid bacteria beverage.

In the present invention, among forms of a fermented milk (i.e. set type yogurt) and a fermented milk product (i.e. a drinkable yogurt, a soft stirred type yogurt, and a lactic acid bacteria beverage) as finished products, in general, the degree of an influence by a sensory change in sourness (i.e. taste) due to an increase in acidity and a decrease in pH during refrigerated storage is the largest in liquid form such as drinkable yogurt (i.e. pre-fermentation type) and the lactic acid bacterium beverage, is the second largest in paste form such as soft stirred type yogurt (i.e. pre-fermentation type), and is relatively small in solid form such as set type yogurt (i.e. post-fermentation type). That is, although the effect of the present invention can be certainly obtained regardless of the forms of the finished products, the effect of the present invention is more remarkable in the case of the pre-fermentation type such as drinkable yogurt and soft stirred type yogurt which are liable to be affected by a change in sourness. Further, the effect of the present invention is most remarkable

in the case of drinkable yogurt which is particularly liable to be affected by the surrounding environment because of its liquid form. Furthermore, the effect of the present invention can be expected to be obtained similarly in a yogurt-based beverage containing lactic acid bacteria (e.g. viable cells) such as a lactic acid bacteria beverage, which is not classified as fermented milk in Ministerial Ordinance Regarding Compositional Standards, etc. of Milk and Dairy Products in Japan but has a form close to drinkable yogurt.

[0021] The method for producing fermented milk according to the present invention may include a pasteurization step and the like before the fermentation step. Examples of the pasteurization step include a ultra high temperature (abbreviated as "UHT") pasteurization method including a heating treatment under the condition of, for example, 120 to 150°C for 1 second to 60 seconds, and a high temperature short time (abbreviated as "HTST") pasteurization method including a heating treatment under the condition of, for example, 80 to 100°C for 10 seconds to 30 minutes.

[0022] The method for producing fermented milk according to the present invention may include a cooling step, a curd crushing step, an auxiliary raw material addition step, and the like after the fermentation step.

In the cooling step, for example, the fermented milk is cooled from the fermentation temperature to a predetermined low temperature (e.g. 10°C or less as a condition in labeling of "Keep Refrigerated").

In the curd crushing step, for example, the fermented milk is subjected to stirring, pressurization, and the like to achieve the reduction in particle size (i.e. micronization) and dispersion of fermented milk curd. It should be noted that the curd crushing step also encompasses the case where the fermented milk is homogenized to liquefy fermented milk curd, for example.

In the auxiliary raw material addition step, for example, a component (i.e. auxiliary raw material) other than fermented milk, such as a sugar solution, fruit juice, fruit pulp, or a fruit preparation is mixed with fermented milk, and the obtained mixture is stirred. It should be noted that the auxiliary raw material addition step also encompasses the case where the auxiliary raw material is mixed with fermented milk in a tank or the like, and the obtained mixture is stirred to be stabilized.

[0023] The method for producing fermented milk according to the present invention may include other steps such as the curd crushing step and the auxiliary raw material addition step as necessary in addition to steps to be generally included, i.e. the pasteurization step, the fermentation step, and the cooling step.

Any one of the curd crushing step and the auxiliary raw material addition step may be included alone, or both of the steps may be included in the method of the present invention. Further, in the case where both of the steps are included, in general, the auxiliary raw material addition step is included after the curd crushing step.

[0024] When the fermented milk or the dairy product containing

the fermented milk to be obtained in the present invention (hereinafter, referred to as "fermented milk or the like of the present invention") is stored at a temperature of 10°C for 25 days from the end of the preparation of a finished product (in more detail, in the case where the finished product is a fermented milk, the end of the fermentation step of the fermented milk, and in the case where the finished product is a dairy product other than fermented milk, the end of the preparation step of the dairy product), the amount of increase in acidity (%) for 25 days (in other words, a value obtained by subtracting a value of acidity after 0 days from a value of acidity after 25 days) is preferably 0.25% or less, more preferably 0.23% or less, even more preferably 0.20% or less, particularly preferably 0.18% or less. The lower limit of the value is not particularly limited, is preferably as small as possible, and is generally 0.10%.

Further, when the fermented milk or the like of the present invention is stored at a temperature of 10°C for 25 days from the end of the preparation of a finished product, the acidity (%) after the lapse of 25 days is preferably 0.98% or less, more preferably 0.96% or less, even more preferably 0.93% or less, particularly preferably 0.91% or less. The lower limit of the value is not particularly limited, and is generally 0.80%.

[0025] When the fermented milk or the like of the present invention is stored at a temperature of 10°C for 12 days from the end of the preparation of a finished product, the amount of increase

in acidity (%) for 12 days is preferably 0.18% or less, more preferably 0.17% or less, even more preferably 0.15% or less, particularly preferably 0.13% or less. The lower limit of the value is not particularly limited, is preferably as small as possible, and is generally 0.10%.

Further, when the fermented milk or the like of the present invention is stored at a temperature of 10°C for 12 days from the end of the preparation of a finished product, the acidity (%) after the lapse of 12 days is preferably 0.91% or less, more preferably 0.90% or less, even more preferably 0.88% or less, even more preferably 0.86% or less. The lower limit of the value is not particularly limited, and is generally 0.80%.

[0026] When the fermented milk or the like of the present invention is stored at a temperature of 10°C for 25 days from the end of the preparation of a finished product, the amount of decrease in pH for 25 days (in other words, a value obtained by subtracting a value of pH after 25 days from a value of pH after 0 days) is preferably 0.28 or less, more preferably 0.25 or less, even more preferably 0.20 or less, particularly preferably 0.15 or less. The lower limit of the value is not particularly limited, is preferably as small as possible, and is generally 0.05.

When the fermented milk or the like of the present invention is stored at a temperature of 10°C for 25 days from the end of the preparation of a finished product, pH after the lapse of 25 days is preferably 3.90 or more, more preferably 3.95 or more, even more

preferably 4.00 or more, particularly preferably 4.05 or more. The upper limit of the value is not particularly limited, and is generally 4.20.

[0027] When the fermented milk or the like of the present invention is stored at a temperature of 10°C for 12 days from the end of the preparation of a finished product, the amount of decrease in pH for 12 days is preferably 0.20 or less, more preferably 0.18 or less, even more preferably 0.15 or less, particularly preferably 0.10 or less. The lower limit of the value is not particularly limited, is preferably as small as possible, and is generally 0.05.

When the fermented milk or the like of the present invention is stored at a temperature of 10°C for 12 days from the end of the preparation of a finished product, pH after the lapse of 12 days is preferably 3.95 or more, more preferably 4.00 or more, even more preferably 4.05 or more, even more preferably 4.10 or more. The upper limit of the value is not particularly limited, and is generally 4.20.

[0028] In the present invention, when the acidity or pH falls within the preferred range described above, the best-before date of a fermented milk-containing product (i.e. a fermented milk or a fermented dairy product) as a finished product can be sufficiently extended.

Meanwhile, in the fermented milk or fermented dairy product, in general, in order to suppress sourness to provide mild taste, a sweetener or the like is added to enhance sweetness and to strike

a balance between sourness and sweetness for increasing preference (i.e. palatability). In this regard, in the present invention, sourness derived from the fermented milk or fermented dairy product can be suppressed, because an increase in acidity and a decrease in pH are suppressed. Hence, the amount of the sweetener or the like to be added can be reduced. In this case, fermented milk or a fermented dairy product, which has light sourness while maintaining richness and freshness inherent in the fermented milk or fermented dairy product, can be provided.

Examples

[0029] Hereinafter, the present invention is explained by way of Examples. However, it should be noted that the present invention is not limited to the following Examples. For example, the present invention is applicable to set type yogurt as well.

[0030] [Example 1; Case of carrying out fermentation at a high temperature of 45°C (laboratory-scale experiment)]

A raw material of fermented milk (i.e. yogurt mix) was prepared by mixing 705 g of skim milk powder with 4,195 g of tap water. The raw material of fermented milk was subjected to heat sterilization at 95°C for 10 minutes and then cooled to 45°C. Next, 100 g of a mixed starter of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* each isolated from "Meiji Bulgaria Yogurt" (trade name; manufactured by Meiji Dairies Corporation) were inoculated therein. The resultant was subjected to fermentation in a tank at 45°C. The

fermentation step was terminated at the fermentation time of 5 hours when the acidity reached 1.20% through the generation of lactic acid. The resultant was then cooled to 10°C or less to yield fermented milk. It should be noted that the fermentation time of 5 hours was the same as that of Comparative Example 1 described below in which fermentation was carried out at the conventional optimum temperature.

[0031] The resultant fermented milk was homogenized through first pressurization at about 10 MPa and second pressurization at about 5 MPa to yield liquid fermented milk. The liquid fermented milk was then mixed with a sugar solution (i.e. aqueous solution obtained by blending 5.5 mass% (in other words, % by weight) of sugar, 16 mass% of high-fructose corn syrup, and 0.6 mass% of pectin) at a mass ratio of 6:4 to yield a fermented dairy product (i.e. drinkable yogurt) as a finished product. The resultant fermented dairy product was stored at 10°C, and changes with time in acidity, pH, viscosity, and viable cell counts of rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria in the fermented dairy product were examined with a starting point of the fermented dairy product being in a fresh state immediately after preparation. It should be noted that the viable cell count of each of rod-shaped lactic acid bacteria and viable coccus-shaped lactic acid bacteria is a numerical value obtained by measuring the number of colonies per ml (i.e. colony forming unit) of a fermented dairy product.

[0032] [Example 2; Case of carrying out fermentation at a high

temperature of 47°C (laboratory-scale experiment)]

A raw material of fermented milk (i.e. yogurt mix) was prepared by mixing 705 g of skim milk powder with 4,195 g of tap water. The raw material of fermented milk was subjected to heat sterilization at 95°C for 10 minutes and then cooled to 47°C. Next, 100 g of a mixed starter were inoculated therein in the same manner as that in Example 1. The resultant was subjected to fermentation in a tank at 47°C. The fermentation step was terminated at the fermentation time of 5.5 hours when the acidity reached 1.20% through the generation of lactic acid. The resultant was then cooled to 10°C or less to yield fermented milk. It should be noted that the fermentation time of 5.5 hours was substantially the same as that of Comparative Example 1 described below in which fermentation was carried out at the conventional optimum temperature.

[0033] The resultant fermented milk was subjected to the same procedure as that in Example 1 to yield a fermented dairy product (i.e. drinkable yogurt) as a finished product. With regard to the resultant fermented dairy product, changes with time in acidity, pH, viscosity, and viable cell counts of rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria in the fermented dairy product were examined in the same manner as those in Example 1.

[0034] [Comparative Example 1; Case of carrying out fermentation at the conventional optimum temperature of 43°C (laboratory-scale experiment)]

A raw material of fermented milk (i.e. yogurt mix) was prepared by mixing 705 g of skim milk powder with 4,195 g of tap water. The raw material of fermented milk was subjected to heat sterilization at 95°C for 10 minutes and then cooled to 43°C. Next, 100 g of a mixed starter were inoculated therein in the same manner as that in Example 1. The resultant was subjected to fermentation in a tank at 43°C. The fermentation step was terminated at the fermentation time of 5 hours when the acidity reached 1.20% through the generation of lactic acid. The resultant was then cooled to 10°C or less to yield fermented milk.

[0035] The resultant fermented milk was subjected to the same procedure as that in Example 1 to yield a fermented dairy product (i.e. drinkable yogurt) as a finished product. With regard to the resultant fermented dairy product, changes with time in acidity, pH, viable cell counts of rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria, and viscosity in the fermented dairy product were examined in the same manner as those in Example 1.

[0036] Tables 1 to 4 show changes with time in acidity, pH, and viable cell counts of rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria, respectively, in the fermented dairy products of Example 1, Example 2, and Comparative Example 1.

[0037] [Table 1]

Change with time in acidity in fermented dairy product
(laboratory scale)

Acidity (%)	Number of days elapsed (days)				
	0	5	12	17	25
Example 1	0.73	0.82	0.88	0.92	0.93
Example 2	0.73	0.81	0.85	0.87	0.88
Comparative Example 1	0.73	0.84	0.94	0.97	1.00

[0038] [Table 2]

Change with time in pH in fermented dairy product
(laboratory scale)

pH	Number of days elapsed (days)				
	0	5	12	17	25
Example 1	4.24	4.16	4.15	4.08	4.05
Example 2	4.24	4.19	4.17	4.18	4.14
Comparative Example 1	4.14	3.95	3.91	3.87	3.84

[0039] [Table 3]

Change with time in viable cell count of rod-shaped lactic acid bacteria in fermented dairy product (laboratory scale)

Viable cell count of rod-shaped lactic acid bacteria ($\times 10^7$ cfu/ml)	Number of days elapsed (days)				
	0	5	12	17	25
Example 1	7.0	5.0	6.0	4.5	4.0
Example 2	7.0	4.5	6.0	5.5	4.5
Comparative Example 1	7.0	6.0	5.0	4.5	4.0

[0040] [Table 4]

Change with time in viable cell count of coccus-shaped lactic acid bacteria in fermented dairy product (laboratory scale)

Viable cell count of coccus-shaped lactic acid bacteria ($\times 10^7$ cfu/ml)	Number of days elapsed (days)				
	0	5	12	17	25
Example 1	125	95	95	80	55
Example 2	90	70	70	65	45
Comparative Example 1	130	100	95	80	55

[0041] As shown in Tables 1 and 2, an increase in acidity and a decrease in pH during refrigerated (i.e. 10°C or less) storage were suppressed in Example 1 in which fermentation was carried out at a high temperature (i.e. 45°C) as well as in Example 2 in which fermentation was carried out at a high temperature (i.e. 47°C) as compared to Comparative Example 1 in which fermentation was carried out at the conventional optimum temperature (i.e. 43°C).

[0042] Tables 1 and 2 reveal that an increase in acidity and a decrease in pH were suppressed in the storage for 25 days (about 4 weeks) in Examples 1 and 2 as compared to those in the storage for 12 to 17 days in Comparative Example 1. This indicates that the best-before date of the fermented milk or fermented dairy product can be extended by the present invention.

Meanwhile, in the fermented milk or fermented dairy product, in general, in order to suppress sourness to provide mild taste, a sweetener or the like is added to enhance sweetness and to strike a balance between sourness and sweetness for increasing preference. According to the present invention, sourness derived from the fermented milk or fermented dairy product can be suppressed through the suppression of an increase in acidity and a decrease in pH. Hence, the amount of the sweetener or the like to be added can be reduced in the present invention. In this case, fermented milk or a fermented dairy product, which has light sourness while maintaining richness and freshness inherent in the fermented milk or fermented dairy product, can be provided.

[0043] On the other hand, as shown in Tables 3 and 4, there was no significant difference in changes with time in counts of rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria between Example 1 in which fermentation was carried out at a high temperature (i.e. 45°C) and Comparative Example 1 in which fermentation was carried out at a conventional optimum temperature (i.e. 43°C), as well as between Example 2 in which fermentation was carried out at a high temperature (i.e. 47°C) and Comparative Example 1. In addition, it was able to be confirmed that in each of Examples 1 and 2, the viable cell count per ml of lactic acid bacteria was 10,000,000 (i.e. 1×10^7) cfu or more, sufficiently satisfying the standard of fermented milk in Japan. Further, although not shown in the Tables, the viscosity as an indicator of the properties (i.e. quality) of the fermented dairy product were examined. As a result, there was no significant difference in change with time in viscosity between Example 1 in which fermentation was carried out at a high temperature (i.e. 45°C) and Comparative Example 1 in which fermentation was carried out at the conventional optimum temperature (i.e. 43°C), as well as between Example 2 in which fermentation was carried out at a high temperature (i.e. 47°C) and Comparative Example 1. In other words, it was able to be confirmed that no increase in viscosity during refrigerated (i.e. 10°C or less) storage occurred.

[0044] The results of Example 1, Example 2, and Comparative Example 1 reveal that by carrying out fermentation at a higher

temperature (i.e. 45 to 47°C) than a fermentation temperature which has been said to be the conventional optimum temperature during the preparation of fermented milk or a fermented dairy product, the standard and commercial value of a fermented milk-containing dairy product can be sufficiently satisfied, and the generation of an acid during refrigerated storage can be suppressed, while keeping a fermentation time equivalent to the conventional one.

[0045] [Example 3; Case of carrying out fermentation at a high temperature of 45 to 47°C (real-scale experiment)]

A raw material of fermented milk (i.e. yogurt mix) was prepared by mixing 1.4 tons of skim milk powder with 8.4 tons of tap water. The raw material of fermented milk was subjected to heat sterilization at 95°C for 10 minutes and then cooled to about 45°C. Next, 0.2 ton of a mixed starter of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* each isolated from "Meiji Bulgaria Yogurt" was inoculated therein. Fermentation was started in a tank at about 45°C. The fermentation step was terminated at the fermentation time of 4 hours when the acidity reached 1.10% through the generation of lactic acid. The resultant was then cooled to 10°C or less to yield fermented milk. It should be noted that the fermentation time of 4 hours was the same as that of Comparative Example 2 described below in which fermentation was carried out at the conventional optimum temperature. At the time when 4 hours elapsed as the fermentation time, the fermentation temperature reached about 47°C through the progression of the fermentation. Further, the

fermentation temperature was not entirely uniform in the tank, and an outer portion and an inner (i.e. central) portion had different temperatures. The temperatures of about 45°C and about 47°C described above are measured at the outermost point in the tank. The innermost point (i.e. central point) has a higher temperature than that of the outermost point by about 2.0°C.

[0046] The resultant fermented milk was homogenized through first pressurization at about 10 MPa and second pressurization at about 5 MPa to yield liquid fermented milk. The liquid fermented milk was then mixed with a sugar solution (i.e. aqueous solution obtained by blending 5.5 mass% of sugar, 16 mass% of high-fructose corn syrup, and 0.6 mass% of pectin) at a mass ratio of 6:4 to yield a fermented dairy product (i.e. drinkable yogurt) as a finished product. The resultant fermented dairy product was stored at 10°C and 5°C, and changes with time in the amount of increase in acidity in the fermented dairy product were examined with a starting point of the fermented dairy product being in a fresh state immediately after preparation.

[0047] [Example 4; Case of carrying out fermentation at a high temperature of 47 to 49°C (real-scale experiment)]

A raw material of fermented milk (i.e. yogurt mix) was prepared by mixing 1.4 tons of skim milk powder with 8.4 tons of tap water. The raw material of fermented milk was subjected to heat sterilization at 95°C for 10 minutes and then cooled to about 47°C. Next, 0.2 ton of a mixed starter was inoculated therein in the same manner

as that in Example 3. Fermentation was started in a tank at about 45°C. The fermentation step was terminated at the fermentation time of 4.7 hours when the acidity reached 1.10% through the generation of lactic acid. The resultant was then cooled to 10°C or less to yield fermented milk. It should be noted that the fermentation time of 4.7 hours was somewhat longer than that of Comparative Example 2 described below in which fermentation was carried out at the conventional optimum temperature. At the time when 4.7 hours elapsed as the fermentation time, the fermentation temperature reached about 49°C through the progression of the fermentation. Further, the fermentation temperature was not entirely uniform in the tank, and an outer portion and an inner (i.e. central) portion had different temperatures. It should be noted that the measurement points and the difference in temperatures in the tank were the same as those in Example 3.

[0048] The resultant fermented milk was subjected to the same procedure as that in Example 3 to yield a fermented dairy product (i.e. drinkable yogurt) as a finished product. With regard to the resultant fermented dairy product, changes with time in the amount of increase in acidity in the fermented dairy product were examined in the same manner as that in Example 3.

[0049] [Comparative Example 2; Case of carrying out fermentation at the conventional optimum temperature of 43 to 44°C (real-scale experiment)]

A raw material of fermented milk (i.e. yogurt mix) was prepared

by mixing 1.4 tons of skim milk powder with 8.4 tons of tap water. The raw material of fermented milk was subjected to heat sterilization at 95°C for 10 minutes and then cooled to about 43°C. Next, 0.2 ton of a mixed starter was inoculated therein in the same manner as that in Example 3. Fermentation was started in a tank at about 43°C. The fermentation step was terminated at the fermentation time of 4 hours when the acidity reached 1.10% through the generation of lactic acid. The resultant was then cooled to 10°C or less to yield fermented milk. At the time when 4 hours elapsed as the fermentation time, the fermentation temperature reached about 44°C through the progression of the fermentation. Further, the fermentation temperature was not entirely uniform in the tank, and an outer portion and an inner (i.e. central) portion had different temperatures. It should be noted that the measurement points and the difference in temperatures in the tank were the same as those in Example 3.

[0050] The resultant fermented milk was subjected to the same procedure as that in Example 3 to yield a fermented dairy product (i.e. drinkable yogurt) as a finished product. With regard to the resultant fermented dairy product, changes with time in the amount of increase in acidity in the fermented dairy product were examined in the same manner as that in Example 3.

[0051] Table 5 (storage temperature: 10°C) and Table 6 (storage temperature: 5°C) show changes with time in the amount of increase in acidity in the fermented dairy products of Example 3, Example

4, and Comparative Example 2.

[0052] [Table 5]

Change with time in the amount of increase in acidity in
fermented dairy product (real scale; storage temperature: 10°C)

Amount of increase in acidity (%)	Number of days elapsed (days)					
	0	7	12	18	27	36
Example 3	0	0.08	0.13	0.14	0.16	0.16
Example 4	0	0.03	0.06	0.06	0.08	0.08
Comparative Example 2	0	0.14	0.21	0.26	0.28	0.28

[0053] [Table 6]

Change with time in the amount of increase in acidity in
fermented dairy product (real scale; storage temperature: 5°C)

Amount of increase in acidity (%)	Number of days elapsed (days)					
	0	7	12	18	27	36
Example 3	0	0.05	0.07	0.09	0.11	0.11
Example 4	0	0.01	0.03	0.04	0.06	0.06
Comparative Example 2	0	0.07	0.14	0.17	0.18	0.18

[0054] As shown in Tables 5 and 6, an increase in acidity was suppressed in the storage for 36 days (i.e. 1 month or more) in Examples 3 and 4 as compared to the storage for 7 to 12 days in Comparative Example 2. This indicates that the best-before date of the fermented milk or fermented dairy product can be extended by the present invention. Meanwhile, according to the present invention, sourness derived from the fermented milk or fermented dairy product can be suppressed through the suppression of an increase in acidity. Hence, the amount of the sweetener or the like to be added can be reduced. In this case, fermented milk or a fermented dairy product, which has light sourness while maintaining richness

and freshness inherent in the fermented milk or fermented dairy product, can be provided.

[0055] The fermented dairy products of Example 3 and Comparative Example 2 were each subjected to sensory evaluation by twelve specialized panelists. In this sensory evaluation, degrees of sourness, sweetness, aftertaste, and texture (i.e smoothness) were selected as evaluation items, and evaluation scores were expressed with five grades of "2, 1, 0, -1, and -2." With regard to these grades, larger numerical values in the evaluation scores mean "stronger" in sourness and sweetness, and mean "better" in aftertaste and texture. A smaller numerical value is better for sourness, and a larger numerical value is better for sweetness, aftertaste, and texture. Table 7 shows changes with time in average values of the evaluation scores given by twelve specialized panelists in this sensory evaluation.

[0056] [Table 7]

**Change with time in sensory evaluation in fermented dairy product
(real scale; storage temperature: 10°C)**

	Sensory evaluation items	Number of days elapsed (days)			
		7	18	27	36
Example 3	Strength of sourness	0.0	-0.5	-0.5	-0.5
Comparative Example 2		1.5	1.5	1.5	1.5
Example 3	Strength of sweetness	0.5	1.0	0.5	0.5
Comparative Example 2		-0.5	-0.5	0.0	-0.5
Example 3	Goodness of aftertaste	0.0	0.0	0.5	0.0
Comparative Example 2		0.0	0.0	0.0	0.5
Example 3	Goodness of texture	0.0	0.5	1.0	0.0
Comparative Example 2		0.0	-0.5	0.0	0.0

[0057] As shown in Table 7, Example 3 is evaluated to have weaker sourness, stronger sweetness, equivalent aftertaste, and better texture as compared to Comparative Example 2. This indicates that according to the present invention, it is possible to enhance sweetness while suppressing sourness of fermented milk or a fermented dairy product, and to improve the texture while maintaining the aftertaste unchanged. From this sensory evaluation, it was confirmed that according to the present invention, it was possible to provide fermented milk or a fermented dairy product, which has light sourness while maintaining richness and freshness inherent in the fermented milk or fermented dairy product, as a stored product after refrigerated storage as well as a fresh product immediately after production. The result obtained in the sensory evaluation was similar to the result in Examples described above.

Industrial Applicability

[0058] According to the present invention, changes in acidity and pH during refrigerated storage can be suppressed while maintaining a commercial value as a fermented milk-containing dairy product without adding any new step such as heating or use of an additive after a fermentation step. Thus, even when a fermented milk as an intermediate product during production (e.g. fermented milk as a raw material for drinkable yogurt), or a finished product such as fermented milk (e.g. set type yogurt) or a fermented dairy product (e.g. drinkable yogurt) is stored for a long period of time,

changes with time in taste and quality can be suppressed as compared to taste and quality of a fresh product immediately after the production. Hence, the best-before date can be extended. In addition, the amount to be used of a flavoring agent, a sweetener, or the like, which has been added in order to artificially adjust the taste and quality of fermented milk or a fermented dairy product, can be reduced.

CLAIMS

1. A method for producing fermented milk, comprising a fermentation step of adding rod-shaped lactic acid bacteria and coccus-shaped lactic acid bacteria to a raw material of fermented milk and carrying out fermentation at a fermentation temperature of from 44 to 55°C to yield fermented milk.
2. The method for producing fermented milk according to claim 1, wherein the fermentation temperature is 44 to 49°C.
3. The method for producing fermented milk according to claim 1 or 2, wherein a retention time of the fermentation temperature is 2 to 24 hours.
4. The method for producing fermented milk according to any one of claims 1 to 3, wherein the rod-shaped lactic acid bacteria are *Lactobacillus bulgaricus* and the coccus-shaped lactic acid bacteria are *Streptococcus thermophilus*.
5. A dairy product, comprising the fermented milk produced by the method for producing fermented milk according to any one of claims 1 to 3.
6. The dairy product according to claim 5, wherein the dairy product is one selected from a drinkable yogurt, a soft stirred

type yogurt, a lactic acid bacteria beverage, and a set type yogurt.

7. The dairy product according to claim 5 or 6, wherein when the dairy product is stored at a temperature of 10°C for 25 days from the completion of preparing the dairy product, the amount of increase in acidity (%) of the dairy product is 0.25% or less.

8. The dairy product according to any one of claims 5 to 7, wherein when the dairy product is stored at a temperature of 10°C for 25 days from the completion of preparing the dairy product, the amount of decrease in pH of the dairy product is 0.28 or less.