

FERMENTED MILK AND PRODUCTION METHOD THEREOF

FIELD OF THE INVENTION

[0001]

The present invention relates to a production method to obtain a fermented milk having hardness (strength) to be able to tolerate vibration at the time of circulation and being superior in the smooth texture and a fermented milk provided by the production method thereof.

BACKGROUND ART

[0002]

A fermented milk is milk or milk products including milk solids-not-fat at the same level as milk fermented by lactic acid bacteria or yeast and is paste, liquid state, solid state or frozen state, and it can be classified roughly to two types. One is a pre-fermentation type and another is a post-fermentation type. For preparing the former (pre-fermentation type), predetermined quantity of starter (lactic acid bacteria, etc.) is added to a raw material milk, and this raw material milk is fermented until it reaches to predetermined lactic acid acidity or predetermined pH and cooled using tank, etc. before filling up in the individual container for circulation, and then this provided fermented milk is crushed and sarcocarp or sweetener (carbohydrate solution, etc.), etc. is mixed as necessary, then it is filled in the individual container (paper container, plastic container, glass container or the like) for circulation. For preparing the latter (post-fermentation type), predetermined quantity of starter is added to a raw material milk and individual container for circulation is filled with this raw material milk, then using fermentation chambers, etc., this raw material milk is fermented until the time to reach to the predetermined lactic acid acidity or predetermined pH and cooled after solidifying into a pudding form. The pre-fermentation is often used for production of such as a soft type yogurt with sarcocarp and a drink type yogurt with sweetener, etc. On the other hand, the post-fermentation is often used for production of such as a hard type (set type) yogurt not to include sarcocarp or sweetener, etc., so-called plane type yogurt.

[0003]

The fermented milk is produced by adding starter to a sterilized raw material milk, and fermenting. When the raw material milk is processed by ultrahigh temperature sterilization (UHT processing, e. g., heat treatment of 120°C or more) and fermented, the fermented milk with small (fragile) hardness of the curd is provided although the texture extremely gets smooth and palatability is significantly improved. Therefore, in a set type yogurt, etc., generally the raw material milk is processed by high temperature short time sterilization (HTST processing, e. g., heat treatment of 85-95°C) and fermented in case of intending to obtain the fermented milk with big (firm) hardness of the curd. However, it is difficult to

obtain the fermented milk with sufficient smooth texture when the raw material milk is processed by high temperature short time sterilization and fermented.

[0004]

As a method for producing a fermented milk using high temperature short time sterilization processing, a method for producing a fermented milk is described in patent document 1, wherein the method comprises reducing dissolved oxygen density of a raw material milk (5ppm or less), processing the raw material milk by high temperature short time sterilization and then fermenting them at low temperature (30-37°C) to produce the fermented milk that is superior in the smooth texture and has sufficient hardness to allow the texture maintained at the time of circulation. Also, a method for producing a fermented milk is described in patent document 2, wherein the method comprises reducing dissolved oxygen density of a raw material milk (5ppm or less), processing the raw material milk by high temperature short time sterilization and then fermenting them at low temperature (30-40°C) to produce the fermented milk that is superior in the smooth texture and has sufficient hardness to allow the texture maintained at circulation stage.

[prior art documents]

[patent documents]

[0005]

[patent document 1]

Japanese Unexamined Patent Application Publication No. 2005-176603

[patent document 2]

Japanese Unexamined Patent Application Publication No. 2005-348703

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0006]

The accessory production facilities such as a facility to inject an inert gas (nitrogen (N₂), etc.), a facility to depressurize, a facility to degas, etc. other than general production facilities of the fermented milk are necessary to reduce dissolved oxygen density of the raw material milk in the method for producing the fermented milk of patent document 1 and 2. Also, the raw material milk is processed by high temperature short time sterilization, and therefore it cannot be asserted that the fermented milk with sufficient smooth texture can be provided in comparison with the case that the raw material milk is processed by ultrahigh temperature sterilization. That is, it is demanded to improve the texture than the conventional one, and improve the smooth texture of the fermented milk. When the raw material milk is processed by high temperature short time sterilization, it cannot be asserted that the production efficiency of fermented milk is preferable because sterilization time becomes generally long. That is, it is

demanding to shorten sterilization time than the conventional one to improve the production efficiency of fermented milk.

[0007]

Also, it is demanded to process fresh milk or a raw material milk by ultrahigh temperature sterilization to sterilize heat-resistant sporular bacteria and to secure bacterial quality in producing process of such as milk or milk drink when the milk or the milk drink is circulated refrigerated.

[0008]

That is, a sterilization condition must be changed while switching in each producing process when the same sterilization facilities will be used in the producing process of such as milk or milk drink as the producing process of the fermented milk, since the sterilization condition is different between producing process of such as milk or milk drink and producing process of a fermented milk when fresh milk or a raw material milk is processed by high temperature short time sterilization in producing process of a fermented milk. Therefore, in the whole of the dairy factory, the production efficiency of various products has been reduced. Also, sterilization facilities must be installed in each producing process when different sterilization facilities will be used in the producing process of a fermented milk and producing processes of such as milk or milk drink. Therefore, in the whole of the dairy factory, the number of the production facilities of various products has been increased.

[0009]

As mentioned above, conventionally, to produce the fermented milk having the sufficient hardness to allow the texture maintained at the time of circulation and the smooth texture, the dissolved oxygen density of the raw material milk had to be reduced, the raw material milk had to be sterilized at low temperature than sterilization temperature of milk and milk drink and whey protein (α -lactalbumin, β -lactoglobulin, etc.) had to be added to the raw material milk. Therefore it costed the producing cost of the fermented milk, and a drop of the production efficiency of fermented milk could not be avoided.

[0010]

Thus, the purpose of the invention is to provide a method for producing a fermented milk which can produce a fermented milk having sufficient hardness and smooth texture without reducing production efficiency of fermented milk.

MEANS TO SOLVE THE PROBLEM

[0011]

As a result of having examined zealously to solve the above problem, the inventors found that the fermented milk having the sufficient hardness can be produced by homogenizing the raw material milk to reduce the average particle size of the raw material milk even in the case that

the raw material milk is processed by ultrahigh-temperature sterilization, and was able to complete the present invention.

[0012]

The present invention provides a method for producing a fermented milk comprising a step of homogenizing a raw material milk to reduce an average particle size of the raw material milk, a step of sterilizing the raw material milk at 115°C -150°C before or after the step of homogenizing the raw material milk and a step of fermenting the raw material milk (including the meaning of the fermented milk base material which is in the state after adding the starter, etc. of lactic acid bacteria to the raw material milk) after the step of homogenizing the raw material milk and the step of sterilizing the raw material milk.

[0013]

Also, the present invention provides a method for producing a fermented milk, wherein the raw material milk is homogenized so that the average particle size of the raw material milk is 0.8μm or less in the above step of homogenizing.

[0014]

Also, the present invention provides a method for producing a fermented milk further comprising a step of reducing dissolved oxygen density of the raw material milk before the step of fermenting the raw material milk in the above production method.

[0015]

Also, the present invention provides a method for producing a fermented milk wherein the fermented milk is a set type yogurt.

[0016]

Also, the present invention provides a method for improving hardness of a fermented milk comprising a step of homogenizing a raw material milk, a step of sterilizing the raw material milk at 115°C -150°C before or after the step of homogenizing the raw material milk and a step of fermenting the raw material milk after the step of homogenizing the raw material milk and the step of sterilizing the raw material milk.

[0017]

Also, the present invention provides a method for improving smooth texture of a fermented milk comprising a step of homogenizing a raw material milk, a step of sterilizing the raw material milk at 115°C -150°C before or after the step of homogenizing the raw material milk and a step of fermenting the raw material milk after the step of homogenizing the raw material milk and the step of sterilizing the raw material milk.

[0018]

Also, the present invention provides a method for improving hardness and smooth texture of a fermented milk comprising a step of homogenizing a raw material milk, a step of sterilizing the raw material milk at 115°C -150°C before or after the step of homogenizing the raw material

milk and a step of fermenting the raw material milk after the step of homogenizing the raw material milk and the step of sterilizing the raw material milk.

[0019]

Also, the present invention provides a fermented milk, wherein the hardness is 26g or more, the intrusion angle of the yogurt knife is less than 60 degrees and the average particle size after stirring is 43 μ m or less.

[0020]

Also, the present invention provides a fermented milk, wherein the adhesion is 0.0008J/m² or more in the above fermented milk.

[0021]

Also, the present invention provides a fermented milk prepared by the above method for producing a fermented milk in the above fermented milk.

[0022]

Also, the present invention provides a fermented milk packed in a container in the above fermented milk.

[0023]

Also, the present invention provides a fermented milk which is a set type yogurt in the above fermented milk.

[0024]

Also, the present invention provides a set type yogurt made by a method for producing a fermented milk comprising a step of homogenizing a raw material milk to reduce the average particle size of the raw material milk, a step of sterilizing the raw material milk at 115°C -150°C before or after the step of homogenizing the raw material milk, a step of filling a container with the raw material milk and a step of fermenting the raw material milk after the step of homogenizing the raw material milk, the step of sterilizing the raw material milk and the step of filling the raw material milk.

[0025]

Also, the present invention provides a soft type yogurt made by a method for producing a fermented milk comprising a step of homogenizing a raw material milk to reduce the average particle size of the raw material milk, a step of sterilizing the raw material milk at 115°C -150°C before or after the step of homogenizing the raw material milk, a step of fermenting the raw material milk to obtain the fermented milk, a step of stirring the fermented milk (crushing the curd of the fermented milk), a step of mixing sarcocarp, vegetables, preparation, source and carbohydrate solution, etc. as necessary and a step of filling a container with the fermented milk.

[0026]

Also, the present invention provides a drink type yogurt made by a method for producing a

fermented milk comprising a step of homogenizing a raw material milk to reduce the average particle size of the raw material milk, a step of sterilizing the raw material milk at 115°C -150°C before or after the step of homogenizing the raw material milk, a step of fermenting the raw material milk to obtain the fermented milk, a step of stirring the fermented milk (crushing the curd of the fermented milk), a step of homogenizing the fermented milk (making curd of the fermented milk finer), a step of mixing sarcocarp, vegetables, preparation, source and carbohydrate solution, etc. as necessary and a step of filling a container with the fermented milk.

EFFECT OF THE INVENTION

[0027]

The method for producing the fermented milk of the present invention can produce the fermented milk having sufficient hardness and smooth texture without reducing production efficiency of the fermented milk because homogenizing the raw material milk to reduce the average particle size of the raw material milk and sterilizing the raw material milk at 115°C -150°C are the important requirements.

BRIEF DESCRIPTION OF DRAWINGS

[0028]

Figure 1 is a graph indicating the hardness (curd tension) of the fermented milk of example 1 and comparative example 1 of the present invention.

Figure 2 is a graph indicating the sensory evaluation of the fermented milk of example 2 and comparative example 2 of the present invention.

Figure 3 is a figure indicating the constitution of the eating and swallowing measuring device of the present invention.

Figure 4 is a graph indicating the adhesion of the fermented milk of comparative example 4 and example 13 of the present invention.

Embodiments to carry out invention

[0029]

The present invention provides a method for producing a fermented milk.

[0030]

Herein, "fermented milk" is milk products and processed products which are provided by fermenting milk, etc. with lactic acid bacteria or yeast and includes "fermented milk", "milk products fermented milk drink" and "fermented milk drink", etc. defined in Ministerial Ordinance Concerning Compositional Standards, etc. for Milk and Milk Products. The fermented milk made in accordance with the present invention, for example, may be yogurt. The fermented milk made in accordance with the present invention may be either the

pre-fermentation type yogurt which is prepared by fermenting the raw material milk in a tank and then filling them in a container or the post-fermentation type yogurt which is prepared by filling the raw material milk in a container and then fermenting them. For example, the fermented milk made in accordance with the present invention may be plain yogurt, set type yogurt (solid fermented milk), soft yogurt (paste fermented milk) and drink yogurt (liquid fermented milk), etc. Because the production method of the present invention can produce the fermented milk having the sufficient hardness as described below, it can be preferably used for set type yogurt.

[0031]

The production method of the present invention comprises a step of homogenizing the raw material milk to reduce the average particle size of the raw material milk.

[0032]

Herein, "raw material milk" is milk, milk components or the composition including milk components. For example, milk components include fresh milk, milk, nonfat milk, whole powdered milk, skimmed milk powder, whole concentrated milk, concentrated skimmed milk, sweetened condensed milk, sweetened condensed skimmed milk, evaporated milk, evaporated skimmed milk, whey (whey), whey powder, desalted whey, desalted whey powder, whey protein concentrate (WPC), whey protein isolate (WPI), α -lactalbumin, β -lactoglobulin, milk protein concentrate (MPC), casein, sodium caseinate, calcium caseinate, cream, fermentated cream, compound cream, cream powder, butter, fermentated butter, butter milk, butter milk powder and butter oil, etc. The raw material milk may include two kinds of milk components or more. Furthermore, the raw material milk may include, for example, water, lipid, protein, saccharide, flavor components, fragrance, pigment, minerals (salts), vitamins and other food additives, etc. other than milk components. The raw material milk may also include the gelatine liquid warmed and dissolved beforehand, etc. For example, the raw material milk may be a well-known yogurt mixture.

[0033]

Herein, "the average particle size of the raw material milk" is the mean of the particle size of the particle comprised of protein and /or lipid (fat) included in the raw material milk. For example, the particle comprised of protein and /or fat is a casein micelle and /or a fat globule, etc. The average particle size of the raw material milk may be evaluated by laser diffraction-type particle size distribution measuring equipment (e. g., SALD-2200, Shimazu Corporation).

[0034]

Herein, "homogenizing the raw material milk" refers to crushing particles finely (making them finer) comprised of protein and /or lipid included in the raw material milk. As the method for homogenizing the raw material milk of the present invention, for example, a method for

passing the raw material milk through a narrow gap while pressurizing and extruding and a method for passing the raw material milk through a narrow gap while depressurizing and absorbing can be used. The pressure and the flow rate (flow velocity) to homogenize the raw material milk should be the pressure and the flow rate which can adjust the average particle size of the raw material milk to $0.8\mu\text{m}$ or less, preferably $0.77\mu\text{m}$ or less, more preferably $0.75\mu\text{m}$ or less, still more preferably $0.73\mu\text{m}$ or less and most preferably $0.7\mu\text{m}$ or less, and can be set appropriately. At this time, the pressure to homogenize the raw material milk is preferably $180\text{kg}/\text{cm}^2$ or more, more preferably $200\text{kg}/\text{cm}^2$ or more, still more preferably $220\text{kg}/\text{cm}^2$ or more, still more preferably $240\text{kg}/\text{cm}^2$ or more, still more preferably $260\text{kg}/\text{cm}^2$ or more, still preferably $280\text{kg}/\text{cm}^2$ or more and still more preferably $300\text{kg}/\text{cm}^2$ or more. and the pressure to homogenize the raw material milk is preferably $800\text{kg}/\text{cm}^2$ or less, more preferably $700\text{kg}/\text{cm}^2$ or less, still more preferably $600\text{kg}/\text{cm}^2$ or less and still more preferably $550\text{kg}/\text{cm}^2$ or less. Also, the flow rate to homogenize the raw material milk is preferably $100\text{-}30,000\text{kg}/\text{h}$, more preferably $150\text{-}25,000\text{kg}/\text{h}$, still more preferably $200\text{-}20,000\text{kg}/\text{h}$ and still more preferably $250\text{-}15,000\text{kg}/\text{h}$. Note that not only the methods described above but any well-known methods and facilities can be used as the method and facility for homogenizing the raw material milk.

[0035]

The step of homogenizing the raw material milk may be performed so that the average particle size of the raw material milk achieves $0.8\mu\text{m}$ or less from just after the step of homogenizing the raw material milk until just before at least the step of fermenting the raw material milk. That is, for example, the step of homogenizing the raw material milk may be performed so that the average particle size of the raw material milk achieves $0.8\mu\text{m}$ or less just after the step of homogenizing the raw material milk, before the step of sterilizing the raw material milk, after the step of sterilizing the raw material milk or just before the step of fermenting the raw material milk. Now, the step of homogenizing the raw material milk may be performed before the step of sterilizing the raw material milk, after the step of sterilizing the raw material milk or just before the step of fermenting the raw material milk, however from the viewpoint of simplifying the production method of the present invention, etc. (for example, facilitating the hygienic handling of the raw material milk), the step of homogenizing the raw material milk is performed preferably (just) before the step of sterilizing the raw material milk. The step of homogenizing the raw material milk may be performed in one time and may be performed twice or more, however to simplify the production method of the present invention, etc, the step of homogenizing the raw material milk is preferably performed in one time. In the production method of the present invention, the fermented milk having the sufficient hardness to be able to tolerate vibration at the time of circulation can be obtained by homogenizing the raw material milk on a predetermined condition and adjusting the average particle size of the

raw material milk small even when the raw material milk is processed at high temperature of 115°C -150°C. At this time, the average particle size of the raw material milk of the present invention is preferably 0.8μm or less, more preferably 0.77μm or less, still more preferably 0.75μm or less, still more preferably 0.73μm or less, still more preferably 0.7μm or less, still more preferably 0.67μm or less and still more preferably 0.65μm or less. Also, the average particle size of the raw material milk of the present invention is preferably 0.2μm or more, more preferably 0.25μm or more, still more preferably 0.3μm or more, still more preferably 0.35μm or more and still more preferably 0.4μm or more. Also, the standard deviation of the particle size of the raw material milk of the present invention is preferably 0.16μm or less, more preferably 0.15μm or less, still more preferably 0.14μm or less and still more preferably 0.13μm or less. Also, the standard deviation of the particle size of the raw material milk of the present invention is preferably 0.01μm or more, more preferably 0.05μm or more, still more preferably 0.08μm or more and still more preferably 0.1μm or more.

[0036]

The production method of the present invention comprises a step of sterilizing the raw material milk at 115°C -150°C.

[0037]

The step of sterilizing the raw material milk may be performed before the step of homogenizing the raw material milk and may be performed after the step of homogenizing the raw material milk. In the method for sterilizing the raw material milk, so-called "high temperature short time sterilization" (HTST) or "ultrahigh temperature sterilization" (UHT) can be used. The temperature and the time to sterilize the raw material milk should be the temperature and the time which can produce the fermented milk having the sufficient hardness and the smooth texture, and can be set appropriately. At this time, the temperature to sterilize the raw material milk is preferably 115°C or more, more preferably 116°C or more, still more preferably 120°C or more, still more preferably 125°C or more and still more preferably 130°C or more. Also, the temperature to sterilize the raw material milk is preferably 150°C or less, more preferably 145°C or less and still more preferably 140°C or less. Also, the time to sterilize the raw material milk is preferably for 1-300 seconds, more preferably for 1-120 seconds, still more preferably for 1-60 seconds, still more preferably for 1-30 seconds, still more preferably for 1-10 seconds and most preferably 1-5 seconds. Note that not only the methods described above but any well-known methods and facilities can be used for the method and facility for sterilizing the raw material milk. Note that the fermented milk having improved smooth texture can be obtained by processing the raw material milk at high temperature of 115°C -150°C.

[0038]

The production method of the present invention comprises a step of fermenting the raw

material milk (including the meaning of the fermented milk base material which is in the state after adding the starter of lactic acid bacteria, etc. to the raw material milk).

[0039]

The step of fermenting the raw material milk is performed after the step of homogenizing the raw material milk and the step of sterilizing the raw material milk. In the step of fermenting the raw material milk, after homogenizing the raw material milk to sterilize the raw material milk or after sterilizing the raw material milk to homogenize the raw material milk, the starter of lactic acid bacteria and yeast, etc. can be added (inoculated) to the raw material milk and then the raw material milk can be fermented. Also, in the step of fermenting the raw material milk, the starter of lactic acid bacteria and yeast, etc. is added to the raw material milk after sterilizing the raw material milk, then the raw material milk can be homogenized and the raw material milk can be fermented. That is, the step of adding the starter to the raw material milk may be performed at any stages of before the step of homogenizing the raw material milk and after the step of homogenizing the raw material milk if it is after the step of sterilizing the raw material milk and is before the step of fermenting the raw material milk, however from the viewpoint of simplifying the production method of the present invention, etc. (for example, facilitating the hygienic handling of the raw material milk), the step of adding the starter to the raw material milk is preferably performed (just) before the step of fermenting the raw material milk. The step of adding the starter to the raw material milk may be performed in one time and may be performed twice or more, however from the viewpoint of simplifying the production method of the present invention, etc., the step of adding the starter to the raw material milk is preferably performed in one time.

[0040]

In the step of fermenting the raw material milk or the step of adding the starter to the raw material milk, any starters, etc. such as lactic acid bacteria, bifidobacteria and yeast, etc. can be used. For example, one kind selected from lactic acid bacteria such as *Lactobacillus bulgaricus* (*Lactobacillus bulgaricus*, *L. bulgaricus*), *Streptococcus thermophilus* (*Streptococcus thermophilus*, *S. thermophilus*), *Lactobacillus lactis* (*Lactobacillus lactis*, *L. lactis*), *Lactobacillus gasseri* (*Lactobacillus gasseri*, *L. gasseri*), *Lactobacillus plantarum* (*Lactobacillus plantarum*, *L. plantarum*), *Lactobacillus casei* (*Lactobacillus casei*, *L. casei*), *Lactobacillus acidophilus* (*L. acidophilus*) and *Bifidobacterium* (*Bifidobacterium*), etc. and yeast which are generally used in production of the fermented milk can be independently used for the starter, or two or more kinds selected from them can be used in combination. Note that the starter, from the viewpoint of that it is standardized as a yogurt starter in the codex standard, is preferably the starter based on the mixed starter of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*. Also, *Lactobacillus gasseri*, bifidobacteria and yeast, etc. may be added based on the yogurt starter depending on the fermented milk to be practically obtained.

At this time, the amount of addition of the starters should be the amount used generally in production of the fermented milk and, for example, is 0.1-10% by weight, preferably 0.2-5% by weight, more preferably 0.5-4% by weight and still more preferably 1-3% by weight relative to the raw material milk. Also, the method for adding the starter can be the method used generally in production of the fermented milk and, for example, is a method that the starter is added aseptically in the condition where the raw material milk is stored in the tank, etc. and is a method that the starter is added in-line in the condition where the raw material milk is drifting in the plumbing. Note that not only the methods described above but any well-known methods and facilities can be used for the method and facility for fermenting the raw material milk.

[0041]

The method for fermenting the raw material milk may be a method for keeping the raw material milk in a fermentation chamber after adding the starter to the raw material milk and filling the container with the raw material milk or a method for keeping the raw material milk in the tank, etc. after adding the starter to the raw material milk and filling the tank, etc. with the raw material milk. In the method for keeping the raw material milk in the tank, etc., after filling the tank, etc. with the raw material milk, the methods of stirring the fermented milk (crushing the curd of the fermented milk) after the fermented milk was prepared in the tank, mixing them with sarcocarp, vegetables, preparation, source and carbohydrate solution as necessary and filling the container with this fermented milk may be added to produce a soft type yogurt. Also, in the method for keeping the fermented milk in the tank, etc. after filling the tank, etc. with the raw material milk, the methods of stirring the fermented milk (crushing the curd of the fermented milk) after the fermented milk was prepared in the tank, homogenizing the fermented milk (making the curd of the fermented milk finer), mixing them with sarcocarp, vegetables, preparation, source and carbohydrate solution as necessary and filling the container with this fermented milk may be added to produce a drink type yogurt.

[0042]

The condition to ferment the raw material milk should be adjusted considering the kinds and the loadings of lactic acid bacteria, etc. added to the raw material milk and a flavor, a texture and physical properties, etc. of the fermented milk to be practically obtained. The temperature and the time to ferment the raw material milk should be the temperature and the time which can produce the fermented milk having the sufficient hardness and the smooth texture and can be set appropriately. At this time, the temperature to ferment the raw material milk (fermentation temperature) is preferably 30°C or more, more preferably 33°C or more, still more preferably 35°C or more and most preferably 37°C or more. Also, the temperature to ferment the raw material milk is preferably 50°C or less, more preferably 45°C or less and still more preferably 43°C or less. Also, the time to ferment the raw material milk (fermentation

time) is preferably for 1-24 hours, more preferably for 1-12 hours, still more preferably for 2-8 hours, still more preferably for 2-6 hours and still more preferably for 2-4 hours. Also, the lactic acid acidity (the acidity) varies according to composition when the raw material milk is fermented, however it preferably reaches 0.5% and more preferably 0.6% if milk solids-not-fat is around 8% by weight. Also, if milk solids-not-fat is around 10% by weight, the lactic acid acidity (the acidity) preferably reaches 0.6% and more preferably 0.7%. Also, if milk solids-not-fat is around 12% by weight, the lactic acid acidity (the acidity) preferably reaches 0.7% and more preferably 0.8%. Also, if milk solids-not-fat is around 14% by weight, the lactic acid acidity (the acidity) preferably reaches 0.8% and more preferably 1.0%. Also, if milk solids-not-fat is around 16% by weight, the lactic acid acidity (the acidity) preferably reaches 1.0% and more preferably 1.1%. Also, if milk solids-not-fat is around 18% by weight, the lactic acid acidity (the acidity) preferably reaches 1.1% and more preferably 1.3%. Also, if milk solids-not-fat is around 20% by weight, the lactic acid acidity (the acidity) preferably reaches 1.2% and more preferably 1.4%. Note that not only the methods described above but any well-known methods and facilities can be used for the method and facility for fermenting the raw material milk. Note that the fermented milk which the smooth texture is improved more can be obtained by fermenting the raw material milk at low temperature of 35°C -40°C.

[0043]

In the production method of the present invention, according to the examples described below, specifically the fermented milk which is superior in the density of texture of the curd, mellow aftertaste, the creamy feeling of flavor, denseness feeling, milk feeling of aftertaste, smoothness and fillingness and has good flavor and is superior in the smooth texture can be obtained.

[0044]

The production method of the present invention may further comprises a step of reducing the dissolved oxygen density of the raw material milk before the step of fermenting the raw material milk (including the meaning of the fermented milk base material which is in a state after adding the starter, etc. of lactic acid bacteria to the raw material milk).

[0045]

The step of reducing the dissolved oxygen density of the raw material milk should be performed before the step of fermenting the raw material milk and, for example, may be performed any of before the step of homogenizing the raw material milk, after the step of homogenizing the raw material milk, before the step of sterilizing the raw material milk, after the step of sterilizing the raw material milk, before the step of adding the starter to the raw material milk and after the step of adding the starter to the raw material milk. The step of reducing the dissolved oxygen density of the raw material milk may be performed in one time and may be performed twice or more, however from the viewpoint of simplifying the

production method of the present invention, etc., the step of reducing the dissolved oxygen density of the raw material milk is preferably performed either once or twice either before the step of sterilizing the raw material milk or before the step of fermenting the raw material milk. At this time, the step of reducing the dissolved oxygen density of the raw material milk should be processed so that the dissolved oxygen density of the raw material milk at the time of starting the fermentation becomes lower than usual, for example, 5ppm or less, preferably 4ppm or less, more preferably 3ppm or less, still more preferably 2ppm or less and still more preferably 1ppm or less. Because the lactic acid acidity reaches the predetermined numerical value early by reducing the dissolved oxygen density of the raw material milk at the time of starting the fermentation, the fermentation time can be shortened and the production efficiency can be improved.

[0046]

The method for reducing the dissolved oxygen density of the raw material milk may be a method for replacing oxygen of the raw material milk with an inert gas by pouring an inert gas into the raw material milk and may be a method for removing oxygen of the raw material milk by maintaining the raw material milk in the state of low pressure or vacuum and depressurizing and deaerating the raw material milk. Not only the methods described above but well-known methods and facilities can be used for the method and facility for reducing the dissolved oxygen density of the raw material milk. Note that N_2 may be used, for example, and rare gas such as helium, neon, argon and xenon may be used for an inert gas. At this time, the method for reducing the dissolved oxygen density of the raw material milk may be a method to set the retention time in the heating temperature to the predetermined value (lengthening a little) in the method of heating (sterilization) the raw material milk and, for example, in the case that the heating temperature of the raw material milk is at 115°C -150°C, this retention time should be set preferably for 5-60 seconds, more preferably for 5-30 seconds and still more preferably for 5-10 seconds. At this time, the step of reducing the dissolved oxygen density of the raw material milk can be performed simultaneously with the step of sterilizing the raw material milk.

[0047]

The production method of the present invention may further comprises a step of filling a container with the raw material milk before the step of fermenting the raw material milk (including the meaning of the fermented milk base material which is in a state after adding the starter, etc. such as lactic acid bacteria to the raw material milk).

[0048]

The step of filling the container with the raw material milk should be performed before the step of fermenting the raw material milk and, for example, may be performed any of after the step of homogenizing the raw material milk, after the step of sterilizing the raw material milk,

before the step of adding the starter to the raw material milk and after the step of adding the starter to the raw material milk. In the step of filling the container with the raw material milk, the raw material milk may be filled in the container, for example, after homogenizing and sterilizing the raw material milk and adding the starter to the raw material milk. Note that the container should be the container which is generally used in production of the fermented milk (milk products) and, for example, should be the container made of plastic, glass and paper, etc.

[0049]

The production method of the present invention can provide the fermented milk not only having the sufficient hardness to be able to tolerate vibration at the time of circulation but also being superior in the smooth texture by reducing the average particle size of the raw material milk in the step of homogenizing the raw material milk and processing at high temperature of 115°C or more in the step of sterilizing the raw material milk. Also, in the production method of the present invention, the sterilization condition same as the product except fermented milk such as milk or milk drink can be set in the step of sterilizing the raw material milk by processing at high temperature of 115°C or more. Therefore, in the production method of the present invention, the methods and facilities same as the product except fermented milk such as milk or milk drink can be used in the step of sterilizing the raw material milk, and the production efficiency of various products is not reduced in the whole dairy factory and there is also no need to install new facilities for each various product.

[0050]

Also, the present invention provides the fermented milk having the sufficient hardness and being superior in the smooth texture. The fermented milk of the present invention may have the hardness of 26g or more. Also, in the fermented milk of the present invention, the intrusion angle of the yogurt knife (one of the indexes indicating the smooth texture) may be less than 60 degrees. Also, in the fermented milk of the present invention, the average particle size after stirring (one of the indexes indicating the smooth texture) may be 43 μ m or less. Also, the fermented milk of the present invention can be prepared by the method for producing the fermented milk described above. Also, the fermented milk of the present invention has the sufficient hardness and can be adjusted to the physical properties superior in the smooth texture by being prepared by the method for producing the fermented milk described above.

[0051]

Herein, "having the sufficient hardness" refers to having the hardness (strength) that can tolerate the vibration at the time of circulation and is not crushed by the impact, etc. while transportation. Herein, "hardness" can be expressed in other words with strength and curd tension. "Hardness" in the fermented milk of the present invention may be evaluated for measurement of the rupture point of the yogurt knife in a curd meter (e. g., MAX ME-500, Aitechno engineering company) and, specifically, may be evaluated and measured by the

rupture point of the curd meter when measurement temperature is 5-10°C and load is 100g. At this time, in the fermented milk of the present invention, the hardness should be 26g or more, and the texture is maintained at the time of circulation stably and the crush by impact, etc. while transportation is inhibited effectively. That is, the hardness of the fermented milk of the present invention is preferably 26g or more, more preferably 28g or more, still more preferably 30g or more and still more preferably 32 g or more. Also, the hardness of the fermented milk of the present invention is preferably 100g or less, more preferably 90g or less, still more preferably 80g or less and still more preferably 70g or less.

[0052]

Herein, "superior in the smooth texture" refers to that the texture of the curd is dense and not being rough feeling on the tongue at the time of putting it in oral cavity. "Smooth texture" in the fermented milk of the present invention may be evaluated for measurement of the intrusion angle of the yogurt knife in a curd meter (e. g., MAX ME-500, Aitechno engineering company) and specifically, may be evaluated and measured by the angle between the tangent line for the rupture point passing through the origin and the time - weighting curve after the rupture point in the measurement curve of the curd meter when measurement temperature is 5-10°C and weight is 100g. The fermented milk is evaluated to have a rough coarse texture if this angle is big, while the fermented milk is evaluated to have a smooth texture if this angle is small. At this time, in the fermented milk of the present invention, the intrusion angle of the yogurt knife may be less than 60 degrees, and the smooth texture of the taste is improved effectively while maintaining the texture at the time of circulation stably. That is, the intrusion angle of the yogurt knife of the fermented milk of the present invention is preferably less than 60 degrees, more preferably less than 56 degrees, still more preferably less than 52 degrees and still more preferably less than 48 degrees. Also, the intrusion angle of the yogurt knife of the fermented milk of the present invention is preferably 10 degrees or more, more preferably 15 degrees or more, still more preferably 20 degrees or more and still more preferably 25 degrees or more.

[0053]

"Smooth texture" in the fermented milk of the present invention may be evaluated for measurement of the average particle size after stirring the fermented milk (the final product, intermediate product), and the average particle size after stirring the fermented milk may be measured and evaluated by laser diffraction-type particle size distribution measuring equipment (e. g., SALD-2200, Shimazu Corporation). The fermented milk is evaluated to have a rough coarse texture if this particle diameter after stirring is big, while the fermented milk is evaluated to have a smooth texture if this particle diameter after stirring is small. At this time, in the fermented milk of the present invention, the average particle size after stirring may be 43µm or less, and the smooth texture of the taste is improved effectively while maintaining the

texture at the time of circulation stably. That is, the average particle size after stirring of the fermented milk of the present invention is preferably 43 μ m or less, more preferably 42 μ m or less, still more preferably 41 μ m or less and most preferably 40 μ m or less.

[0054]

The fermented milk of the present invention may be a yogurt and may be either a pre-fermentation type yogurt or a post-fermentation type yogurt, however is preferably a post-fermentation type yogurt. Also, the fermented milk of the present invention may be a plane type yogurt and may be any of a set type yogurt(solid fermented milk), a soft type yogurt(paste fermented milk) and a drink type yogurt (liquid fermented milk), however is preferably a plane type yogurt and is a set type yogurt.

[0055]

The fermented milk of the present invention may be packed in a container. Herein, "packed in a container" refers to what it is filled in (inside of) a container and sealed up. The container should be the container which is generally used in production of the fermented milk (milk products) and, for example, should be the container made of plastic, glass and paper, etc. The fermented milk of the present invention may be the one fermented in the container after filling the container with the raw material milk (including the meaning of the fermented milk base material which is in a state after adding the starter of lactic acid bacteria to the raw material milk)(post-fermentation type) and may be the one fermented in a tank, etc. before filling the container with the fermented milk (the one that the fermented milk is filled in the container after fermenting the raw material milk in a tank, etc.) (pre-fermentation type).

[0056]

According to the present invention, milk solids-not-fat of the raw material milk and /or the fermented milk (final product and /or intermediate product) is preferably 8% by weight or more, more preferably 8.2% by weight or more, still more preferably 8.5% by weight or more, still more preferably 8.7% by weight or more and still more preferably 9% by weight or more. Also, milk solids-not-fat of the raw material milk and /or the fermented milk is preferably 30% by weight or less, more preferably 25% by weight or less, still more preferably 20% by weight or less, still more preferably 18% by weight or less, still more preferably 15% by weight or less, still more preferably 13% by weight or less, still more preferably 10% by weight or less and still more preferably less than 10% by weight. Also, in the present invention, fat (lipid) of the raw material milk and /or the fermented milk is preferably 0.3% by weight or more, more preferably 0.5% by weight or more, still more preferably 1% by weight or more, still more preferably is 1.5% by weight or more, still more preferably 2% by weight or more, still more preferably 2.5% by weight or more, still more preferably 3% by weight or more and still more preferably more than 3% by weight. Also, fat (lipid) of the raw material milk and /or the fermented milk is preferably 8% by weight or less, more preferably 7% by weight or less, still

more preferably 6% by weight or less, still more preferably 5% by weight or less, still more preferably 4.5% by weight or less, still more preferably 4% by weight or less and still more preferably 3.5% by weight or less. Also, in the present invention, milk fat of the raw material milk and /or the fermented milk is preferably 0.3% by weight or more, more preferably 0.5% by weight or more, still more preferably 1% by weight or more, still more preferably 1.5% by weight or more, still more preferably 2% by weight or more, still more preferably 2.5% by weight or more, still more preferably 3% by weight or more and still more preferably more than 3% by weight. Also, milk fat of the raw material milk and /or the fermented milk is preferably 8% by weight or less, more preferably 7% by weight or less, still more preferably 6% by weight or less, still more preferably 5% by weight or less, still more preferably 4.5% by weight or less, still more preferably 4% by weight or less and still more preferably 3.5% by weight or less. Also, in the present invention, carbohydrates of the raw material milk and /or the fermented milk are preferably 3% by weight or more, more preferably 4% by weight or more, still more preferably 5% by weight or more and still more preferably more than 5% by weight. Also, carbohydrates of the raw material milk and /or the fermented milk are preferably 15% by weight or less, more preferably 13% by weight or less, still more preferably 10% by weight or less, still more preferably 8% by weight or less and still more preferably 6% by weight or less. Also, in the present invention, lactose of the raw material milk and /or the fermented milk is preferably 3% by weight or more, more preferably 4% by weight or more, still more preferably 5% by weight or more and still more preferably more than 5% by weight. Also, lactose of the raw material milk and /or the fermented milk is preferably 15% by weight or less, more preferably 13% by weight or less, still more preferably 10% by weight or less, still more preferably 8% by weight or less and still more preferably 6% by weight or less.

[0057]

Also, the adhesion of the fermented milk of the present invention may be 0.0008J/m^2 or more, and is preferably 0.0009J/m^2 or more. Also, the adhesion of the fermented milk of the present invention may be 0.0050J/m^2 or less, and may preferably be 0.0030J/m^2 or less. Herein, "adhesion" represents the energy used per unit area of the slant surface when it flows down or slips down over the slant plate imitating the living body surface. The adhesion can be measured using a measuring device as shown in the test 6 of the examples described below. Because the adhesion is higher than the conventional fermented milk as shown in the examples described below, the fermented milk of the present invention can be assumed to be the full-bodied fermented milk.

[0058]

The fermented milk of the present invention may be the fermented milk that milk solids-not-fat is 8-30% by weight and the hardness is 26g or more. Also, the fermented milk of the present invention may be the fermented milk that milk solids-not-fat is 8-10% by weight and the

hardness is 26g or more. Also, the fermented milk of the present invention may be the fermented milk that fat (lipid) is 0.3-8% by weight and the hardness is 26g or more. Also, it may be the fermented milk that fat (lipid) is 0.1-4% by weight and the hardness is 26g or more. Also, the fermented milk of the present invention may be the fermented milk that milk fat is 0.3-8% by weight and the adhesion is 0.0008J/m² or more and 0.0050J/m² or less. Also, the fermented milk of the present invention may be the fermented milk that milk fat is 0.5-3.8% by weight and the adhesion is 0.0008J/m² or more and 0.0040J/m² or less. Also, the fermented milk of the present invention may be the fermented milk that milk solids-not-fat is 8-30% by weight and the adhesion is 0.0008J/m² or more and 0.0040J/m² or less. Also, the fermented milk of the present invention may be the fermented milk that milk solids-not-fat is 8-10% by weight and the adhesion is 0.0008J/m² or more and 0.0050J/m² or less. Also, the fermented milk of the present invention may be the fermented milk that fat (lipid) is 0.3-8% by weight and the adhesion is 0.0008J/m² or more. Also, the fermented milk of the present invention may be the fermented milk that fat (lipid) is 0.3-3.8% by weight and the adhesion is 0.0008J/m² or more and 0.0050J/m² or less. Also, the fermented milk of the present invention may be the fermented milk that milk fat is 0.5-3.8% by weight and the adhesion is 0.0008J/m² or more and 0.0050J/m² or less. Also, the fermented milk of the present invention may be the fermented milk that lactose is 3-15% by weight and the adhesion is 0.0008J/m² or more and 0.0050J/m² or less.

[0059]

Also, the raw materials indication of the fermented milk of the present invention may combine one or more of milk, fresh milk, milk products, milk protein and /or saccharide (sugar, liquid sugar, and oligosaccharide) and sweetener. As a plane type, the raw materials indication of the fermented milk of the present invention is preferably only milk (fresh milk) and milk products or milk protein, more preferably only milk (fresh milk) and milk products and still more preferably only milk (fresh milk). That is, in the fermented milk of the present invention, even if the raw materials indication is only milk (fresh milk), the hardness (strength) that can tolerate the transportation same as before is provided and the hardness is 26g or more specifically.

[0060]

Also, the present invention provides a method for improving hardness of a fermented milk and a method for improving smooth texture of a fermented milk. The method of the present invention (the method for improving hardness of the fermented milk and the method for improving smooth texture of the fermented milk) comprises a step of homogenizing a raw material milk, a step of sterilizing the raw material milk at 115°C -150°C and a step of fermenting the raw material milk. In the method of the present invention, the step of homogenizing the raw material milk, the step of sterilizing the raw material milk at 115°C

-150°C and the step of fermenting the raw material milk can be performed same as each step described above about the production method of the present invention.

[0061]

In the method of the present invention, the step of homogenizing the raw material milk may be performed from just after the step of homogenizing the raw material milk until just before at least the step of fermenting the raw material milk so that the average particle size of the raw material milk achieves 0.8 μ m or less. At this time, from a viewpoint of further improving the smooth texture of the fermented milk and a viewpoint of further improving the hardness of the fermented milk, the average particle size of the raw material milk of the present invention is preferably 0.77 μ m or less, more preferably 0.75 μ m or less, still more preferably 0.73 μ m or less and most preferably 0.7 μ m or less.

[0062]

The method of the present invention may further comprise a step of reducing the dissolved oxygen density of the raw material milk. In the method of the present invention, the step of reducing the dissolved oxygen density of the raw material milk can be performed same as the step of reducing the dissolved oxygen density of the raw material milk described above about the production method of the present invention.

[0063]

In the method of the present invention, the fermented milk having the sufficient hardness to be able to tolerate vibration at the time of circulation can be obtained by homogenizing the raw material milk on a predetermined condition and adjusting the average particle size of the raw material milk small even when the raw material milk is processed at high temperature of 115°C -150°C. Also, the fermented milk having improved smooth texture can be obtained by processing the raw material milk at high temperature of 115°C -150°C. That is, the method of the present invention can provide the fermented milk not only having the sufficient hardness to be able to tolerate vibration at the time of circulation but also being superior in the smooth texture by making the average particle size of the raw material milk small in the step of homogenizing the raw material milk and processing at high temperature of 115°C or more in the step of sterilizing the raw material milk.

[0064]

In the method of the present invention, according to the examples described below, the fermented milk, specifically, which is superior in the density of texture of the curd, mellow aftertaste, creamy feeling of flavor, denseness feeling, milk feeling of aftertaste, smoothness and fillingness, and has good flavor and is superior in the smooth texture can be obtained.

EXAMPLES

[0065]

Examples are shown below and embodiments of the present invention are further described in detail, however the present invention is not limited to the following examples.

[0066]

[Method for measuring the average particle size]

Using the laser diffraction-type particle size distribution measuring equipment SALD-2200 (Shimazu Corporation), the average particle size of the raw material milk and standard deviation were measured in the examples. Specifically, the raw material milk was diluted with ion exchanged water and was adjusted such that the maximum value of the distribution of the light intensity of the diffraction and dispersion thereof was 35-75% (absolute value: 700-1500). Then, using software WingSALD II for particle size distribution measuring equipment, the distribution of the light intensity was analyzed and the average particle size $\pm$ standard deviation was obtained.

[0067]

[Method for measuring the hardness of the fermented milk]

Using the curd meter MAX ME-500 (Aitechno engineering company), the hardness (strength or curd tension) of the fermented milk was measured in the examples. Specifically, the yogurt knife attached with a weight of 100g was put on the top surface of the fermented milk, and the fermented milk was raised continuously and weighted with around 2g/s, and the measurements of the weighting to the weighted elapsed time were expressed in a curve. At this time, the weighted elapsed time (second) was expressed in a vertical axis, the measurements of the weighting was expressed in a horizontal axis and 10g of the vertical axis and four seconds of horizontal axis were expressed as the same distance. and when the fermented milk reached the rupture, a point of inflection (rupture point) was produced in the time - weighting curve because the yogurt knife intruded from the top surface of the fermented milk and weighting until reaching this rupture was used as an index of the hardness (g).

[0068]

[Evaluation method of the smoothness of the fermented milk]

The intrusion angle of the yogurt knife and the average particle size after stirring was measured and evaluated, and the smooth texture of the fermented milk was evaluated in the examples. Here, in the method for measurement of the hardness of the fermented milk, in the measurement curve of the curd meter, the angle between the tangent line for the rupture point passing through the origin and the time - weighting curve after the rupture point was measured and the intrusion angle of the yogurt knife was evaluated. Also, after stirring the fermented milk (sample) at around 100 rounds using a propeller-shaped stirring wing or a medicine spoon and destroying the curd, using laser diffraction-type particle size distribution measuring equipment SALD-2200 (Shimazu Corporation), the average particle size after stirring of the fermented milk was measured.

[0069]

[Test1]

(Example 1)

Fresh milk, powdered skim milk and water were mixed to prepare the raw material milk (yogurt mixture; fat:3.1% by weight, milk solids-not-fat:9.70% by weight), and the raw material milk was warmed (around 80°C), homogenized (400 kg/cm²), processed by ultrahigh temperature sterilization (UHT; 130°C, two seconds) and then cooled (approximately 10°C).

[0070]

At this time, the average particle size $\pm$ standard deviation of the raw material milk was 0.52 $\pm$ 0.13 μ m.

[0071]

After the raw material milk was warmed (around 43°C), N₂ was injected, and the dissolved oxygen density of the raw material milk (DO) was reduced to 5ppm, and then the starter of lactic acid bacteria (isolated from Meiji Bulgaria Yogurt LB81 (Meiji Co., Ltd.)) was added (inoculated) at 3% by weight.

[0072]

After it was filled in the cup container (capacity:100 g, made of plastic), it was kept in the fermentation chamber (43°C) and left until the lactic acid acidity reached 0.70%(approximately three hours), and then it was kept in the cold room (10°C or less) to produce the set type yogurt (Example 1).

[0073]

(Comparative example 1)

Fresh milk, powdered skim milk and water were mixed to prepare the raw material milk (yogurt mixture; fat:3.1% by weight, milk solids-not-fat:9.7% by weight), and the raw material milk was warmed (around 80°C), homogenized (150kg/cm²), processed by ultrahigh temperature sterilization (UHT; 130°C, two seconds) and then cooled (approximately 10°C).

[0074]

At this time, the average particle size $\pm$ standard deviation of the raw material milk was 1.38 $\pm$ 0.13 μ m.

[0075]

After the above raw material milk was warmed (around 43°C), N₂ was injected, and the dissolved oxygen density of raw material milk (DO) was reduced to 5ppm, and then the starter of lactic acid bacteria (isolated from Meiji Bulgaria Yogurt LB81 (Meiji Co., Ltd.)) was added (inoculated) at 3% by weight.

[0076]

After it was filled in the cup container (capacity: 100g, made of plastic), it was kept in the fermentation chamber (43°C), and left until the lactic acid acidity reached 0.7%

(approximately three hours), and then it was kept in the cold room (10°C or less) to produce the set type yogurt (Comparative example 1).

[0077]

(The hardness of the fermented milk)

The hardness (curd tension) of the yogurt of the example 1 and the comparative example 1 were measured. Figure 1 is a graph which shows the hardness of the yogurt of the example 1 and the comparative example 1. Here, it can be said that it is the fermented milk which can maintain the texture at the time of circulation if the hardness is 26g or more.

[0078]

As shown in Figure 1, as for the yogurt of the comparative example 1 (the average particle size of the raw material milk: $1.38 \pm 0.13 \mu\text{m}$), the hardness was shown to be 25g, which was less than 26g and was insufficient to allow the texture maintained at the time of circulation. In contrast, as for the yogurt of the example 1 (the average particle size of the raw material milk: $0.52 \pm 0.13 \mu\text{m}$), the hardness was shown to be 51g, which was 26g or more and was sufficient to allow the texture maintained at the time of circulation. From the above-mentioned results, in the case that the raw material milk is processed by ultrahigh temperature sterilization without reducing the average particle size of the raw material milk, it is confirmed that the fermented milk having the sufficient hardness to be able to tolerate vibration at the time of circulation cannot be obtained. In contrast, when the average particle size of the raw material milk is reduced, it is confirmed that the fermented milk having the sufficient hardness to be able to tolerate vibration at the time of circulation can be obtained even in the case that the raw material milk is processed by ultrahigh temperature sterilization.

[0079]

[Test2]

(Example 2)

Fresh milk, powdered skim milk and water were mixed to prepare the raw material milk (yogurt mixture; fat: 3.1% by weight, milk solids-not-fat: 9.7% by weight), and the raw material milk was warmed (around 80°C), homogenized (400kg/cm²), processed by ultrahigh temperature sterilization (UHT; 130°C, two seconds) and then cooled (approximately 10°C).

[0080]

At this time, the average particle size $\pm$ standard deviation of the raw material milk was $0.52 \pm 0.13 \mu\text{m}$.

[0081]

After the raw material milk was warmed (around 39°C), nitrogen (N₂) was injected, and the dissolved oxygen density of the raw material milk (DO) was reduced to 5ppm, and then the starter of lactic acid bacteria (isolated from Meiji Bulgaria Yogurt LB81 (MeijiCo., Ltd.)) was added (inoculated) at 3% by weight.

[0082]

After it was filled in the cup container (capacity: 100g, made of plastic), it was kept in the fermentation chamber (43°C) and left until the lactic acid acidity reached 0.7%(approximately three hours), and then it was kept in the cold room (10°C or less) to produce the set type yogurt (Example 2).

[0083]

As for the yogurt of the example 2 (the average particle size of the raw material milk: $0.52\pm 0.13\mu\text{m}$), it was shown that the hardness was 49g, which was 26g or more and could allow the texture maintained at the time of circulation. Additionally, it was shown that the intrusion angle of the yogurt knife was 47 degrees and the average particle size after stirring was $27\mu\text{m}$ so that it was superior in the smooth texture. From the above-mentioned results, in the case that the average particle size of the raw material milk is reduced and the raw material milk is processed by ultrahigh temperature sterilization, it is able to be confirmed that the fermented milk having the sufficient hardness to be able to tolerate vibration at the time of circulation and being superior in the smooth texture can be obtained.

[0084]

(Comparative example 2)

Fresh milk, powdered skim milk and water were mixed to prepare the raw material milk (yogurt mixture; fat:3.1% by weight, milk solids-not-fat:9.70% by weight), and the raw material milk was warmed (around 80°C), homogenized ($150\text{kg}/\text{cm}^2$), processed by high temperature short time sterilization (HTST; 95°C, sterilization at reaching temperature) and then cooled (approximately 10°C).

[0085]

At this time, the average particle size $\pm$ standard deviation of the raw material milk was $1.40\pm 0.15\mu\text{m}$.

[0086]

After the raw material milk was warmed (around 39°C), N_2 was injected, and the dissolved oxygen density of the raw material milk (DO) was reduced to 5ppm, and then the starter of lactic acid bacteria (isolated from Meiji Bulgaria Yogurt LB81 (Meiji Co., Ltd.)) was added (inoculated) at 3% by weight.

[0087]

After it was filled in the cup container (capacity: 100g, made of plastic), it was kept in the fermentation chamber (43°C) and left until the lactic acid acidity reached 0.7%(approximately three hours), and then it was kept in the cold room (10°C or less) to produce the set type yogurt (Comparative example 2).

[0088]

As for the yogurt of the comparative example 2 (the average particle size of the raw material

milk: $1.40 \pm 0.15\mu\text{m}$), it was shown that the hardness was 55g, which was 26g or more and could allow the texture maintained at the time of circulation. However, it was shown that the intrusion angle of the yogurt knife was 91 degrees and the average particle size after stirring was $45\mu\text{m}$ so that it was inferior to the smooth texture.

[0089]

(Sensory evaluation)

Sensory evaluation of the yogurt of the example 2 and the comparative example 2 were performed. In the sensory evaluation, based on 7 scales (-3 - +3), pair test by 17 specialized panels was performed after six days from the production of the yogurt. It was evaluated as significantly different with 1% of levels of significance (it is represented in "***"). Figure 2 is a figure indicating the results of the sensory evaluation of the yogurt of the example 2 and the comparative example 2.

[0090]

As for the yogurt of the example 2 (the average particle size of the raw material milk: $0.52 \pm 0.13\mu\text{m}$, sterilization: UHT), in comparison with the yogurt of the comparative example 2 (the average particle size of the raw material milk: $1.40 \pm 0.15\mu\text{m}$, sterilization: HTST), each item of the density of texture (of the curd), mellow aftertaste, the creamy feeling of the flavor, heavy feeling, milk feeling of aftertaste, smoothness, fillingness and the overall evaluation was significantly superior. That is, in these each item, it was able to be confirmed that there was statistical significant difference between the example 2 and the comparative example 2. Therefore, it was able to be confirmed that the fermented milk having dense texture and being superior in mellowness, creamy feeling of flavor, denseness feeling, milk feeling of aftertaste, smoothness and fillingness can be obtained when the raw material milk is homogenized and the average particle size of the raw material milk is adjusted small and it is processed by ultrahigh temperature sterilization. That is, it was able to be confirmed that the fermented milk having a good flavor and being superior in the smooth texture can be obtained by homogenizing the raw material milk, adjusting the average particle size of the raw material milk small and processing it by ultrahightemperature sterilization.

[0091]

[Test3]

(Example 3)

Fresh milk, powdered skim milk and water were mixed to prepare the raw material milk (yogurt mixture; fat:3.1% by weight, milk solids-not-fat:9.70% by weight), and the raw material milk was warmed (around 80°C), homogenized ($400\text{kg}/\text{cm}^2$), processed by ultrahigh temperature sterilization (130°C , two seconds) and then cooled (approximately 10°C).

[0092]

At this time, the average particle size $\pm$ standard deviation of the raw material milk was

0.52±0.13μm.

[0093]

After the raw material milk was warmed (around 43°C), N₂ was injected, and the dissolved oxygen density of the raw material milk (DO) was reduced to 5ppm, and then the starter of lactic acid bacteria (isolated from Meiji Bulgaria Yogurt LB81 (Meiji Co., Ltd.)) was added (inoculated) at 3% by weight.

[0094]

After it was filled in the cup container (capacity: 100g, made of plastic), it was kept in the fermentation chamber (43°C) and left until the lactic acid acidity reached 0.7%, during which two hours 50 minutes (approximately three hours) passed, and then it was kept in the cold room (10°C or less) to produce the set type yogurt (Example 3).

[0095]

(Example 4)

Fresh milk, powdered skim milk and water were mixed to prepare the raw material milk (yogurt mixture; fat:3.1% by weight, milk solids-not-fat: 9.7% by weight), and the raw material milk was warmed (around 80°C), homogenized (400kg/cm²), processed by ultrahigh temperature sterilization (130°C, two seconds) and then cooled (approximately 10°C).

[0096]

At this time, the average particle size ± standard deviation of the raw material milk was 0.52±0.13μm.

[0097]

After the raw material milk was warmed (around 43°C), the starter of lactic acid bacteria (isolated from Meiji Bulgaria Yogurt LB81 (Meiji Co., Ltd.)) was added (inoculated) at 3% by weight without adjusting the dissolved oxygen density (DO) of the raw material milk.

[0098]

After it was filled in the cup container (capacity: 100g, made of plastic), it was kept in the fermentation chamber (43°C) and left until the lactic acid acidity reached 0.7%, during which three hours 50 minutes (approximately four hours) passed, and then it was kept in the cold room (10°C or less) to produce the set type yogurt (Example 4).

[0099]

(Fermentation time)

Fermentation time of the yogurt of the examples 3 and 4 (time for the lactic acid acidity to reach 0.7%) was measured and was shown in Table 1. As shown in Table 1, as for the yogurt of the example 3 (deoxidation processing before fermentation: present), it was shown that fermentation time was greatly shortened in comparison with the yogurt of the example 4 (deoxidation processing before fermentation: absent). From the above-mentioned result, it was confirmed that the production efficiency of the fermented milk can be improved when

deoxidation processing is performed before fermentation to reduce dissolved oxygen density of the raw material milk because fermentation time is shortened so that the time required to produce the fermented milk can be shortened.

[0100]

[Table 1]

Items	Sterilization temperature [°C]	Condition of homogenization [kg/cm ²]	Average particle size of raw material milk [μm]	Hardness [g]
Example 9	130	400	0.45	60
Example 10	135	400	0.46	60
Example 11	140	400	0.48	55
Example 12	144	400	0.57	50

[0101]

[Test4]

(Example 5-8 and Comparative example 3)

Fresh milk, powdered skim milk and water were mixed to prepare the raw material milk (yogurt mixture; fat: 3.1% by weight, milk solids-not-fat: 9.7% by weight), and the raw material milk was warmed (around 80°C), homogenized (various pressure described below), processed by ultrahigh temperature sterilization (130°C, two seconds) and then cooled (approximately 10°C).

[0102]

At this time, the average particle size was changed variously by adjusting the condition (pressure) for homogenizing the raw material milk to prepare the raw material milk. As for the yogurt of the examples 5-8 and the comparative example 3, the average particle sizes after the homogenization of the raw material milk were shown in Table 2.

[0103]

After the raw material milk was warmed (around 43°C), N₂ was injected, and the dissolved oxygen density of the raw material milk (DO) was reduced to 5ppm, and then the starter of lactic acid bacteria (isolated from Meiji Bulgaria Yogurt LB81 (Meiji Co., Ltd.)) was added (inoculated) at 3% by weight.

[0104]

After it was filled in the cup container (capacity:100g, made of plastic), it was kept in the fermentation chamber (43°C) and left until the lactic acid acidity reached 0.7% (approximately three hours), and then it was kept in the cold room (10°C or less) to produce the set type yogurt (Examples 5-8 and Comparative example 3).

[0105]

(The hardness of the fermented milk)

The hardness of the yogurt of the examples 5-8 and the comparative example 3 was measured and shown in Table 2. As shown in Table 2, as for the yogurt of the comparative example 3 (the average particle size of the raw material milk: $1.30\mu\text{m}$), it was shown that the hardness was 20g, which was less than 26g and was insufficient hardness to allow the texture maintained at the time of circulation. In contrast, as for the yogurt of the examples 5-8 (the average particle size of the raw material milk: $0.40\text{--}0.73\mu\text{m}$, $0.73\mu\text{m}$ or less, homogenization pressure of the raw material milk: $250\text{--}400\text{kg/cm}^2$), it was shown that the hardness was 34-59g, which was 26g or more and was sufficient hardness to allow the texture maintained at the time of circulation. From the above-mentioned results, it was able to be confirmed that the fermented milk having sufficient hardness to be able to tolerate vibration at the time of circulation cannot be obtained in the case that the pressure to homogenize the raw material milk is set to 150kg/cm^2 (150kg/cm^2 or less) and the raw material milk is processed by ultrahigh-temperature sterilization without reducing the average particle size of the raw material milk to $1\mu\text{m}$ or less. In contrast, it was confirmed that the fermented milk having sufficient hardness to be able to tolerate vibration at the time of circulation can be obtained if the pressure for homogenizing the raw material milk is set to $250\text{--}400\text{kg/cm}^2$ (180kg/cm^2 or more) to reduce the average particle size of the raw material milk to $1\mu\text{m}$ or less ($0.8\mu\text{m}$ or less) even in the case that the raw material milk is processed by ultrahigh-temperature sterilization.

[0106]

[Table 2]

Items	Condition of homogenization [kg/cm^2]	Average size of raw material milk [μm]	Standard deviation [μm]	Hardness [g]
Comparative example 3	150	1.30	0.17	20
Example 5	250	0.73	0.13	34
Example 6	300	0.62	0.13	42
Example 7	350	0.50	0.13	45
Example 8	400	0.40	0.12	59

[0107]

[Test5]

(Examples 9-12)

After fresh milk was warmed (around 80°C) and homogenized (400kg/cm^2), it was processed by ultrahigh temperature sterilization (retention time: two seconds) and then cooled (approximately 10°C).

[0108]

At this time, the heat history was changed variously by adjusting the condition (temperature) for sterilizing the raw material milk to prepare the raw material milk. Thus, as for the yogurt of

the examples 9-12, the average particle sizes after the homogenization of the raw material milk were shown in Table 3.

[0109]

After the raw material milk was warmed (around 43°C), nitrogen (N₂) was injected, and the dissolved oxygen density of the raw material milk (DO) was reduced to 5ppm, and then the starter of lactic acid bacteria (isolated from Meiji Bulgaria Yogurt LB81 (Meiji Co., Ltd.)) was added (inoculated) at 3% by weight.

[0110]

After it was filled in the cup container (capacity:100g, made of plastic), it was kept in the fermentation chamber (43°C) and left until the lactic acid acidity reached 0.7% (approximately three hours), and then it was kept in the cold room (10°C or less) to produce the set type yogurt (Examples 9-12).

[0111]

(The hardness of the fermented milk)

The hardness of the yogurt of the examples 9-12 was measured and shown in Table 3. As shown in Table 3, as for the yogurt of the examples 9-12 (the average particle size of the raw material milk: 0.45-0.57μm (0.57μm or less), sterilization temperature of the raw material milk: 130-144°C), it was shown that the hardness was 50-60g, which was 26g or more and was sufficient hardness to allow the texture maintained at the time of circulation. From the above-mentioned results, it was able to be confirmed that the fermented milk having sufficient hardness to be able to tolerate vibration at the time of circulation can be obtained if the average particle size of the raw material milk is reduced to 1μm or less (0.8μm or less) even in the case that the raw material milk is processed by ultrahigh temperature sterilization with sterilization temperature of the raw material milk set to around 130-144°C (115°C or more).

[0112]

[Table 3]

Items	Sterilization temperature [°C]	Condition of homogenization [kg/cm ²]	Average particle size of raw material milk [μm]	Hardness [g]
Example 9	130	400	0.45	60
Example 10	135	400	0.46	60
Example 11	140	400	0.48	55
Example 12	144	400	0.57	50

[0113]

[Test6]

(Example 13)

Fresh milk, powdered skim milk and water were mixed to prepare the raw material milk

(yogurt mixture; fat:3.1% by weight, milk solids-not-fat: 9.7% by weight), and the raw material milk was warmed (around 80°C), homogenized (250kg/cm²+50kg/cm²), processed by ultrahigh temperature sterilization (130°C, two seconds) and then cooled (approximately 10°C).

[0114]

At this time, the average particle size $\pm$ standard deviation of the raw material milk was 0.5 $\pm$ 0.13 μ m.

[0115]

After the above cooled raw material milk was warmed to around 43°C, nitrogen (N₂) was injected, and the dissolved oxygen density of the raw material milk (DO) was reduced to 5ppm, and then the lactic acid bacteria starter (isolated from Meiji Bulgaria Yogurt LB81 (Meiji Co., Ltd.)) was added (inoculated) at 3% by weight.

[0116]

After it was filled in the cup container (capacity:100g, made of plastic), it was kept in the fermentation chamber (43°C) and left for approximately three hours until the lactic acid acidity reached 0.7%, and then it was kept in the cold room (10°C or less) to produce the set type yogurt (Example 13).

[0117]

(Evaluation of the adhesion)

Using a device for measuring characteristic of eating and swallowing (hereinafter referred to as eating and swallowing measuring device), the difference of flavor properties (mainly the texture at the time of eating and swallowing) between the fermented milk of the example 13 and Meiji Bulgaria Yogurt LB81 (Meiji Co., Ltd.; the comparative example 4) which is a conventional set type yogurt was evaluated.

[0118]

The constitution of used eating and swallowing measuring device is shown in Figure 3. The eating and swallowing measuring device comprises the slant plate affixed the material (prepared by mixing water, hydrophilic polyvinyl alcohol and dimethyl sulfoxide) imitating the living body surface. A phenomenon of eating and swallowing can be imitated by supplying the predetermined quantity of the sample (liquid, solid, semisolid and jelly, etc.) on the slant plate to allow the sample to flow down or slip down over the slant plate. The eating and swallowing measuring device is the measuring device which simulates and quantifies the phenomenon of eating and swallowing by measuring behavior the sample flows down or slips down over the slant plate with a plurality of sensors and a plurality of cameras versatile and performing numerical analysis.

[0119]

Specifically, as shown in Figure 3, the eating and swallowing measuring device comprises a

slant plate having a slant surface, a supply providing a sample on a slant surface (high precision metering piston pump), a supply sensor (discharge confirmation sensor) detecting the sample which has been supplied from the supply on a slant surface, an arrival sensor (upper part arrival confirmation sensor and lower part arrival confirmation sensor) detecting the sample flowing down the predetermined spot on the slant surface, a data logger recording the output of each sensor, atop surface camera imaging the sample flowing down on the slant surface from the upper part of the slant surface and generating the top surface image, a side camera imaging the sample flowing down on the slant surface from the side part of the slant surface and generating the side image and an operation part to operate the state parameter of the sample flowing down on the slant surface using at least one of the output of data logger, the side surface image and the top surface image.

[0120]

The eating and swallowing measuring device defines the behavior of the meal lump which flows down or slips down over the slant plate as a pseudo-swallowing phenomenon, and it can obtain speed, acceleration, pressure, power, shear speed, wall surface shear stress, wall surface shear force, energy used on the wall surface, dynamic contact angle, flowing down area, slipping down area, flowing down trace, slipping down trace, the thickness of center when the sample flows down, thickness of center when the sample slips down and the adhesion at the time of flowing down or slipping down. Here, the adhesion means energy used on the slant surface per unit area of the slant surface. The eating and swallowing measuring device can be used to evaluate a difference of the physical quantity occurred at the time of eating and swallowing about the meal lump sample which has different physical properties and characteristics, and thereby the influence of the physical properties of the meal lump on behavior at the time of swallowing can be evaluated.

[0121]

Each physical quantity can be calculated by the formula shown below. Here, it is expressed as shear speed γ , thickness δ , viscosity μ , shear stress τ , power F , area S , length L (distance between the sensors), work load W and adhesion f_s [J/m^2]. Note that, for example, the viscosity is measured with rheometer (dynamic viscoelastic measuring equipment).

[0122]

[Equation 1]

$$\gamma = \frac{u}{\delta}$$

$$\tau = \mu \cdot \gamma = \mu \cdot \frac{u}{\delta}$$

$$F = \tau \cdot S = \mu \cdot \frac{u}{\delta} \cdot S$$

$$W = F \cdot L = \mu \cdot \frac{u}{\delta} \cdot S \cdot L$$

$$P = F \cdot u = \mu \cdot \frac{u}{\delta} \cdot S \cdot u$$

$$fs = W / S = \mu \cdot \frac{u}{\delta} \cdot L = \tau \cdot L$$

[0123]

Using the eating and swallowing measuring device, each physical quantity at the time of flowing down or slipping down of Meiji Bulgaria Yogurt LB81 (Meiji Co., Ltd. ; the comparative example 4) and the fermented milk of the example 13 was measured four times each. A result of each measured physical quantity is shown in Table 4. Also, Figure 4 is a graph indicating the adhesion of the comparative example 4 and the example 13.

[0124]

As shown in Table 4 and Figure 4, the fermented milk of the example 13 was shown to be high in adhesion in comparison with the conventional fermented milk (Meiji Bulgaria Yogurt LB81). The adhesion of the fermented milk of the example 13 was 0.0008[J/m²] or more and approximately 1.3 times adhesion was provided in comparison with the conventional fermented milk. Also, it was shown that the hardness equal to the conventional set type yogurt (Meiji Bulgaria Yogurt LB81, etc.) was able to be maintained although the fermented milk of the present invention was prepared only by "milk" in indication.

[0125]

[Table 4]

	Mean value of physical quantity		Standard deviation of physical quantity	
	Comparative example 4	Example 13	Comparative example 4	Example 13
Upper part of nozzle (msec)	98.3	115.2	2.1	1.4
Middle part of upper part (msec)	0.256	0.222	0.010	0.005
Bottom of middle part (msec)	0.246	0.129	0.006	0.009
Bottom of upper part (msec)	0.251	0.163	0.007	0.007
Thickness (mm)	5.14	6.34	0.19	0.17
Spreading area (mm ²)	778.6	714.2	21.3	8.3
Middle part area (mm ²)	1389.0	1183.2	45.2	19.6
Bottom area (mm ²)	1878.6	1558.6	66.4	15.3
Spreading rate (l/s)	7928.3	6199.2	369.0	94.6
Change of rate	-0.0103	-0.0928	0.0071	0.0099
Changing time (msec)	0.0813	0.1557	0.0019	0.0107
Force from wall surface (dyn)	5.04E-05	5.64E-05	7.63E-07	1.38E-06
Work load (J)	1.01E-06	1.13E-06	1.53E-08	2.75E-08
Power(J)	1.24E-05	7.27E-06	3.14E-07	4.18E-07
Impulse (J/msec)	4.09E-06	8.79E-06	1.26E-07	7.64E-07
Adhesion (J/m ²)	7.26E-04	9.54E-04	2.39E-05	2.59E-05

[Industrial applicability]

[0126]

The present invention can be used for production of a fermented milk such as yogurt, and can be preferably used particularly for production of a set type yogurt.

Claims

1. A method for producing a fermented milk comprising the steps of:
homogenizing a raw material milk to reduce an average particle size of said raw material milk;
sterilizing said raw material milk at 115°C-150°C before or after said step of homogenizing ; and
fermenting said raw material milk after said step of homogenizing and said step of sterilizing.
2. A method for producing a fermented milk according to claim 1, wherein
said raw material milk is homogenized so that the average particle size of said raw material milk is 0.8 μ m or less in said step of homogenizing.
3. A method for producing a fermented milk according to claim 1 or 2, further comprising a step of reducing dissolved oxygen density of said raw material milk before said step of fermenting.
4. A method for producing a fermented milk according to any one of claims 1-3, wherein said fermented milk is a set type yogurt.
5. A method for improving hardness of a fermented milk comprising the steps of:
homogenizing a raw material milk;
sterilizing said raw material milk at 115°C-150°C before or after said step of homogenizing ; and
fermenting said raw material milk after said step of homogenizing and said step of sterilizing.
6. A method for improving smooth texture of a fermented milk comprising the steps of:
homogenizing a raw material milk;
sterilizing said raw material milk at 115°C-150°C before or after said step of homogenizing ; and
fermenting said raw material milk after said step of homogenizing and said step of sterilizing.
7. A fermented milk, wherein the hardness is 26g or more, the intrusion angle of the yogurt knife is less than 60 degrees and the average particle size after stirring is 43 μ m or less.
8. A fermented milk according to claim 7, wherein the adhesion is 0.0008J/m² or more.
9. A fermented milk according to claim 7 or 8, produced by the production method according to any one of claims 1-4.
10. A fermented milk according to any one of claims 7-9, packed in a container.
11. A fermented milk according to any one of claims 7-10, wherein said fermented milk is a set type yogurt.