DESCRIPTION

Title of Invention: METHOD FOR PRODUCING FERMENTED MILK HAVING IMPROVED PHYSICAL PROPERTIES

Technical Field

[0001]

The present invention relates to a method for producing fermented milk with a smooth texture that is excellent in quality due to suppressed change in physical properties caused by coagulation of milk protein during chilled storage or distribution (occurrence of syneresis, an increase in particle size of milk protein (coagulated particles), or thus-developed grainy texture).

Background Art

[0002]

It is known that milk-derived protein in fermented milk, such as yogurt, coagulates during chilled storage or chilled transport (distribution), and that its physical properties (texture) change accordingly. Specifically, it is known that the coagulation of milk protein causes syneresis, and that the particles of milk protein generated due to coagulation become larger over time, which leads to a gritty feeling in the mouth; thus, both the appearance and flavor worsen, which results in a decrease in quality.

[0003]

In order to solve this problem, PTL 1 proposes a method comprising adding a specific amount of whey hydrolysate to a raw milk material, fermenting the mixture to produce fermented milk, and homogenizing the fermented milk; PTL 1 teaches that this method can produce a fermented milk beverage (drinking yogurt) in which coagulation and precipitation of suspended milk protein particles are suppressed. PTL 2 proposes a method comprising adding a specific amount of high-purity whey protein to a raw

milk material, fermenting the mixture to produce fermented milk, and homogenizing the fermented milk as with the above method; PTL 2 teaches that this method can produce fermented milk having a moderate viscosity and smooth texture (soft fermented milk) without adding a thickener. PTL 3 and 4 disclose that fermented milk having a smooth mouthfeel and texture can be produced by incorporating a step of extruding fermented milk curd through a mesh or nozzle having a predetermined opening size in the production of soft fermented milk. However, none of these methods can be applied to static fermented milk (hard yogurt and set type yogurt), and none of the references teaches the use of glucose oxidase.

[0004]

PTL 5 to 8 also disclose that peroxidase is added together with a lactic acid bacteria starter to a mix of starting milk materials for fermented milk and the mixture is fermented; thus, whey separation and protein coagulation that occur during the storage or distribution process are suppressed, thereby producing fermented milk products with a fine and smooth texture. However, there is no teaching regarding the use of glucose oxidase in these references either.

[0005]

Glucose oxidase has been known to have an antibacterial effect. The antibacterial effect is because of glucose oxidase oxidizing glucose to thereby generate hydrogen peroxide. As a method for producing fermented milk using this antibacterial effect of glucose oxidase, PTL 9 discloses a method for producing an antibody-containing fermented food product in which glucose oxidase is added to raw milk as a hydrogen-peroxide generator to kill harmful microorganisms in the raw milk while preventing the antibody from being deactivated by heating, and subsequently fermentation is performed using lactic acid bacteria. In PTL 9, however, glucose oxidase is disclosed together with its substrate, glucose, merely as a hydrogen-peroxide generator, i.e., a bactericide. Moreover, in the production method disclosed in PTL

9, heating treatment at 63°C or above must be avoided to prevent the antibody from being deactivated; thus, there is no problem of milk protein coagulation. In other words, suppressing a change in physical properties caused by coagulation of milk protein is not an object to be achieved in PTL 9, and the use of glucose oxidase to address such a problem is therefore not suggested.

[0006]

PTL 10 teaches that fermented milk excellent in quality due to suppressed change in physical properties caused by coagulation of milk protein (occurrence of syneresis, an increase in particle size of milk protein, or thus-developed grainy texture) can be produced by adding to a raw milk material a substrate for glucose oxidase (glucose) or a substance that can serve as a substrate for glucose oxidase in a specific amount or more in addition to glucose oxidase. However, PTL 10 neither discloses nor suggests that adding glucose oxidase alone to a raw milk material (i.e., without adding a substrate for glucose oxidase (glucose) or a substance that can serve as a substrate for glucose oxidase to a raw milk material) can bring about such a desired effect (suppression of change in physical properties caused by coagulation of milk protein (occurrence of syneresis, an increase in particle size of milk protein, or thus-developed grainy texture)).

Citation List

Patent Literature

[0007]

PTL 1: JP2007-006738A

PTL 2: JPH07-000104A

PTL 3: WO2006/057265 pamphlet

PTL 4: WO2006/057266 pamphlet

PTL 5: JPS62-228224A

PTL 6: JPH06-276933A

PTL 7: JPH10-262550A

PTL 8: JPH10-099019A

PTL 9: JP2007-053930A

PTL 10: WO2012/121090 pamphlet

Summary of Invention

Technical Problem

[0008]

An object of the present invention is to provide a method for producing fermented milk in which a change in physical properties caused by coagulation of milk protein, which occurs during chilled storage or distribution, is suppressed, and specifically to provide a method for producing fermented milk in which occurrence of syneresis, an increase in particle size of milk protein (coagulated particles), or thus-developed grainy texture is suppressed. Further, an object of the present invention is to provide a method for suppressing the change in physical properties caused by coagulation of milk protein of fermented milk.

Solution to Problem

[0009]

To solve this problem, the present inventors conducted extensive research and found that, as compared to when no glucose oxidase is added, adding glucose oxidase, without adding (blending) glucose or a substance that generates glucose, to a raw milk material and allowing glucose oxidase to act in the production process of fermented milk significantly suppresses syneresis or an increase in particle size of milk protein (coagulated particles), which occurs over time along with coagulation of milk protein, and also significantly suppresses an increase in firmness and a decrease in viscosity, which are observed over time in fermented milk produced by adding no glucose oxidase, thereby providing a fermented milk having an excellent mouthfeel (texture), which is smooth and viscous (with a stringiness) (see Experimental Example 1 below). The present inventors also found that the viscosity (stringiness) of the

fermented milk, in combination with the fat content of the fermented milk, is a factor that provides the richness to the fermented milk (see Experimental Example 2 below). The inventors further found that syneresis and an increase in coagulated particles occurring over time in cold storage are significantly suppressed, and a certain level of stability is observed immediately after the production in fermented milk produced by adding glucose oxidase as compared to fermented milk produced by adding glucose oxidase together with its substrate, glucose, or a substance that generates glucose (see Experimental Example 1 below).

[0010]

The present inventors confirmed that fermented milk with such stable physical properties does not lose the original flavor of fermented milk and keeps the suitable physical properties and excellent flavor required in fermented milk, even when the fermented milk is distributed or stored (displayed in stores) under chilled conditions over a set period of time from immediately after the production until reaching the hands of consumers. The inventors then completed the invention.

[0011]

Specifically, the present invention relates to the embodiments described below.

[0012]

<u>I. Method for Producing Fermented Milk Having Improved Physical Properties</u>

I-1: A method for producing a fermented milk comprising the following three steps:

(1) preparing a fermented milk mix using at least one starting milk material;

(2) heat-pasteurizing the fermented milk mix; and

(3) adding a starter to (blending a starter with) the heat-pasteurized fermented milk mix to ferment the mix

wherein, in performing steps (1) to (3) above, at least one of the following operations (A) to (C) is carried out:

(A) adding glucose oxidase to a fermented milk mix having a glucose concentration of 0.05 wt% or less, preferably 0.04 wt% or less, more preferably 0.03 wt% or less, and even more preferably 0.02 wt% or less to thereby prepare the fermented milk mix in step (1) under the conditions of that glucose concentration;

(B) adding, before step (3), glucose oxidase to the heat-pasteurized fermented milk mix having a glucose concentration of 0.05 wt% or less, preferably 0.04 wt% or less, more preferably 0.03 wt% or less, and even more preferably 0.02 wt% or less; and

(C) adding, after step (3), glucose oxidase to the fermented milk having a glucose concentration of 0.05 wt% or less, preferably 0.04 wt% or less, more preferably 0.03 wt% or less, and even more preferably 0.02 wt% or less prepared in step (3).

[0013]

I-2: The method according to Item I-1 wherein operation (A) is carried out in step (1), and the heat-pasteurizing in step (2) is carried out at a temperature of 65°C or above.

[0014]

I-3: The method according to Item I-1 or I-2 wherein the starter is a combination of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.

[0015]

I-4: The method according to any one of Items I-1 to I-3, which is a method for producing a fermented milk that undergoes less change in physical properties caused by coagulation of milk protein than a fermented milk produced without adding glucose oxidase and/or a fermented milk produced by adding glucose oxidase under the conditions of a glucose concentration of 1 wt% or more, and preferably 3 wt% or more.

[0016]

I-5: The method according to any one of Items I-1 to I-4 wherein the change in physical properties caused by coagulation of milk

protein is at least one selected from the group consisting of occurrence of syneresis (water separation), an increase in particle size of milk protein (and/or fat), and development of grainy texture of the fermented milk.

[0017]

I-6: The method according to any one of Items I-1 to I-4 wherein the change in physical properties caused by coagulation of milk protein is at least one selected from the group consisting of occurrence of syneresis (water separation) and an increase in particle size of milk protein (and/or fat).

[0018]

I-7: The method according to any one of Items I-1 to I-6 wherein the at least one starting milk material is unpasteurized milk.

[0019]

I-8: The method according to any one of Items I-1 to I-7 wherein the heat-pasteurizing in step (2) is carried out at a temperature of 65°C or above, preferably 90°C or above, and more preferably 90 to 100°C.

[0020]

I-9: The method according to any one of Items I-1 to I-8, the method including no operation of adding, as a component other than the at least one staring milk material, a substrate for glucose oxidase or a substance that can serve as a substrate for glucose oxidase over the entire process including steps (1) to (3).

[0021]

I-10: The method according to any one of Items I-1 to I-9 wherein the fermented milk is yogurt.

[0022]

I-11: The method according to Item I-10 wherein the fermented milk is pre-fermentation yogurt.

[0023]

I-12: The method according to Item I-10 wherein the fermented milk is post-fermentation yogurt, and operation (A) is carried out in step (1), or operation (B) is carried out before step (3).

[0024]

I-13: The method according to any one of Items I-10 to I-12 wherein the fermented milk is soft yogurt or drinking yogurt.

[0025]

I-14: A fermented milk obtainable by the method according to any one of Items I-1 to I-13 wherein change in physical properties caused by coagulation of milk protein is suppressed.

[0026]

II. Method for Improving Physical Properties of Fermented Milk

II-1: A method for suppressing a change in physical properties caused by coagulation of milk protein in a fermented milk produced by a method comprising the following steps (1) to (3):

(1) preparing a fermented milk mix using at least one starting milk material;

(2) heat-pasteurizing the fermented milk mix; and

(3) adding a starter to (blending a starter with) the heat-pasteurized fermented milk mix to ferment the mix,

wherein, in performing steps (1) to (3) above, at least one of the following operations (A) to (C) is carried out:

(A) adding glucose oxidase to a fermented milk mix having a glucose concentration of 0.05 wt% or less, preferably 0.04 wt% or less, more preferably 0.03 wt% or less, and even more preferably 0.02 wt% or less to thereby prepare the fermented milk mix in step (1) under the conditions of that glucose concentration;

(B) adding, before step (3), glucose oxidase to the heat-pasteurized fermented milk mix having a glucose concentration of 0.05 wt% or less, preferably 0.04 wt% or less, more preferably 0.03 wt% or less, and even more preferably 0.02 wt% or less; and

(C) adding, after step (3), glucose oxidase to the fermented milk having a glucose concentration of 0.05 wt% or less, preferably 0.04 wt% or less, more preferably 0.03 wt% or less, and even more preferably 0.02 wt% or less prepared in step

(3).

[0027]

II-2: The method according to Item II-1 wherein operation (A) is carried out in step (1), and the heat-pasteurizing in step (2) is carried out at a temperature of 65°C or above.

[0028]

II-3: The method according to Item II-1 or II-2 wherein the starter is a combination of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.

[0029]

II-4: The method according to any one of Items II-1 to II-3 that suppresses a change in physical properties caused by coagulation of milk protein, compared with a fermented milk produced without adding glucose oxidase and/or a fermented milk produced by adding glucose oxidase under the conditions of a glucose concentration of 1 wt% or more, and preferably 3 wt% or more.

[0030]

II-5: The method according any one of Items II-1 to II-4 wherein the change in physical properties caused by coagulation of milk protein is at least one selected from the group consisting of occurrence of syneresis (water separation), an increase in particle size of milk protein (and/or fat), and development of grainy texture of the fermented milk.

[0031]

II-6: The method according any one of Items II-1 to II-4 wherein the change in physical properties caused by coagulation of milk protein is at least one selected from the group consisting of occurrence of syneresis (water separation) and an increase in particle size of milk protein (and/or fat).

[0032]

II-7: The method according to any one of Items II-1 to II-6 wherein the at least one starting milk material is unpasteurized milk.

[0033]

II-8: The method according to any one of Items II-1 to II-7

wherein the heat-pasteurizing in step (2) is carried out at a temperature of 65°C or above, preferably 90°C or above, and more preferably 90 to 100°C.

[0034]

II-9: The method according to any one of Items II-1 to II-8, the method including no operation of adding, as a component other than the at least one staring milk material, a substrate for glucose oxidase or a substance that can serve as a substrate for glucose oxidase over the entire process including steps (1) to (3).

[0035]

II-10: The method according to any one of Items II-1 to II-9 wherein the fermented milk is yogurt.

[0036]

II-11: The method according to Item II-10 wherein the fermented milk is pre-fermentation yogurt.

[0037]

II-12: The method according to Item II-10 wherein the fermented milk is post-fermentation yogurt, and operation (A) is carried out in step (1), or operation (B) is carried out before step (3).

[0038]

II-13: The method according to any one of Items II-10 to II-12 wherein the fermented milk is soft yogurt or drinking yogurt.

Advantageous Effects of Invention

[0039]

The method of the present invention enables production of fermented milk that undergoes significantly less change in physical properties caused by coagulation of milk protein during chilled storage or distribution, specifically, occurrence of syneresis, an increase in particle size of milk protein (coagulated particles), or thus-developed grainy texture, than fermented milk produced without glucose oxidase added. The method of the present invention particularly enables production of fermented milk that undergoes significantly less syneresis and

significantly less increase in particle size of milk protein (coagulated particles) over time in a stable manner during chilled storage or distribution, as compared with a fermented milk produced by adding, in addition to glucose oxidase, a substrate (glucose) for glucose oxidase, or a substance that generates the substrate to a starting milk material.

[0040]

The method of the present invention is convenient because it can be applied to the current production process of fermented milk; moreover, the method does not negatively affect the original flavor of fermented milk while maintaining an appropriate level of the physical properties and excellent flavor required of fermented milk for a longer period of time in a stable manner.

Description of Embodiments

[0041]

I. Method for Producing Fermented Milk Having Improved Physical Properties

The method for producing a fermented milk of the present invention comprises at least the following three steps:

(1) preparing a fermented milk mix using at least one starting milk material;

(2) heat-pasteurizing the fermented milk mix; and

(3) adding a starter to the heat-pasteurized fermented milk mix to ferment the mix

wherein, in performing steps (1) to (3) above, at least one of the following operations (A) to (C) is carried out:

(A) adding glucose oxidase to a fermented milk mix having a glucose concentration of 0.05 wt% or less to thereby prepare the fermented milk mix in step (1) under the conditions of that glucose concentration;

(B) adding, before step (3), glucose oxidase to the heat-pasteurized fermented milk mix having a glucose concentration of 0.05 wt% or less; and

(C) adding, after step (3), glucose oxidase to the fermented milk having a glucose concentration of 0.05 wt% or less prepared in step (3).

[0042]

As used herein, "fermented milk" means "the products which are obtained by fermenting milk, or milk, etc., containing an equal or greater amount of milk solids-not-fat with lactic acid bacteria or yeast and then forming a paste or liquid, or the frozen product" as defined in the Ministerial Ordinance on Milk and Milk Products Concerning Compositional Standards. Fermented milk includes yogurt (milk solids-not-fat content: 8% or more, lactic acid bacteria count or yeast count: 10 million or more per 1 mL, as defined by an Ordinance of the Ministry of Health, Labour and Welfare of Japan), fermented milk drink under the category of milk products (milk solids-not-fat content: less than 8%, lactic acid bacteria count or yeast count: 10 million or more per 1 mL, as defined by an Ordinance of the Ministry of Health, Labour and Welfare of Japan), and fermented milk drink (milk solids-not-fat content: less than 3%, lactic acid bacteria count or yeast count: 10 million or more per 1 mL, as defined by an Ordinance of the Ministry of Health, Labour and Welfare of Japan). A preferable fermented milk is yogurt.

[0043]

According to the preparation method, yogurt is classified into two types: pre-fermentation yogurt and post-fermentation yogurt. Pre-fermentation yogurt is produced by a method comprising the steps of fermenting a fermentation mix in a tank, the fermentation mix being prepared by adding a fermented milk starter to a raw milk material; squishing the produced curd; and packing the squished curd into individual-portion containers optionally with a gelatinizing agent. Post-fermentation yogurt is produced by the method comprising the steps of adding a fermented milk starter to a raw milk material to prepare a fermentation mix, and packing the fermentation mix into individual-portion containers to ferment the mix in the containers. Typically, soft

yogurt and drinking yogurt are pre-fermentation yogurt, and hard yogurt is post-fermentation yogurt.

[0044]

Yogurt intended in the present invention includes two types of yogurt: "pre-fermentation yogurt" and "post-fermentation yogurt." In the case of post-fermentation yogurt produced through fermentation in individual-portion containers, operation (C) cannot be performed; i.e., glucose oxidase or the like cannot be added to fermented milk after fermentation step (3). Thus, when producing post-fermentation yogurt, the production method of the present invention is carried out by performing operation (A) in step (1) above, or by performing operation (B) before step (3). However, in the case of pre-fermentation yogurt produced by packing fermented milk into individual-portion containers after fermentation, there is no such limitation, and at least one of the following operations can be performed: operation (A) in step (1), operation (B) before step (3), or operation (C) after step (3).

[0045]

Fermented milk intended in the present invention is preferably pre-fermentation yogurt, which has a smooth texture, and the method of the present invention is suitably used in producing the pre-fermentation yogurt (soft yogurt or drinking yogurt).

[0046]

Production steps (1) to (3) of the present invention will be explained below in order.

<u>(1) Step of Preparing a Fermented Milk Mix Using a Starting Milk Material</u>

The term "starting milk material" refers to a dairy product that is used as a raw material of fermented milk. A starting milk material is suitably selected from, for example, raw milk (unpasteurized milk), milk that has been pasteurized (pasteurized milk), skim milk, whole condensed milk, skimmed condensed milk, whole milk powder, skim milk powder, butter

(salt-free butter), buttermilk, cream, whey protein concentrate (WPC), whey protein isolate (WPI), α-lactalbumin (α-La), and β-lactoglobulin (β-Lg), depending on the type of fermented milk to be produced. These can be used in a combination of two or more; for example, for producing reduced-energy yogurt with 8% or more of a milk solids-not-fat content, raw milk and/or milk that has been pasteurized (pasteurized milk) may be combined with skim milk and/or a skim milk powder. In combining materials, from the standpoint of excellent flavor, it is preferable to use raw milk (unpasteurized milk) and its processed product as starting milk materials.

[0047]

The glucose concentration of a fermented milk mix depends on the glucose concentration of each starting milk material. Thus, the glucose concentration of a fermented milk mix is not particularly limited insofar as it is the total value of the glucose concentration of each starting milk material. However, for yogurt, for example, the starting milk materials mentioned above can suitably be combined for use such that glucose is present in an amount of 0 to 0.05 wt%, preferably 0.003 to 0.04 wt%, more preferably 0.005 to 0.03 wt%, and even more preferably 0.007 to 0.02 wt% based on fermented milk mix taken as 100 wt%.

[0048]

A “fermented milk mix” is a raw material preparation that is a mixture of raw materials of fermented milk. Such a fermented milk mix is prepared by optionally adding to the starting milk materials mentioned above (blending the starting milk materials with), water, a sweetening additive such as saccharides, typically sucrose (except for substrate for glucose oxidase (i.e., glucose)), or a sweetener, and a flavor, followed by dissolution optionally with heating. Further, a stabilizer (gelatinizer), such as gelatin, agar, carrageenan, guar gum, low methoxyl pectin, or high methoxyl pectin, can be optionally added.

[0049]

In the present invention, however, a substrate for

glucose oxidase and a substance that can serve as a substrate for glucose oxidase are preferably not used as a raw material other than the starting milk materials. Specifically, in the present invention, a substrate for glucose oxidase and/or a substance that can serve as a substrate for glucose oxidase contained in a fermented milk mix is preferably originated from the starting milk materials. As used herein, "substrate for glucose oxidase" refers to glucose, and "substance that can serve as a substrate for glucose oxidase" refers to a substance that generates a substrate (glucose) for glucose oxidase. Examples that generate glucose, although are not particularly limited, include substances that generate glucose by acting on a starting milk material or a component contained in the starting milk material as a substrate. Specific examples include glucose-generating enzymes, such as lactase, which generates glucose by acting on lactose as a substrate.

[0050]

The proportions of raw materials contained in a fermented milk mix are not particularly limited insofar as the milk solids-not-fat content satisfies the proportion predetermined for each type of fermented milk (yogurt: not less than 8%, fermented milk drink under the category of milk products: less than 8%, fermented milk drink: less than 3%). For example, for yogurt, the starting milk materials mentioned above may suitably be combined for use such that the fat content is 0 to 8 wt%, preferably 0.1 to 6 wt%, and more preferably 0.5 to 4 wt%, and the milk solids-not-fat content is 5 to 25 wt%, preferably 6 to 20 wt%, and more preferably 7 to 15 wt%, based on fermented milk mix taken as 100 wt%. In the present invention, a fermented milk mix is fermented, and the resulting product is fermented milk intended in the present invention. Thus, the "fermented milk mix taken as 100 wt%" can also be expressed as "fermented milk taken as 100 wt%."

[0051]

Starting milk materials may suitably be combined to

have a fat content or a milk solids-not-fat content in the ranges given above. For example, when using raw milk (and/or pasteurized milk, etc.) and a skim milk powder as starting milk materials, it is preferable that the proportion of raw milk (and/or pasteurized milk) is 0 to 100 wt%, preferably 10 to 90 wt%, more preferably 20 to 80 wt%, even more preferably 40 to 80 wt%; and that the proportion of a skim milk powder is 0 to 25 wt%, preferably 1 to 20 wt%, more preferably 2 to 15 wt%, and even more preferably 2 to 10 wt%.

[0052]

The production method in which operation (A) is carried out in step (1) is one embodiment of the present invention, and is characterized in that glucose oxidase is used as one of the raw materials in the preparation of the fermented milk mix mentioned above. The production method in which operation (A) is carried out in step (1) is a preferable embodiment of the present invention because the reaction time for glucose oxidase is easily adjusted.

[0053]

When glucose oxidase is added to a fermented milk mix that has been prepared with heating, the enzyme may be deactivated. For this reason, when adding glucose oxidase, it is preferable to cool the thus-prepared fermented milk mix to a temperature at which the enzyme is not deactivated or below, preferably to room temperature (25±5°C) or below, more preferably to 15°C or below.

[0054]

For glucose oxidase, a commercially available glucose oxidase preparation can be used. Examples of commercially available glucose oxidase preparations include enzyme preparations distributed by Shin Nihon Kagaku Kogyo Co., DKSH Japan K.K., Shonan Wako Junyaku, Nagase Seikagaku Kogyo, Kyowa Enzyme, and Danisco Cultor Japan Ltd. (all based in Japan). However, glucose oxidase is not limited to these glucose oxidase preparations.

[0055]

The proportion of glucose oxidase (approx. 2,000 to 4,000 units/kg) based on the fermented milk mix taken as 100 wt% is 0.1 to 1 wt%, preferably 0.1 to 0.5 wt%, more preferably 0.15 to 0.3 wt%, and even more preferably 0.15 to 0.2 wt%.

[0056]

The fermented milk mix to which glucose oxidase has been added (blended) is allowed to stand undisturbed at a temperature of 5 to 43°C, preferably 5 to 35°C, more preferably 5 to 30°C, and even more preferably 5 to 25°C. Although not particularly limited, this static incubation time period is typically 1.5 hours or more, preferably 1.5 to 24 hours, more preferably 2 to 16 hours, even more preferably 2 to 6 hours, and particularly more preferably 2 to 4 hours.

[0057]

(2) Step of Heat-pasteurizing a Fermented Milk Mix

The fermented milk mix (the fermented milk mix refers to both the mix prepared by carrying out operation (A) and the mix prepared by not carrying out operation (A)) prepared in step (1) is subsequently subjected to pasteurization by heating.

[0058]

The heating temperature and the heating duration are not particularly limited insofar as intended pasteurization can be performed. Thus, unlike the method disclosed in PTL 9, a heating temperature of 65°C or above is applied. In a preferable embodiment, it is sufficient if the temperature of the fermented milk mix itself is at least 90°C or above, preferably 90 to 100°C, and more preferably about 95°C, and examples of pasteurization methods include, without limitations, a method comprising treating the fermented milk mix at 90 to 100°C for 1 to 5 minutes, and a method comprising treating the fermented milk mix at 90 to 95°C for 1 to 3 minutes.

[0059]

The production method in which operation (B) is carried out before step (3) is one embodiment of the present invention,

and is characterized in that glucose oxidase is added to (blended with) the fermented milk mix that has been heat-pasteurized in step (2) according to the method described above.

[0060]

A fermented milk mix to be used in the embodiment is preferably a mix prepared without carrying out operation (A) in step (1). Thus, after this fermented milk mix is heat-pasteurized, glucose oxidase is added to (blended with) the fermented milk mix. In this case, when glucose oxidase is added to the fermented milk mix that remains at a high temperature, the enzyme may be deactivated. Thus, when adding glucose oxidase, it is preferable to cool the fermented milk mix in advance to a temperature at which the enzyme is not deactivated, 5 to 43°C, preferably 5 to 35°C, more preferably 5 to 30°C, and even more preferably 5 to 25°C.

[0061]

The amount and supply source of glucose oxidase are as stated above.

[0062]

<u>(3) Step of Adding a Fermented Milk Starter to a Heat-Pasteurized Fermented Milk Mix to Ferment the Mix</u>

The fermented milk mix that has been heat-pasteurized in step (2) is subsequently subjected to fermentation treatment (the mix refers to the mix prepared by carrying out operation (A), the mix prepared by carrying out operation (B), and the mix prepared by carrying out neither of operations (A) and (B)).

[0063]

The “starter” refers to a seed strain, such as a lactic acid bacterium or yeast, that is inoculated into a fermented milk mix to ferment the mix. Although a known starter can be suitably used in the present invention, a preferable starter is a lactic acid bacteria starter. A usable lactic acid bacteria starter is one or at least two species selected from *Lactobacillus bulgaricus* (*L. bulgaricus*), *Streptococcus thermophilus* (*S. thermophilus*), *Streptococcus makedonisu*, *Lactococcus lactis* (*L.*

lactis), *Lactobacillus gasseri* (*L. gasseri*), *Lactobacillus acidophilus (L. acidophilus), Bifidobacterium,* and other lactic acid bacteria that are typically used in the production of fermented milk. Among these, a lactic acid bacteria starter based on a mixed starter of *Lactobacillus bulgaricus* (*L. bulgaricus*) and *Streptococcus thermophilus* (*S. thermophilus*), which are defined as a yogurt starter in the Codex Alimentarius, can be preferably used. While using this lactic acid bacteria starter as a base, other lactic acid bacteria, such as *Lactobacillus gasseri* (*L. gasseri*) and *Bifidobacterium*, may be further added, taking into consideration the fermentation temperature and fermentation conditions for the desired fermented milk.

[0064]

The amount of a starter to be added may be suitably determined with reference to the amount of starters adopted in known methods for producing fermented milk. The inoculation method for a starter is not particularly limited, and any method conventionally used in the production of fermented milk may be suitably used.

[0065]

The fermentation treatment conditions can be suitably determined, taking into consideration the type of fermented milk, the desired flavor, and the type of starter to be used. Examples include a fermentation method in which the temperature of a fermentation chamber (fermentation temperature) is maintained in the range of 30 to 50°C, and static fermentation is performed in the fermentation chamber. Under such temperature conditions, lactic acid bacteria typically become active, and fermentation can therefore proceed effectively. The fermentation temperature is typically about 30 to 50°C, preferably about 35 to 45°C, and more preferably about 37 to 43°C.

[0066]

The fermentation time can be suitably determined and adjusted with a view to achieving a predetermined lactic acid

acidity of a fermented milk mix. For example, the lactic acid acidity of pre-fermentation yogurt is about 0.7 to 1.5%, and the lactic acid acidity of post-fermentation yogurt is about 0.7 to 0.8%. The fermentation time is typically about 1 hour or more to about 12 hours or less, preferably about 2 hours or more to about 5 hours or less, and more preferably about 3 hours or more to about 4 hours or less.

[0067]

When the lactic acid acidity of pre-fermentation yogurt and the lactic acid acidity of post-fermentation yogurt reach about 1.5 to 2% and about 0.7 to 0.8%, respectively, fermentation is ended by cooling to, for example, 15°C or below, preferably 0 to 10°C, and more preferably 3 to 7°C.

[0068]

In the case of pre-fermentation yogurt, it is possible to carry out operation (C) after step (3). Specifically, glucose oxidase can be added to (blended with) fermented milk that has been prepared by steps (1) to (3).

[0069]

The fermented milk to which glucose oxidase has been added (blended) is allowed to stand undisturbed at a temperature of 5 to 43°C, preferably 5 to 35°C, more preferably 5 to 30%, and even more preferably 5 to 25°C. Although not particularly limited, this static incubation time period is typically 1.5 hours or more, preferably 1.5 to 24 hours, more preferably 2 to 16 hours, even more preferably 2 to 6 hours, and particularly more preferably 2 to 4 hours.

[0070]

The production method including operation (C) is one embodiment of the production method according to the present invention. Fermented milk intended here is preferably pre-fermentation yogurt, mentioned above, that is prepared by carrying out neither operation (A) in step (1) nor operation (B) before step (3).

[0071]

The amount and supply source of glucose oxidase are as stated above.

[0072]

Fermented milk intended in the present invention can be produced through steps (1) to (3) described above. When fermented milk is pre-fermentation yogurt, the incubation process in step (3) is performed using a tank (tank incubation). When operation (C) is performed after step (3), operation (C) is also performed on fermented milk prepared in a tank. After tank incubation, fermented and thus-coagulated curd is squished by stirring, followed by pasteurizing, cooling, emulsifying, and aging as necessary. Thereafter, the resulting product is packed into individual-portion containers and prepared as a fermented milk product.

[0073]

When pre-fermentation yogurt is produced by the production method according to the present invention, the firmness of the curd obtained after fermentation in a tank is as relatively low as 35 to 55 g, preferably 35 to 50 g, and more preferably 35 to 45 g, regardless of the high solids content of the fermented milk mix. Thus, curd can be easily squished, not by using the conventional homogenization technique, but by passing the curd through a filter (membrane) with a pore diameter of about 60 mesh to thereby prepare yogurt with a smooth mouthfeel.

[0074]

In contrast, when fermented milk is post-fermentation yogurt, the fermented milk mix is packed into individual-portion containers before the incubation process of step (3), and the fermented milk mix in the individual-portion containers is subjected to the incubation process of step (3) (in-container incubation). Thus, as described above, operation (C) is not carried out in the incubation process of step (3) in the case of post-fermentation yogurt. After in-container incubation, the resulting product is cooled (cold storage) and prepared as a fermented milk product.

[0075]

II. Method for Improving Physical Properties of Fermented Milk

The method for improving physical properties of fermented milk according to the present invention is a method for suppressing a change in the physical properties caused by coagulation of milk protein in a fermented milk product produced by the method comprising at least the following three steps:

(1) preparing a fermented milk mix using at least one starting milk material;

(2) heat-pasteurizing the fermented milk mix; and

(3) adding a starter to the heat-pasteurized fermented milk mix to ferment the mix

wherein, in performing steps (1) to (3) above, at least one of the following operations (A) to (C) is carried out:

(A) adding glucose oxidase to a fermented milk mix having a glucose concentration of 0.05 wt% or less to thereby prepare the fermented milk mix in step (1) under the conditions of that glucose concentration;

(B) adding, before step (3), glucose oxidase to the heat-pasteurized fermented milk mix having a glucose concentration of 0.05 wt% or less; and

(C) adding, after step (3), glucose oxidase to the fermented milk having a glucose concentration of 0.05 wt% or less prepared in step 3.

[0076]

In the method of the present invention described above, the treatments and conditions of each step and operation, and the materials used in each step and operation, may be the same as those used in the "I. Method for Producing Fermented Milk Having Improved Physical Properties" section.

[0077]

As described in the Examples below, the fermented milk produced and treated as described above underwent significantly less change in physical properties caused by coagulation of milk protein than fermented milk produced without carrying out any of

operations (A) to (C), i.e., fermented milk that has been produced by not adding glucose oxidase and/or fermented milk produced by adding glucose oxidase under the conditions of a glucose concentration of 1 wt% or more (collectively, "control of fermented milk"). The change in physical properties caused by coagulation of milk protein is at least one selected from occurrence of syneresis, an increase in particle size of milk protein (coagulated particles), and development of grainy texture of fermented milk. The grainy texture of fermented milk is presumably, although not limited to, a phenomenon caused by an increase in particle size of milk protein.

[0078]

Of the changes in physical properties, syneresis preferably does not occur during the storage period of 16 days from the production day (syneresis: 0%), or even when syneresis does occur, the occurrence rate is preferably 19% or less, more preferably 15% or less, and particularly more preferably 10% or less. The occurrence rate of syneresis can be determined according to the weight percentage of the supernatant generated by syneresis based on the total weight of the fermented milk (100 wt%). The rate of increase in average particle size of milk protein (coagulated particles) during the storage period of 16 days from the production day is preferably 30% or less, and more preferably 25% or less. The rate of increase in average particle size can be determined according to the percentage of the average particle size (L_0) immediately after the production based on the difference ($Lt-L_0$) between the average particle size (Lt) after the storage period of 16 days and the average particle size (L_0) ($\{[Lt-L_0]/L_0\}x100$). The average particle size of milk protein (coagulated particles) after the storage period of 16 days is preferably 13 μm or less. Further, the change in firmness and the change in viscosity during the storage period of 16 days from the production day are preferably 20% or less and 30% or less, respectively. These numerical ranges provide an approximate guide for preferable embodiments of the present invention, but do not

limit the scope of the invention.

[0079]

The physical properties of any fermented milk change over time even during chilled storage; however, the fermented milk of the present invention exhibits significantly less change over time (change in physical properties) than the control of fermented milk. Therefore, the method of the present invention is useful to keep fermented milk excellent in quality (appearance and texture) for as long as possible, at least until the best-before date. As far as the best-before date of yogurt is concerned, the duration during which fermented milk maintains excellent quality is about 7 days, preferably about 10 days, more preferably about 12 days, and even more preferably about 14 days from the production day.

Examples

[0080]

The Examples below describe the present invention in detail. However, the present invention is not limited to these Examples, and various modifications can be added based on known techniques.

[0081]

Experimental Example 1: Improvement in Physical Properties of Fermented Milk of Typical Formulation

(1) Preparation of Fermented Milk 1 to 3

Three types of fermented milk 1 to 3 were prepared in accordance with the formulations shown in Table 1.

Fermented milk 1 (Comparative Example 1) in Table 1 was prepared in accordance with a traditional known formulation (traditional formulation, glucose concentration: about 0.015 wt%). Fermented milk 2 (Example 1) was prepared by adding glucose oxidase to fermented milk prepared in accordance with the formulation for fermented milk 1 (glucose concentration: about 0.015 wt%). Fermented milk 3 (Comparative Example 2) was prepared by adding lactase to fermented milk prepared in accordance with

the formulation for fermented milk 2. Because of the addition of lactase, lactose (lactose concentration: about 6 wt%) contained in raw milk or skim milk powder was hydrolyzed, and glucose was generated in the raw materials. The glucose concentration of fermented milk 3 (Comparative Example 2) is 3.07 wt% (theoretical value) if lactose is assumed to have been totally decomposed by lactase.

[0082]

Table 1: Formulations of Fermented Milk (Yogurt Mix) (1)

Raw Materials	Fermented Milk 1 (Comp.Ex.1)	Fermented Milk 2 (Ex.1)	Fermented Milk 3 (Comp.Ex.2)
Raw Milk [%(w/w)] Meiji Co., Ltd.	50.00	50.00	50.00
Skim Milk Powder [%(w/w)] Meiji Co., Ltd.	5.07	5.07	5.07
Salt-free Butter [%(w/w)] Meiji Co., Ltd.	1.17	1.17	1.17
WPC34 [%(w/w)] Leprino Foods Company	1.50	1.50	1.50
Lactase [%(w/w)] Godo Shusei Co., Ltd. (5000 unit/g, GODO-YNL)			0.20
Glucose Oxidase [%(w/w)] Shin-Nihon Kagaku Kogyo (2000 unit/g, Sumizyme PGO)		0.088	0.088
Starter for Meiji Yogurt R-1 [%(w/w)] Meiji Co., Ltd.	2.00	2.00	2.00
Water [%(w/w)]	40.26	40.17	39.97
Total [%(w/w)]	100	100	100

[0083]

Specifically, for fermented milk 1 to 3, starting milk materials shown in Table 1 (raw milk, skim milk powder, salt-free butter, and WPC34 (whey protein concentrate)) (fat content: 3.1 wt%, milk solids-not-fat content: 10.8 wt%) and water were placed in a small tank, and dissolved with stirring while being heated at about 60°C to thereby prepare raw milk materials (fermented milk mix). Each raw milk material was cooled to about 5°C, and then glucose oxidase was added for fermented milk 2, and lactase and glucose oxidase were added for fermented milk 3 in accordance with the formulations shown in Table 1 (step (1)).

[0084]

Subsequently, each prepared raw milk material (fermented milk mix) was allowed to stand undisturbed at about 5°C for about 14 hours, and then subjected to pasteurization by heating with stirring until each raw milk material reached about 95°C (step (2)). Each of the thus-prepared heat-pasteurized milk was cooled to about 43°C, and then 2 wt% of a lactic acid bacteria starter was inoculated (added) into each (step (3)).

[0085]

The resulting heat-pasteurized milk to which a lactic acid bacteria starter was added was packed into small containers, followed by static incubation in a fermentation chamber at a temperature of about 43°C. When the lactic acid acidity reached 0.72%, the milk was placed in a refrigerator at about 5°C. Because of the static storage in a refrigerator, fermentation was ended, thereby preparing fermented milk 1 to 3.

[0086]

(2) Evaluation of Physical Properties of Fermented Milk 1 to 3

The thus-prepared fermented milk 1 to 3 were allowed to stand undisturbed at about 5°C for 16 days, and then measured over time (production day (day 1), and day 8 and 16 after production) for syneresis (%), average particle size (μm) of coagulated particles contained in fermented milk 1 to 3, lactic acid acidity (%), pH (20°C), firmness (curd tension, CT) (g), and viscosity (Pa·s).

[0087]

The physical properties were measured in accordance with the following procedures.

[0088]

(a) Measurement of Syneresis Rate of Fermented Milk

40 g of each fermented milk (10°C) was individually packed into a centrifuge tube (internal diameter: 20 mm), and treated with a centrifugal separator (centrifugal force: about 180 G, radius gyration: 160 mm, revolving speed: 1,000 rpm, processing time: 10 minutes). Subsequently, the weight of each supernatant was measured, and the weight percentage (%) of the

supernatant to the total weight (40 g) of fermented milk was determined to be the syneresis rate (%).

[0089]

(b) Measurement of Average Particle Size of Coagulated Particles Contained in Fermented Milk

The average particle size (μm) of coagulated particles contained in fermented milk was measured with a laser diffraction particle size analyzer (SALD-2000 produced by Shimadzu Corporation).

[0090]

(c) Measurement of Lactic Acid Acidity (Acidity) of Fermented Milk

After phenolphthalein was added to fermented milk as an indicator, sodium hydrate (decinormal solution) was added as a titrant to the fermented milk to measure the acidity. Specifically, the amount of sodium hydrate at the point the fermented milk underwent a color change to pale pink was converted into the amount of lactic acid contained in the fermented milk (concentration). The value was taken as an index.

[0091]

(d) Measurement of Firmness of Fermented Milk (Curd Tension, CT)

The firmness (g) of fermented milk was measured with a Neo Curd meter M302 (produced by I Techno Engineering Co., formerly Iio Electronic Co.). With the curd meter, firmness and smoothness of fermented milk can be evaluated, for example, by filling a small container with 100 g of fermented milk (10°C) and inserting a yogurt knife (a small disc with a diameter of about 20 mm). Specifically, an insert angle of a yogurt knife with a 100 g weight to fermented milk is measured, and the measured values are expressed as a curve. The vertical axis of the graph is the height of the knife, and the horizontal axis is the load added in addition to the 100 g weight. In the graph, 10 mm on the vertical axis and 10 g on the horizontal axis are the same length. The length of the insert angle curve to the fracture point is an index of the firmness value (firmness and resilience) (g).

[0092]

(e) Measurement of Viscosity of Fermented Milk

The viscosity (Pa·s) of fermented milk was measured with a rotational B-type viscometer (TV-10M produced by Toki Sangyo). Specifically, a small container was filled with 100 g of fermented milk (10°C), and a No. 4 rotor (code M23) of the viscometer was allowed to run into the fermented milk and rotate (30 rpm, 30 seconds) to evaluate the viscosity.

[0093]

Table 2 shows the results of measuring the physical properties of fermented milk 1 to 3 (3 types).

[0094]

Table 2: Change over Time in Syneresis and Particle Size of Fermented Milk (Yogurt) (1)

Evaluation Item	Fermented Milk 1 (Comp. Ex. 1)	Fermented Milk 2 (Ex. 1)	Fermented Milk 3 (Comp. Ex. 2)
Syneresis [%] (day 1: fresh product)	7.8	8.3	6.8
Syneresis [%] (day 8)	31.4	8.7	19.8
Syneresis [%] (day 16)	15.6	9.2	8.6
Particle Size [μm] (day 1)	15.29	10.44	9.99
Particle Size [μm] (day 8)	23.20	10.86	12.54
Particle Size [μm] (day 16)	25.55	12.83	13.33
Acidity [%](day 1)	0.91	0.91	0.90
Acidity [%](day 8)	1.02	1.01	1.01
Acidity [%](day 16)	1.06	1.04	1.06
pH (20°C) [-] (day 1)	4.37	4.42	4.44
pH (20°C) [-] (day 8)	4.15	4.16	4.16
pH (20°C) [-] (day 16)	4.12	4.14	4.11
Firmness [g] (day 1)	43.4	41.1	41.6
Firmness [g] (day 8)	50.1	37.7	36.6
Firmness [g] (day 16)	48.7	34.5	32.7
Viscosity [Pa·s] (day 1)	3.15	2.87	3.22
Viscosity [Pa·s] (day 8)	2.36	2.30	2.30
Viscosity [Pa·s] (day 16)	1.66	2.13	2.10

[0095]

Syneresis

Compared with fermented milk 1 (Comparative Example 1) and fermented milk 3 (Comparative Example 2), fermented milk 2 (Example 1) exhibited less change in syneresis, and the occurrence of syneresis was significantly suppressed in a stable manner during 16 days from the production day. Specifically, the results reveal that syneresis can be stably suppressed over time

during chilled storage or distribution, and thus the excellent physical properties are maintained in fermented milk 2, as compared with fermented milk 1 or fermented milk 3.

[0096]

Average Particle Size

Compared with fermented milk 1 (Comparative Example 1) and fermented milk 3 (Comparative Example 2), fermented milk 2 (Example 1) exhibited less change in average particle size, and the average particle size was stably maintained during the period of 16 days from the production day, in particular, 8 days from the production day. Specifically, the results reveal that fermented milk 2 is more resistant to change in average particle size over time during chilled storage or distribution, and thus the excellent physical properties are maintained, as compared with fermented milk 1 or fermented milk 3.

[0097]

Firmness

The firmness of fermented milk 1 (Comparative Example 1) somewhat increased over time from the production day, whereas the firmness of fermented milk 2 (Example 1) and fermented milk 3 (Comparative Example 2) tended to somewhat decrease over time from the production day. However, the change in firmness over time was minor in fermented milk 1, 2, and 3. In particular, Example 1 exhibited the smallest change in firmness over time.

[0098]

Viscosity

The viscosity of fermented milk 1 (Comparative Example 1), fermented milk 2 (Example 1), and fermented milk 3 (Comparative Example 2) all tended to decrease over time from the production day. However, the degree of decrease was the largest in fermented milk 1 (Comparative Example 1), followed by fermented milk 3 (Comparative Example 2). Thus, the decrease in viscosity over time of fermented milk 2 (Example 1) was significantly suppressed compared with that of fermented milk 1 or fermented milk 3. This indicates that fermented milk 2 is more

resistant to change in viscosity over time during chilled storage or distribution, and the excellent physical properties are maintained, as compared with fermented milk 1 or fermented milk 3.

[0099]

Acidity and pH

Fermented milk 1 (Comparative Example 1), fermented milk 2 (Example 1), and fermented milk 3 (Comparative Example 2) all exhibited substantially the same lactic acid acidity and pH. Specifically, the results reveal that fermented milk 1 to 3 are all resistant to change in flavor (sourness) over time during chilled storage or distribution, and the excellent flavor is maintained.

[0100]

(3)Evaluation of Flavor of Fermented Milk 1 to 3

A sensory evaluation (flavor evaluation) for fermented milk 1 to 3 prepared in section (1) above was carried out by a panel of five experts. Table 3 shows the results (evaluation results).

[0101]

Table 3: Change in Flavor over Time of Fermented Milk (Yogurt) (1)

Fermented Milk 1 (Com.Ex.1) Day 1	Smooth texture, stringiness produced
Fermented Milk 1 (Com.Ex.1) Day 08	Coarse texture, no stringiness produced
Fermented Milk 1 (Com.Ex.1) Day 16	Coarse texture, no stringiness produced
Fermented Milk 2 (Ex.1) Day 1	Smooth texture, stringiness produced
Fermented Milk 2 (Ex.1) Day 08	Smooth texture, stringiness produced
Fermented Milk 2 (Ex.1) Day 16	Smooth texture, stringiness produced
Fermented Milk 3 (Com.Ex.2) Day 1	Smooth texture, stringiness produced
Fermented Milk 3 (Com.Ex.2) Day 08	Smooth texture, stringiness produced
Fermented Milk 3 (Com.Ex.2) Day 16	Smooth texture, stringiness produced

[0102]

As shown in Table 3, smooth texture and stringiness were more prominent in fermented milk 2 (Example 1) and fermented milk 3 (Comparative Example 2) than fermented milk 1 (Comparative Example 1). The smooth texture and stringiness were stably maintained over the period of 16 days from the production day. This indicates that fermented milk 2 and fermented milk 3 are resistant to change in texture over time, and the texture

(smoothness and stringiness) is well maintained during chilled storage or distribution, as compared with fermented milk 1.

[0103]

Experimental Example 2: Improvement in Physical Properties of Fermented Milk of Highly Concentrated Formulation

(1) Preparation of Fermented Milk 4 and 5

Two types of fermented milk 4 and 5 were prepared in accordance with the formulations shown in Table 4.

Fermented milk 4 (Comparative Example 3) in Table 4 is a high-fat fermented milk prepared in accordance with a traditional known formulation (traditional formulation) (glucose concentration: about 0.01 wt%), and fermented milk 5 (Example 2) was prepared by adding glucose oxidase to fermented milk prepared in accordance with the formulation for fermented milk 4 (glucose concentration: about 0.01 wt%).

[0104]

Table 4: Formulations of Fermented Milk (Yogurt Mix) (2)

Raw Materials	Fermented Milk 4 (Comp.Ex.3)	Fermented Milk 5 (Ex.2)
Skim Milk Powder [%(w/w)] Meiji Co., Ltd.	8.74	8.74
Cream [% (w/w)] Meiji Co., Ltd.	16.20	16.20
WPC34 [%(w/w)] Leprino Foods Company	2.40	2.40
MPC [% (w/w)] FrieslandCampina Domo	3.50	3.50
Glucose Oxidase [%(w/w)] Shin-Nihon Kagaku Kogyo (2000 unit/g, Sumizyme PGO)		0.150
Starter for Meiji Bulgaria Yogurt Fruits (Dessert) Type [%(w/w)] Meiji Co., Ltd.	2.00	2.00
Water [%(w/w)]	67.16	67.01
Total [%(w/w)]	100	100

[0105]

Specifically, starting milk materials shown in Table 4 (skim milk powder, cream, WPC34 (whey protein concentrate), MPC (milk protein concentrate); fat content: 8.0 wt%, milk solids-not-fat content: 14.6 wt%) and water were placed in a small tank and dissolved with stirring while being heated at about 60°C to thereby prepare raw milk materials (fermented milk mix). Each raw milk material was cooled to about 5°C, and then glucose oxidase was added for fermented milk 5 in accordance with the formulation shown in Table 4 (step (1)).

[0106]

Subsequently, each prepared raw milk material was allowed to stand undisturbed at a temperature of about 5°C for about 16 hours, and then subjected to pasteurization by heating with stirring until each raw milk material reached about 95°C (step (2)). Each of the thus-prepared heat-pasteurized milk was cooled to about 43°C, and then 2 wt% of a lactic acid bacteria starter was inoculated (added) into each (step (3)).

[0107]

The resulting heat-pasteurized milk to which a lactic acid bacteria starter was added was packed into a small tank, followed by static incubation at a temperature of about 43°C. When the pH reached 4.6, the resulting product was filtered (pureed) with a filter (60-mesh). Subsequently, the product was packed into small containers and cooled to 10°C or below with ice water to terminate fermentation, thereby preparing fermented milk 4 and 5.

[0108]

(2) Evaluation of Physical Properties of Fermented Milk 4 and 5

The thus-prepared fermented milk 4 and 5 were allowed to stand undisturbed at about 5°C for 2 days, and then measured for average particle size (μm), lactic acid acidity (%), pH (20°C), and viscosity (Pa·s) in accordance with the procedures described in Experimental Example 1.

[0109]

Table 5 shows the results of measurement.

[0110]

Table 5: Change over Time in Syneresis and Particle Size of Fermented Milk (Yogurt) (2)

Evaluation Item	Fermented Milk 4 (Comp. Ex. 3)	Fermented Milk 5 (Ex. 2)
Particle Size [μm] (day 2)	35.81	8.47
Acidity [%](day 2)	1.33	1.38
pH (20°C) [-] (day 2)	4.45	4.46
Viscosity [Pa·s] (day 2)	5.26	5.27

[0111]

As shown in Table 5, fermented milk 5 (Example 2)

exhibited an acidity, pH, and viscosity, all substantially the same as those of fermented milk 4 (Comparative Example 3), but exhibited a significantly smaller average particle size than fermented milk 4 (Comparative Example 3). This indicates that when produced by adding glucose oxidase, even fermented milk having a high fat content or a high solids concentration can have a small average particle size and be resistant to change in average particle size over time, thus exhibiting excellent physical properties, as with fermented milk 2 (Example 1) in Experimental Example 1.

[0112]

(3)Evaluation of Flavor of Fermented Milk 4 and 5

A sensory evaluation (flavor evaluation) for fermented milk 4 and 5 was carried out by a panel of five experts. Table 6 shows the results (evaluation results).

[0113]

Table 6: Change Over Time in Flavor of Fermented Milk (Yogurt) (2)

Fermented Milk 4 (Com.Ex.3) Day 02	Grainy texture
Fermented Milk 5 (Ex.2) Day 02	Smooth and rich texture

[0114]

As shown in Table 6, the results reveal that whereas fermented milk 4 (Comparative Example 3) had a grainy texture, fermented milk 5 (Example 2) exhibited a smooth texture and mouthfeel. Fermented milk 5 (Example 2) was also richly textured because of the combination of fattiness and moderate viscosity (stringiness).

CLAIMS

1. A method for producing a fermented milk, comprising the steps of:

(1) preparing a fermented milk mix using at least one starting milk material;

(2) heat-pasteurizing the fermented milk mix; and

(3) adding a starter to the heat-pasteurized fermented milk mix to ferment the mix

wherein, in performing steps (1) to (3) above, at least one of the following operations (A) to (C) is carried out:

(A) adding glucose oxidase to a fermented milk mix having a glucose concentration of 0.05 wt% or less to thereby prepare the fermented milk mix in step (1) under the conditions of that glucose concentration;

(B) adding, before step (3), glucose oxidase to the heat-pasteurized fermented milk mix having a glucose concentration of 0.05 wt% or less; and

(C) adding, after step (3), glucose oxidase to the fermented milk having a glucose concentration of 0.05 wt% or less prepared in step (3).

2. The method according to Claim 1 wherein operation (A) is carried out in step (1), and the heat-pasteurizing in step (2) is carried out at a temperature of 65°C or above.

3. The method according to Claim 1 or 2 wherein the starter is a combination of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.

4. The method according to any one of Claims 1 to 3, which is a method for producing a fermented milk that undergoes less change in physical properties caused by coagulation of milk protein than a fermented milk produced without adding glucose oxidase and/or a fermented milk produced by adding glucose oxidase under the conditions of a glucose concentration of 1 wt%

or more.

5. The method according to Claim 4 wherein the change in physical properties caused by coagulation of milk protein is at least one selected from the group consisting of occurrence of syneresis, an increase in particle size of milk protein and/or fat, and development of grainy texture of the fermented milk.

6. The method according to any one of Claims 1 to 5 wherein the at least one starting milk material is unpasteurized milk.

7. The method according to any one of Claims 1 to 6 wherein the fermented milk is yogurt.

8. A method for suppressing a change in physical properties caused by coagulation of milk protein in a fermented milk produced by a method comprising the following steps:

(1) preparing a fermented milk mix using at least one starting milk material;

(2) heat-pasteurizing the fermented milk mix; and

(3) adding a starter to the heat-pasteurized fermented milk mix to ferment the mix

wherein, in performing steps (1) to (3) above, at least one of the following operations (A) to (C) is carried out:

(A) adding glucose oxidase to a fermented milk mix having a glucose concentration of 0.05 wt% or less to thereby prepare the fermented milk mix in step (1) under the conditions of that glucose concentration;

(B) adding, before step (3), glucose oxidase to the heat-pasteurized fermented milk mix having a glucose concentration of 0.05 wt% or less; and

(C) adding, after step (3), glucose oxidase to the fermented milk having a glucose concentration of 0.05 wt% or less prepared in step (3).

9. The method according to Claim 8 wherein operation (A) is carried out in step (1), and the heat-pasteurizing in step (2) is carried out at a temperature of 65°C or above.

10. The method according to Claim 8 or 9 wherein the starter is a combination of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.

11. The method according to any one of Claims 8 to 10 that suppresses a change in physical properties caused by coagulation of milk protein, compared with a fermented milk produced without adding glucose oxidase and/or a fermented milk produced by adding glucose oxidase under the conditions of a glucose concentration of 1 wt% or more.

12. The method according any one of Claims 8 to 11 wherein the change in physical properties caused by coagulation of milk protein is at least one selected from the group consisting of occurrence of syneresis, an increase in particle size of milk protein and/or fat, and development of grainy texture of the fermented milk.

13. The method according to any one of Claims 8 to 12 wherein the at least one starting milk material is unpasteurized milk.

14. The method according to any one of Claims 8 to 13 wherein the fermented milk is yogurt.