DESCRIPTION

STARTER FOR FERMENTED MILK, LOW-FAT OR FAT-FREE ICE CREAM-LIKE FOOD PRODUCT, AND METHOD FOR PRODUCING LOW-FAT OR FAT-FREE ICE CREAM-LIKE FOOD PRODUCT

Technical Field

[0001]

The present invention relates to a starter added to raw milk for a low-fat or fat-free ice cream-like food product and the low-fat or fat-free ice cream-like food product.

[0002]

Here, the “ice cream-like food product” means an ice cream having a milk fat content of less than 8 wt% among “ice creams” specified by the ministerial ordinance related to compositional standards of milk and dairy products in Japan's Food Sanitation Law. That is, the “ice cream-like food product" has a milk solid content of 3 wt% or more, does not correspond to an “ice cream” according to JAS (milk fat content of 8 wt% or more), and correspond to an "ice milk" (milk fat content of 3 wt% or more) or a "lact ice" (milk fat content of less than 3 wt%).

Background Art

[0003]

In recent years, in response to growing health consciousness of consumers, demand for food which can reduce intake of energy (calories) is increasing. By intake of 1 g of lipid, 9 kcal of energy is absorbed by the body, and the amount of energy absorbed by the body is larger than a case where the same amount of protein or carbohydrate is take in. Therefore, a potential demand for a food containing a smaller amount of lipid than conventional foods, particularly a “lipid zero” (non-fat) foods are

increasing.

[0004]

On the other hand, a lipid is an element to enhance a palatability such as a flavor or texture of foods and drinks, for example, richness, thickness, or mellowness. Therefore, it has been considered to be difficult to make a food which exudes a good taste with fat, particularly such as an ice cream, with excluding any fat, or a flavor or texture of the food will be spoiled.

[0005]

Here, when an "ice cream-like food product" having a fat content of zero is produced, it is an object to supplement smoothness or richness specific to an ice cream in order to make the flavor or texture of the ice cream-like food product similar to that of a normal ice cream.

[0006]

Conventionally, in production of a fat-free ice cream-like food product, in order to enhance the flavor or texture, for example, a method of using a whey protein concentrate (WPC) in place of fat has been known (Patent Literature 1). Or, a method of enhancing the flavor or texture of a fat-free ice cream-like food product by using a stabilizer (including an emulsion stabilizer and a thickening stabilizer, the same hereinafter) together has been also known (Patent Literature 2) for example.

[0007]

In order to smoothen the physical properties of an ice cream-like food product, a method of subjecting raw milk for an ice cream to a desalting treatment and a lactose decomposition treatment with a NF (Nano Filtration) membrane has been known (Patent Literature 3). It has been also publicly known to improve the smoothness of the physical properties of an ice cream-like food product by reducing the size of an ice

crystal.

[0008]

Furthermore, a method for obtaining an ice cream mix having a solid content of 38% or more by mixing fermented milk fermented by lactic acid bacteria to generate a large amount of viscous polysaccharide in place of a stabilizer, has been also known (Patent Literature 4). By using such lactic acid bacteria to generate a large amount of viscous polysaccharide, a food having a smooth texture and melting well in the mouth can be obtained.

Citation List

Patent Literatures

[0009]

Patent Literature 1: JP 08-107759 A

Patent Literature 2: JP 02-255046 A

Patent Literature 3: WO 2011/77739 A

Patent Literature 4: JP 2005-278638 A

Summary of Invention

Technical Problem

[0010]

As described above, an ice cream exuding a good taste with fat (particularly, milk fat) spoils the flavor or texture by the fat content of zero. Therefore, it has been considered to be difficult to realize a fat-free ice cream-like food product having a fat texture.

[0011]

Here, it is considered to produce a fat-free ice cream-like food product by a combination of the conventional technologies disclosed in Patent Literatures 1 to 4 described above. However, only by the combination of the conventional technologies, it was not possible to develop a fat-free smooth ice cream-like food product having a fat texture.

[0012]

Therefore, at present, in order to produce an ice cream-like food product having a high palatability and a low-calorie, a new technology suitable for improving a fat texture of a low-fat or fat-free ice cream-like food product is demanded.

Solution to Problem

[0013]

Therefore, the inventors of the present invention made intensive studies of a means for solving the above problems. As a result, the inventors have found that the fat texture of an ice cream-like food product is improved unexpectedly by using fermented milk obtained by using a starter formed by a combination of specific lactic acid bacteria as a raw material of a low-fat or fat-free ice cream-like food product, and have succeeded in development of a fat-free food having a high palatability. The present inventors have conceived of capability of solving the conventional problems based on the above knowledge, and have completed the present invention.

[0014]

[Starter]

A first aspect of the present invention relates to a starter added to raw milk to ferment the raw milk. The starter of the present invention is a mixture of lactic acid bacteria.

The starter of the present invention includes Lactobacillus bulgaricus and Streptococcus thermophilus, and has a viscosity (measured with a B-type viscometer) of fermented milk of 5000 mPa·s or more when raw milk is cultured to the pH of 4.5 to 5.0 at 37°C and is cooled to 5°C.

Examples of the Lactobacillus bulgaricus include Lactobacillus delbrueckii subsp. bulgaricus OLL1247 strain (deposition number: NITE BP-01814) (hereinafter, Lactobacillus bulgaricus OLL1247 strain) or Lactobacillus delbrueckii ssp. bulgaricus OLL1073R-1 strain (deposition number: FERM BP-10741) (hereinafter, Lactobacillus bulgaricus OLL1073R-1 strain).

Examples of the Streptococcus thermophilus include Streptococcus thermophilus OLS3618 strain (deposition number: NITE BP-01815) (hereinafter, Streptococcus thermophilus OLS3618 strain) or Streptococcus thermophilus OLS3078 strain (deposition number: NITE BP-01697) (hereinafter, Streptococcus thermophilus OLS3078 strain).

[0015]

The starter of the present invention is preferably added to raw milk of a low-fat or fat-free ice cream-like food product having a milk fat content of less than 8 wt% to ferment the raw milk.

[0016]

The starter of the present invention is preferably formed by any one of a combination of Lactobacillus bulgaricus OLL1247 strain and Streptococcus thermophilus OLS3618 strain, a combination of Lactobacillus bulgaricus OLL1247 strain and Streptococcus thermophilus OLS3078 strain, and a combination of Lactobacillus bulgaricus OLL1073R-1 strain or Streptococcus thermophilus OLS3078 strain.

[0017]

As described above, by forming a starter by using a combination of specific kinds of strains of Lactobacillus bulgaricus and Streptococcus thermophilus, it is possible to obtain fermented milk suitable for a raw material of a low-fat or fat-free ice cream-like food product. That is, it has been found that the fat texture of the ice cream-like food product is improved unexpectedly by using fermented milk fermented with the starter of the present invention as a raw material of low-fat or fat-free ice cream-like food product.

[0018]

The present inventors made studies to find the reason why the fat texture of the ice cream-like food product is improved, and have found that the viscosity of fermented milk as a raw material contributes to improvement of the fat texture of the ice cream-like food product. Particularly, it has been found that by inoculation with a starter formed by a combination of Lactobacillus bulgaricus OLL1247 strain and Streptococcus thermophilus OLS3618 strain, a combination of Lactobacillus bulgaricus OLL1247 strain and Streptococcus thermophilus OLS3078 strain, or a combination of Lactobacillus bulgaricus OLL1073R-1 strain and Streptococcus thermophilus OLS3078 strain, fermented milk having a viscosity (measured with a B-type viscometer at 5°C) of 5000 mPa·s or more is obtained without addition of a stabilizer such as an emulsion stabilizer or a thickening stabilizer. By using such fermented milk having a high viscosity as a raw material of an ice cream-like food product, the fat texture has been generated in the ice cream-like food product, and the palatability has been able to be enhanced.

[0019]

However, as described below, when Lactobacillus bulgaricus OLL1247 strain,

Lactobacillus bulgaricus OLL1073R-1 strain, Streptococcus thermophilus OLS3618 strain, or Streptococcus thermophilus OLS3078 strain is used singly as a starter, the generation amount of polysaccharide is smaller than that of another strain. These facts indicate that fermented milk having a preferable viscosity cannot be obtained by using any single one of these strains. Meanwhile, the generation amount of polysaccharide was increased remarkably and fermented milk having a high viscosity was obtained by using a combination of these strains. In addition, when the starter of the present invention formed by a combination of the above strains was added to fat-free or low-fat raw milk to be fermented, the viscosity of the fermented milk became higher than that of fat-free or low-fat fermented milk fermented with a starter using another strain. These facts indicate that a starter including Lactobacillus bulgaricus and Streptococcus thermophilus and having a viscosity (measured with a B-type viscometer) of fermented milk of 5000 mPa·s or more when raw milk is cultured to the pH of 4.5 to 5.0 at 37°C and is cooled to 5°C is suitable for increasing the viscosity of fat-free or low-fat fermented milk. Therefore, by using the starter including Lactobacillus bulgaricus and Streptococcus thermophilus and having a viscosity (measured with a B-type viscometer) of fermented milk of 5000 mPa·s or more when raw milk is cultured to the pH of 4.5 to 5.0 at 37°C and is cooled to 5°C, a low-fat or fat-free ice cream-like food product having a fat texture and a high palatability can be produced.

[0020]

In the present invention, it is preferable to add no stabilizer or add a stabilizer in an amount of 0.05 wt% or less (when the weight of fermented milk is assumed to be 100%) to fermented milk the viscosity of which is measured. Here, the "stabilizer" includes an emulsion stabilizer, a thickening stabilizer, and a mixture thereof. By addition of a predetermined amount or more of stabilizer to fermented milk, the

viscosity thereof can be 5000 mPa·s or more. However, by using fermented milk including a stabilizer as a raw material of an ice cream-like food product, the resulting ice cream-like food product may generate an artificial flavor or texture derived from the stabilizer, for example, the ice cream-like food product may melt poorly in the mouth or exhibit bitterness. Therefore, in order to increase the viscosity of fermented milk, it is preferable to add no stabilizer or, if added, to add a stabilizer in such a small amount not to spoil the flavor or texture of an ice cream-like food product to fermented milk.

[0021]

[Low-fat or fat-free ice cream-like food product]

A second aspect of the present invention relates to a low-fat or fat-free ice cream-like food product obtained by using the starter according to the first aspect of the present invention.

The ice cream-like food product of the present invention is a low-fat or fat-free ice cream-like food product obtained by cooling and solidifying an ice cream mix and having a milk fat content of less than 8 wt%.

The ice cream mix includes fermented milk obtained by adding the starter according to the first aspect to raw milk and fermenting the raw milk.

The ice cream mix has a non-fat milk solid content of 11 wt% or more.

[0022]

In the low-fat or fat-free ice cream-like food product according to the present invention, it is preferable for the ice cream mix to include no stabilizer or include a stabilizer in an amount of 0.05 wt% or less.

[0023]

As described above, use of a starter formed by a combination of specific kinds of strains of lactic acid bacteria makes it possible to obtain fermented milk having a high

viscosity. Use of the fermented milk having a high viscosity as a raw material makes it not essential to add a stabilizer to an ice cream mix. As a result, the fat texture of a fat-free or low-fat ice cream-like food product can be improved, and the artificial texture specific to a stabilizer, which causes poor melting in the mouth, can be solved. The non-fat milk solid component acts as a replacement for fat. Therefore, by using concentrated milk obtained by concentrating an ice cream mix while the ice cream mix is subjected to a desalting treatment or a lactose decomposition treatment such that the solid not fat (SNF) of the ice cream mix is 11 wt% or more, the fat texture of an ice cream-like food product can be further improved. By increasing the solid not fat to 11 wt% or more, overrun can be stabilized during freezing.

[0024]

In the second aspect of the present invention, the viscosity (measured with a B-type viscometer at 5°C) of fermented milk included in the ice cream mix is preferably 5000 mPa·s or more, and more preferably from 5000 to 6000 mPa·s.

[0025]

As described above, by increasing the viscosity of fermented milk as a raw material of an ice cream-like food product, even a low-fat or fat-free ice cream-like food product can exude a texture or flavor as if containing fat.

[0026]

In the second aspect of the present invention, the ice cream mix preferably further includes a whey protein condensate. The "whey protein condensate" is a condensate of particles having an average particle diameter of 2 to 10 μm and containing whey protein as a main component. The whey protein condensate can be obtained by performing a heating treatment and a mechanical shearing treatment simultaneously or alternately. The whey protein condensate acts as a replacement for fat.

[0027]

By addition of the whey protein condensate to an ice cream mix as a replacement for fat, even when the fat content of is low, overrun can be secured sufficiently, and a shape retention property of an ice cream-like food product as a final product can be maintained. The overrun (OR) is an air entrainment amount of an ice cream-like food product, that is, a content of the air. Usually, when the fat content is low, the shape retention property of ice creams is maintained by adding a stabilizer such as a thickening stabilizer or an emulsion stabilizer. However, stabilizer-containing ice creams may generate an artificial flavor or texture derived from the stabilizer, for example, the ice cream may melt poorly in the mouth or exhibit bitterness. In this point, as described above, by adding a whey protein condensate derived from milk to an ice cream mix as a replacement for fat, , the shape of an ice cream-like food product can be stabilized without use of a stabilizer even when the fat content is low.

[0028]

[Method for producing low-fat or fat-free ice cream-like food product]

A third aspect of the present invention relates to a method for producing a low-fat or fat-free ice cream-like food product.

The production method of the present invention includes:

a step for obtaining fermented milk by adding the starter according to the first aspect to raw milk;

a step for obtaining an ice cream mix using fermented milk; and

a step for obtaining a low-fat or fat-free ice cream-like food product having a milk fat content of less than 8 wt% by cooling and solidifying the ice cream mix.

[0029]

By producing an ice cream-like food product according to the above steps, a

low-fat or fat-free ice cream-like food product having a fat texture can be produced.

[0030]

In the third aspect of the present invention, in cooling and solidifying an ice cream mix, the ice cream mix is preferably cooled and solidified using an extrusion apparatus. In this way, by cooling and solidifying the ice cream mix at a low temperature using the extrusion apparatus, the size of an ice crystal included in an ice cream-like food product is reduced. For example, an ice crystal having a diameter of 60 μm or less makes the texture of an ice cream-like food product smooth.

Advantageous Effects of Invention

[0031]

According to the present invention, a low-fat or fat-free ice cream-like food product having a fat texture and a high palatability can be provided.

Brief Description of Drawings

[0032]

Fig. 1 illustrates a graph of a generation amount of polysaccharide for a typical viscous strain of each of Lactobacillus bulgaricus and Streptococcus thermophilus.

Fig. 2 illustrates a graph of the viscosity of fermented milk formed by a combination of Lactobacillus bulgaricus and Streptococcus thermophilus.

Description of Embodiments

[0033]

Hereinafter, embodiments of the present invention will be described with reference to the drawings. The present invention is not limited to the embodiments

described below, but includes embodiments modified appropriately within a range obvious to a person skilled in the art based on the following embodiments.

[0034]

Here, "low-fat" means that the content of lipid is less than 3.0 wt% based on nutritional labeling standards. "Fat-free" means that the content of lipid is less than 0.5 wt%.

[0035]

Here, unless otherwise specified, "A to B" means "A or more and B or less".

Here, "deposition number: FERM ··" means the deposition number in the National Institute of Advanced Industrial Science and Technology Patent Organism Depositary Center, which is an international depositary authority on the Budapest Treaty. "Deposition number: NITE ··" means the deposition number in the National Institute of Technology and Evaluation Patent Microorganisms Depositary Center, which is an international depositary authority on the Budapest Treaty.

[0036]

[1. Starter for low-fat or fat-free ice cream-like food product]

The first aspect of the present invention relates to a starter added to raw milk of a low-fat or fat-free ice cream-like food product. The starter includes lactic acid bacteria, and ferments raw milk by being added to the raw milk.

[0037]

The present inventors made studies to find the reason why the fat texture of the ice cream-like food product is improved, and have found that the viscosity of fermented milk as a raw material contributes to improvement of the fat texture of the ice cream-like food product. Therefore, a main object of the starter of the present invention is to increase the viscosity of fermented milk obtained by fermenting raw milk

including the starter without use of a stabilizer. Particularly, the starter of the present invention has been developed so as to increase the viscosity of fermented milk even when the milk fat content in raw milk is low or raw milk includes no milk fat. The present invention is based on the finding that the fat texture is generated in an ice cream-like food product, and the palatability can be enhanced by using fermented milk having a high viscosity as a raw material of the ice cream-like food product.

[0038]

Specifically, the starter of the present invention is formed by a combination of Lactobacillus bulgaricus and Streptococcus thermophilus. That is, the starter of the present invention includes both Lactobacillus bulgaricus and Streptococcus thermophilus. Particularly, the starter of the present invention preferably includes only Lactobacillus bulgaricus and Streptococcus thermophilus. However, the starter of the present invention may include lactic acid bacteria other than Lactobacillus bulgaricus or Streptococcus thermophilus within a range capable of exhibiting an effect of the present invention.

[0039]

In the present invention, for example, as the Lactobacillus bulgaricus, at least one strain selected from Lactobacillus delbrueckii subsp. bulgaricus OLL1247 strain (deposition number: NITE BP-01814) (hereinafter, Lactobacillus bulgaricus OLL1247 strain) and Lactobacillus delbrueckii ssp. bulgaricus OLL1073R-1 strain (deposition number: FERM BP-10741) (hereinafter, Lactobacillus bulgaricus OLL1073R-1 strain) is used.

[0040]

In the present invention, for example, as the Streptococcus thermophilus, at least one strain selected from Streptococcus thermophilus OLS3618 strain (deposition

number: NITE BP-01815) (hereinafter, Streptococcus thermophilus OLS3618 strain) and Streptococcus thermophilus OLS3078 strain (deposition number: NITE BP-01697) (hereinafter, Streptococcus thermophilus OLS3078 strain) is used.

[0041]

Examples of a combination of Lactobacillus bulgaricus and Streptococcus thermophilus included in the starter of the present invention include the following three patterns.

(1) Combination of Lactobacillus bulgaricus OLL1247 strain and Streptococcus thermophilus OLS3618 strain

(2) Combination of Lactobacillus bulgaricus OLL1247 strain and Streptococcus thermophilus OLS3078 strain

(3) Combination of Lactobacillus bulgaricus OLL1073R-1 strain and Streptococcus thermophilus OLS3078 strain

[0042]

By the way, in general, lactic acid bacteria such as Lactobacillus bulgaricus or Streptococcus thermophilus generates a viscous polysaccharide when the lactic acid bacteria is inoculated to the raw milk and fermented. Examples of a polysaccharide derived from lactic acid bacteria include a general polysaccharide obtained by polymerization of glucose, galactose, rhamnose, and the like, and include a partly phosphorylated polysaccharide. The viscous polysaccharide derived from lactic acid bacteria is characterized in having stronger spinnability than a viscous polysaccharide derived from a plant. Therefore, in general, it is expected that lactic acid bacteria having a larger generation amount of viscous polysaccharide makes the viscosity of fermented milk higher when the lactic acid bacteria is added to raw milk to be fermented.

[0043]

Here, Fig. 1 illustrates a graph of a generation amount of polysaccharide for a typical viscous strain of each of Lactobacillus bulgaricus and Streptococcus thermophilus. The generation amount of polysaccharide was measured under the following conditions.

[0044]

<Measurement of generation amount of polysaccharide>

1. Preparation of cultured product

Powdered skim milk was dissolved in MilliQ water at 10% (w/v), and was subjected to autoclaving at 121°C for seven minutes. The resulting product was used as a medium (hereinafter, referred to as "powdered skim milk medium"). Various kinds of strains were activated twice. Thereafter, 4 ml of the powdered skim milk medium put into a 15 ml conical tube was inoculated with a 1% culture liquid, and the resulting medium was allowed to stand for culture at 37°C for 18 hours.

2. Quantitative determination of generation amount of polysaccharide

400 μl of 100% trichloroacetic acid (Wako) was added to 4 ml of culture liquid (final concentration: 10%), and the resulting mixture was stirred until the viscosity disappeared. A supernatant was collected by centrifugation (12000 g, 4°C, 20 min), and the entire amount thereof was transferred to a new 15 ml conical tube. MilliQ water was added to the collected supernatant so as to be filled up to 4 ml on the scale of the conical tube. 8 ml (2 times the amount) of cold ethanol was gradually added thereto, and was mixed completely therewith. Thereafter, the resulting mixture was allowed to stand at 4°C overnight to precipitate a polysaccharide. The polysaccharide was collected as a precipitate by centrifugation, 4 ml of MilliQ water was added thereto, and then was dissolved completely. Each polysaccharide aqueous solution was applied

to a 96-well dispo DIALYZER (250 to 300 μ; MWCO5,000; HARVARD 74-0902) at 180 μl/well, and was dialyzed against 5 L of MilliQ water for two days (MilliQ water exchanged every day). After completion of the dialysis, the volume of each polysaccharide aqueous solution was measured, and the concentration of a polysaccharide was measured by a phenol-sulfuric acid method (Dubois et al. Colorimetric method for determination of sugars and related substances. Anal. Chem. 1956; 28: 350-356.) to calculate a generation amount of polysaccharide (mg/kg).

[0045]

As illustrated in Fig. 1, in Lactobacillus bulgaricus, the Lactobacillus bulgaricus OLL1251 strain has the largest generation amount of polysaccharide. In Streptococcus thermophilus, the Streptococcus thermophilus OLS3272 strain has the largest generation amount of polysaccharide. Therefore, in order to obtain fermented milk having a high viscosity using a starter formed by a combination of Lactobacillus bulgaricus and Streptococcus thermophilus, in general, it is considered that a starter formed by a combination of the Lactobacillus bulgaricus OLL1251 strain and the Streptococcus thermophilus OLS3272 strain is most efficient. However, contrary to expectations, the viscosity of fermented milk could not be increased sufficiently by using the starter formed by a combination of the Lactobacillus bulgaricus OLL1251 strain and the Streptococcus thermophilus OLS3272 strain. Therefore, when a low-fat or fat-free ice cream-like food product was produced using fermented milk fermented with the starter formed by a combination of the Lactobacillus bulgaricus OLL1251 strain and the Streptococcus thermophilus OLS3272 strain as a raw material, the ice cream-like food product did not exhibit a sufficient fat texture, an excellent flavor or texture, or a good taste.

[0046]

Therefore, the present inventors made studies on a combination of Lactobacillus bulgaricus and Streptococcus thermophilus serving as a starter in order to obtain a low-fat or fat-free ice cream-like food product exhibiting a fat texture and a good taste. As a result of the studies, it has been found that the fat texture and the good taste of an ice cream-like food product are enhanced up to a sufficient level by a combination of the Lactobacillus bulgaricus OLL1247 strain or the Lactobacillus bulgaricus OLL1073R-1 strain selected as Lactobacillus bulgaricus and the Streptococcus thermophilus OLS3618 strain or the Streptococcus thermophilus OLS3078 strain selected as Streptococcus thermophilus.

[0047]

Here, as illustrated in Fig. 1, each of the Lactobacillus bulgaricus OLL1247 strain and the Lactobacillus bulgaricus OLL1073R-1 strain determined to be suitable by the present inventors does not have the largest generation amount of polysaccharide when being used singly. Each of the Streptococcus thermophilus OLS3618 strain and the Streptococcus thermophilus OLS3078 strain determined to be suitable by the present inventors does not have the largest generation amount of polysaccharide when being used singly. In this way, it has been found that the fat texture and the good taste of an ice cream-like food product are enhanced if the viscosity of fermented milk can be finally increased by a combination of a strain not having a very large generation amount of polysaccharide itself and another strain. That is, the fat texture and the good taste of the ice cream-like food product largely depend on affinity between Lactobacillus bulgaricus and Streptococcus thermophilus to be combined.

[0048]

Therefore, the present inventors examined various combinations for typical Lactobacillus bulgaricus and Streptococcus thermophilus. Here, as described above,

the viscosity of fermented milk was measured for each combination based on the finding that the viscosity of fermented milk as a raw material of an ice cream-like food product served as one factor for exhibiting the fat texture and the good taste.

[0049]

Fig. 2 illustrates a graph of the viscosity of fermented milk formed by a combination of Lactobacillus bulgaricus and Streptococcus thermophilus. The viscosity of fermented milk was measured under the following conditions. A Lactobacillus bulgaricus starter and a Streptococcus thermophilus starter were subcultured three times in a 10% powdered skim milk medium at 37°C to be activated.

[0050]

<Measurement of viscosity of fermented milk>

1. Blending of fermented milk (non-fat milk solid content 19%)

Raw material	Blending ratio (%)
Nonfat dry milk	20
Lactic acid bacteria starter	0.2
Water	79.8
Total	100

Lactic acid bacteria starter	Blending ratio (%)
Lactobacillus bulgaricus starter	0.18%
Streptococcus thermophiles starter	0.02%
Total	0.20%

Strain (Lactobacillus bulgaricus)	Strain (Streptococcus thermophile)
Lactobacillus bulgaricus OLL1251	Streptococcus thermophile OLS3272
Lactobacillus bulgaricus OLL1073R-1	Streptococcus thermophile OLS3290
Lactobacillus bulgaricus OLL1247	Streptococcus thermophile OLS3618
Lactobacillus bulgaricus OLL1256	Streptococcus thermophile OLS3078
Lactobacillus bulgaricus OLL1255	Streptococcus thermophile OLS3294

[0051]

2. Measurement of viscosity

A 20% powdered skim milk solution (nonfat dry milk 19%) was heated while being stirred, was sterilized by the temperature reaching 95°C, and was cooled to 37°C.

A lactic acid bacteria starter to be used was added the reto at the above blending ratio, and was stirred for one minute. Thereafter, the resulting mixture was cultured at 37°C. The acidity of lactic acid and the pH were measured with time. Stirring and cooling were started at the pH of 4.7 to 4.8. The temperature was lowered to 10°C or lower. The pH after cooling was set to 4.5 to 4.7. Thereafter, using a rotary B type viscometer, the viscosity was measured at a temperature of the fermented milk of 5°C by the rotor No. 4 at 60 rpm.

[0052]

As illustrated in Fig. 2, each of the combination of "Lactobacillus bulgaricus OLL1247 strain and Streptococcus thermophilus OLS3618 strain", the combination of "Lactobacillus bulgaricus OLL1247 strain and Streptococcus thermophilus OLS3078 strain", and the combination of "Lactobacillus bulgaricus OLL1073R-1 strain and Streptococcus thermophilus OLS3078 strain" determined to be preferable by the present inventors had a viscosity of fermented milk (B-type viscometer, 5°C) of more than 5000 mPa·s. That is, the viscosity of fermented milk (B-type viscometer, 5°C) using "Lactobacillus bulgaricus OLL1247 strain and Streptococcus thermophilus OLS3618 strain" was 5670 mPa·s. The viscosity of fermented milk (B-type viscometer, 5°C) using "Lactobacillus bulgaricus OLL1247 strain and Streptococcus thermophilus OLS3078 strain" was 5110 mPa·s. The viscosity of fermented milk (B-type viscometer, 5°C) using "Lactobacillus bulgaricus OLL1073R-1 strain and Streptococcus thermophilus OLS3078 strain" was 5270 mPa·s. Therefore, it has been found that a fat-free or low-fat ice cream-like food product exhibiting a fat texture and a good taste can be produced by using fermented milk having a viscosity (B-type viscometer, 5°C) of 5000 mPa·s or more as a raw material. For example, the viscosity of fermented milk (B-type viscometer, 5°C) is preferably from 5000 to 6000 mPa·s, from 5100 to

5800 mPa·s, or from 5200 to 5600 mPa·s.

[0053]

On the other hand, as illustrated in Fig. 2, even by a combination of the Lactobacillus bulgaricus OLL1251 strain and the Streptococcus thermophilus OLS3272 strain having the largest generation amount of polysaccharide in the graphs in Fig. 1, the viscosity of fermented milk could not be increased suitably. That is, a starter formed by a combination of the Lactobacillus bulgaricus OLL1251 strain and the Streptococcus thermophilus OLS3272 strain had a viscosity of fermented milk (B-type viscometer, 5°C) of 3000 mPa·s or less, and did not exhibit a preferable viscosity of 5000 mPa·s or more unlike the starter of the present invention.

[0054]

From the above, the starter of the present invention is preferably formed by a combination of Lactobacillus bulgaricus and Streptococcus thermophilus, specifically, a combination of Lactobacillus bulgaricus and Streptococcus thermophilus making the viscosity of fermented milk (B-type viscometer, 5°C) 5000 mPa·s or more, and a combination of the Lactobacillus bulgaricus OLL1247 strain or the Lactobacillus bulgaricus OLL1073R-1 strain selected as Lactobacillus bulgaricus and the Streptococcus thermophilus OLS3618 strain or the Streptococcus thermophilus OLS3078 strain selected as Streptococcus thermophilus. Particularly, as illustrated in Fig. 2, the starter formed by a combination of the Lactobacillus bulgaricus OLL1247 and the Streptococcus thermophilus OLS3618 makes the viscosity of fermented milk highest. Therefore, the starter formed by a combination of the Lactobacillus bulgaricus OLL1247 and the Streptococcus thermophilus OLS3618 is suitable for producing a low-fat or fat-free ice cream-like food product from a viewpoint of capability of increasing the viscosity of fermented milk.

[0055]

In the present invention, when the total weight of the starter is assumed to be 100%, the starter can include Lactobacillus bulgaricus in an amount of 20 to 80%, 30 to 70%, 40 to 60%, or about 50% (± 2%), and can include Streptococcus thermophilus in an amount of 20 to 80%, 30 to 70%, 40 to 60%, or about 50% (± 2%). However, when the number of lactic acid bacteria in a starter is large, the addition amount of the starter required can be reduced. When the number of lactic acid bacteria is small, the addition amount of the starter required can be increased.

[0056]

As clear from the conditions of the experiment for measuring the viscosity, no stabilizer such as an emulsion stabilizer or a thickening stabilizer is added to fermented milk the viscosity of which is measured. The viscosity of fermented milk can be increased by adding a stabilizer to the fermented milk. However, when an ice cream-like food product is produced using fermented milk including a stabilizer as a raw material, an artificial flavor or texture derived from the stabilizer may be generated, and a preferable ice cream-like food product cannot be obtained. Therefore, it is preferable to add no stabilizer or, if added, to add a stabilizer in such a small amount not to spoil the flavor or texture of an ice cream-like food product to fermented milk. For example, when the weight of fermented milk is assumed to be 100%, the addition amount of the stabilizer is preferably zero or 0.05 wt% or less. Particularly, the addition amount of the stabilizer is preferably 0.03 wt% or less.

[0057]

Here, examples of the emulsion stabilizer include general commercial stabilizers such as a Quillaja extract, a glycerol fatty acid ester (an acetic and fatty acid ester of glycerol, a lactic and fatty acid ester of glycerol, a citric and fatty acid ester of glycerol,

a succinic and fatty acid ester of glycerol, a diacetyl tartaric and fatty acid ester of glycerol, a polyglycerol fatty acid ester, a polyglycerol condensed ricinoleic acid ester, a glycerol acetic acid ester), an enzymatically-treated lecithin, an enzymatically decomposed lecithin, a plant sterol, a plant lecithin, a sucrose fatty acid ester, calcium stearoyl lactate, a sorbitan fatty acid ester, a propylene glycol fatty acid ester, a fractionated lecithin, an egg yolk lecithin, polysorbate 20, polysorbate 60, polysorbate 65, and polysorbate 80.

[0058]

Examples of the thickening agent include general commercial thickening agents such as alginic acid, sodium alginate, a salt of carboxymethylcellulose, methyl cellulose, crystalline cellulose, microfibrillated cellulose, fermented cellulose, nata de coco, gum arabic, gum ghatti, curdlan, carrageenan, xanthan gum, guar gum, psyllium seed gum, gellan gum, tamarind seed gum, enzymatically-treated tamarind seed gum, tara gum, pectin, soybean polysaccharide, starch, processed starch (acetylated adipic acid crosslinked starch, acetylated oxidized starch, acetylated phosphate-crosslinked starch, sodium starch octenyl succinate, starch acetate, oxidized starch, sodium starch glycolate, hydroxypropylated phosphate-crosslinked starch, hydroxypropyl starch, phosphoric acid crosslinked starch, phosphorylated starch, phosphoric acid monoester phosphate-crosslinked starch), agar, gelatin, pullulan, and mannan.

[0059]

[2. Low-fat or fat-free ice cream-like food product]

Next, the low-fat or fat-free ice cream-like food product according to the second aspect of the present invention will be described. The ice cream-like food product according to the second aspect is produced by using the starter according to the first aspect of the present invention.

[0060]

Here, "low-fat or fat-free" means that the milk fat content included in an ice cream-like food product is less than 8 wt%. Particularly, the ice cream-like food product of the present invention preferably has a milk fat content of 0 to 7 wt%, 0 to 5 wt%, or 0 to 3 wt%.

[0061]

In order to produce the low-fat or fat-free ice cream-like food product of the present invention, an ice cream mix is prepared. The ice cream mix means a mixture of raw materials for producing ice cream-like food products before the air is entrained into the ice cream mix. An ice cream-like food product is obtained by cooling and solidifying the ice cream mix while the air is entrained into the ice cream mix.

[0062]

The ice cream mix includes fermented milk obtained by fermenting raw milk including the starter according to the first aspect. As the raw milk, low-fat milk or fat-free milk obtained by adjusting the ingredients of raw milk is preferably used. The low-fat milk means milk obtained by adjusting only the milk fat content and having a milk fat content of 0.5 wt% or more and 1.5 wt% or less. The fat-free milk means milk obtained by adjusting only the milk fat content and having a milk fat content of 0 or more and less than 0.5 wt%. A starter is added to the raw milk to be fermented. As described above, as the starter, a combination of specific Lactobacillus bulgaricus and specific Streptococcus thermophilus is used. A pattern of a combination of Lactobacillus bulgaricus and Streptococcus thermophilus included in the starter is described in the following (1) to (3). Conditions for fermenting raw milk including a starter is only necessary to follow a publicly known fermentation method.

(1) Combination of Lactobacillus bulgaricus OLL1247 strain and Streptococcus

thermophilus OLS3618 strain

(2) Combination of Lactobacillus bulgaricus OLL1247 strain and Streptococcus thermophilus OLS3078 strain

(3) Combination of Lactobacillus bulgaricus OLL1073R-1 strain and Streptococcus thermophilus OLS3078 strain

[0063]

The fermented milk obtained in such a manner as described above preferably has a viscosity of 5000 mPa·s or more. The viscosity largely depends on the kind of the starter added to raw milk. That is, by using a starter having a large generation amount of viscous polysaccharide, fermented milk having a high viscosity can be obtained. By using a starter formed by a combination of the above (1) to (3), fermented milk having a viscosity of 5000 to 6000 mPa·s can be obtained. Particularly, it is most preferable to use "(1) combination of Lactobacillus bulgaricus OLL1247 strain and Streptococcus thermophilus OLS3618 strain" as a starter. The viscosity of fermented milk is preferably from 5000 to 5800 mPa·s, and particularly preferably from 5100 to 5600 mPa·s. For example, as a starter other than the starters formed by the combinations of the above (1) to (3), it is only necessary to select a starter having a viscosity (measured with a B-type viscometer) of fermented milk of 5000 mPa·s or more when raw milk including Lactobacillus bulgaricus and Streptococcus thermophilus is cultured to the pH of 4.5 to 5.0 at 37°C and is cooled to 5°C. In this way, the combination of Lactobacillus bulgaricus and Streptococcus thermophilus can be selected from a viewpoint of the viscosity (measured with a B-type viscometer) of fermented milk of 5000 mPa·s or more. Here, the composition of the non-fat milk solid content of raw milk is not limited, but is preferably from 5 to 30%, more preferably from 8 to 30%, and still more preferably from 10 to 30%. The viscosity of fermented milk is a measured

value at 5°C, and can be converted by predicting a factor of the temperature in advance considering change in the viscosity due to rise in the temperature of an object.

[0064]

In addition, the viscosity of fermented milk can be adjusted appropriately using a publicly known technology. For example, it is known that the viscosity of fermented milk obtained can be increased by fermenting raw milk inoculated with a starter at a low temperature for a long time. It is also publicly known that the viscosity of fermented milk obtained is increased by increasing the content of powdered skim milk blended into raw milk. In the present invention, the viscosity of fermented milk (B-type viscometer, 5°C) is preferably 5000 mPa·s or more, but a means for reaching this proper viscosity is not particularly limited.

[0065]

In addition, the ice cream mix may include another additive to the extent capable of producing a low-fat or fat-free ice cream-like food product. For example, the ice cream mix can be prepared by mixing and dissolving a raw material such as a dairy product (cream, butter, condensed milk, powdered milk, or the like), a saccharide (sugar or the like), fat, an egg, a stabilizer (emulsion stabilizer, thickening stabilizer), a flavoring agent, or a colorant, if necessary, in addition to fermented milk. For example, in a case of low-fat ice cream-like food product, a milk fat raw material such as fresh cream or butter, a plant fat raw material such as palm oil or coconut oil, or egg yolk can be used to within a range where the fat content is 3% or less.

[0066]

[2-1. Solid not fat]

As described above, the low-fat or fat-free ice cream-like food product of the present invention increases the viscosity of fermented milk by using a novel starter, and

exudes a fat texture. In addition, in order to further enhance the fat texture of the low-fat or fat-free ice cream-like food product, the ice cream mix is preferably prepared such that the solid not fat content (SNF) is 11 wt% or more. The solid not fat is a content obtained by removing a water content and a milk fat content from milk, and contributes to improvement of the flavor of an ice cream-like food product. Examples of the solid not fat include protein, a carbohydrate, mineral, and vitamin. The fat texture and the good taste of a low-fat or fat-free ice cream-like food product can be further enhanced by using the solid not fat as a replacement for milk fat. The storage stability of an ice cream-like food product can be enhanced by containing large amount of solid not fat. By increasing the solid not fat to 11 wt% or more, overrun can be stabilized during freezing.

[0067]

The contained amount of solid not fat in an ice cream mix is preferably 11 wt% or more, 12 wt% or more, or 14 wt% or more. Specifically, the contained amount of solid not fat is preferably from 11 to 20 wt%, from 12 to 19 wt%, or from 14 to 18 wt%.

[0068]

Here, in a general ice cream product, it is said that the limit of the contained amount of solid not fat is about 11% (reference: "Production of ice cream" (supervised by Sohei Yuyama, issued by Korin) page 19, issued on April 30, 1996). This is because an ice cream-like food product produced using an ice cream mix having a large amount of solid not fat tends to have a stronger salty taste. Therefore, in the present invention, it is preferable to desalt or concentrate the whole or a part of an ice cream mix (skim milk) containing a solid not fat before fermentation. For the step for desalting or concentrating the whole or a part of an ice cream mix (skim milk) containing a non-fat milk solid component before fermentation, a technology disclosed

in Patent Literature 3 (WO 2011/77739 A) can be used appropriately.

[0069]

Specifically, it is preferable to desalt or concentrate the whole or a part of an ice cream mix (nonfat milk) containing a solid not fat before fermentation by a nanofiltration method using a NF membrane. The NF membrane is a membrane-shaped filter having a nano-sized through-hole (for example, pore diameter: 0.5 to 2 nm). In the nanofiltration method, the whole or a part of an ice cream mix (nonfat milk) containing a solid not fat before fermentation is poured to this NF membrane, and filtering is performed using an osmotic pressure. The NF membrane mainly transmits a monovalent ion and water. Therefore, according to the nanofiltration method, a monovalent cation (sodium ion, potassium ion, chloride ion) and water can be removed. In this way, desalting to remove sodium or potassium can be performed by using the nanofiltration method. Examples of a material of the NF membrane include polyamide, cellulose acetate, polyether sulfone, polyester, polyimide, vinyl polymer, polyolefin, polysulfone, regenerated cellulose, and polycarbonate.

[0070]

In a retention liquid obtained by the nanofiltration method, the total solid (TS) of the whole or a part of an ice cream mix (nonfat milk) containing non-fat milk solid before fermentation, that is, milk fat (FAT) and solid not fat (SNF) are concentrated. In this way, the contained amount of solid not fat of the ice cream mix containing fermented milk can be adjusted to 11 wt% or more or 14 wt% or more. On the contrary, the transmission liquid removed by the nanofiltration method includes a large part of water in the whole or a part of the ice cream mix (nonfat milk) containing a non-fat milk solid component before fermentation and a part of a water-soluble component (particularly, a monovalent ion). Here, examples of the component

removed from a water-soluble component of fermented milk include ash. The ash is a generic name for an inorganic substance such as sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), chlorine (Cl), or phosphorus (P), or for a vitamin such as vitamin A, B1, or B2, or niacin. In this way, fermented milk as a raw material of an ice cream mix can be desalted and concentrated. A product obtained by forming desalted and concentrated nonfat milk into powdered milk by the nanofiltration method is also referred to as NF powdered nonfat milk.

[0071]

The transmission liquid removed by the nanofiltration method may be subjected to a reverse osmosis (RO) treatment to obtain a reverse osmosis membrane transmission liquid. For example, the reverse osmosis treatment is performed by pouring the transmission liquid removed by the nanofiltration method to a membrane-shaped filter (reverse osmosis membrane) to capture a monovalent cation and applying a pressure from an upstream side of the reverse osmosis membrane. The reverse osmosis treatment uses a pressure equal to or higher than an osmotic pressure. Therefore, most of the transmission liquid removed by the nanofiltration method passes through the reverse osmosis membrane to become an RO transmission liquid. In a retention liquid of the reverse osmosis membrane (part which has not passed through the reverse osmosis membrane), a sodium ion, a potassium ion, or the like included in the transmission liquid removed by the nanofiltration method is concentrated as a monovalent cation. That is, the reverse osmosis treatment with respect to the transmission liquid removed by the nanofiltration method is also a part of the desalting treatment. The transmission liquid which has passed through the reverse osmosis membrane becomes desalted water.

[0072]

Thereafter, the desalted water obtained by the reverse osmosis treatment is added (returned) to the retention liquid obtained by the nanofiltration method. Desalted milk is thereby obtained as a mixed liquid. Here, the amount of the transmission liquid removed by the nanofiltration method is almost the same as that of the reverse osmosis membrane transmission liquid (desalted water). Therefore, the amount of the desalted milk obtained by mixing the desalted water obtained by the reverse osmosis treatment and the retention liquid obtained by the nanofiltration method is almost the same as that of the raw milk prepared at the beginning. In other words, in this desalted milk, all the solid components of the raw milk are concentrated, and a part of sodium or potassium to cause saltiness is removed.

[0073]

As described above, it is preferable to remove saltiness by desalting and concentrating the whole or a part of an ice cream mix (nonfat milk) containing a solid not fat before fermentation as a raw material of an ice cream mix and adjusting the solid not fat to a predetermined value or more.

[0074]

A higher content of fermented milk in an ice cream mix makes the contained amount of solid not fat higher to generate an ice cream-like food product having a more fat texture. Meanwhile, when the content of fermented milk is reduced, it is preferable to increase the contained amount of solid not fat in an ice cream mix by blending nonfat dry milk subjected to lactose decomposition in advance and adjusting the fermented milk. This is because blending no nonfat dry milk subjected to lactose decomposition may generate a lactose crystal during storage of an ice. The ice cream-like food product produced in this way suppresses growth of a lactose crystal during freezing storage, and therefore has an excellent texture (feeling on the tongue). An ice

cream-like food product having a high fat texture can be obtained by suppressing growth of a lactose crystal by lactose decomposition. For example, for the technology to suppresses growth of a lactose crystal by lactose decomposition, description in WO 2011/077739 A can be referred to.

[0075]

[2-1. Whey protein condensate]

In the low-fat or fat-free ice cream-like food product of the present invention, an ice cream mix as a raw material thereof preferably includes a whey protein condensate. Here, the "whey protein condensate" is a condensate of particles having an average particle diameter of 2 to 10 μm and containing whey protein as a main component. The whey protein condensate can be obtained by subjecting a whey protein solution to a heating treatment and a mechanical shearing treatment simultaneously or alternately. The whey protein condensate acts as a replacement for fat such as milk fat.

[0076]

The ice cream-like food product of the present invention is an air bubble-containing emulsion solidified while the air is entrained thereinto. However, when the fat content is low as in the ice cream-like food product of the present invention, the overrun (OR), that is, an air entrainment amount (content of the air) cannot be secured sufficiently, and a shape retention property of a final product is not necessarily maintained. Here, conventionally, the overrun can be increased by adding various stabilizers in order to reduce the fat content while the physical properties of the final product are maintained. However, these stabilizer-containing ice creams may generate an artificial flavor or texture derived from the stabilizer, for example, the ice cream may melt poorly in the mouth or exhibit bitterness.

[0077]

In this point, by adding the "whey protein condensate" generated as described above to an ice cream mix, a high overrun can be secured and a shape retention property of a final product can be maintained sufficiently without adding a stabilizer required conventionally.

[0078]

As described above, the "whey protein condensate" is included in an ice cream mix as a replacement for fat. The whey protein condensate can be obtained by subjecting a whey protein solution to a heating treatment and a mechanical shearing treatment simultaneously. The whey protein condensate includes particles having an average particle diameter of 2 to 10 μm. As conditions for preparing a whey protein aggregate, the heating temperature is preferably from 75 to 85°C, and the heating time is preferably from 5 to 10 minutes. The concentration of a solid component included in the whey protein solution is preferably from 5 to 20 wt%.

[0079]

The "whey protein solution" used to generate the whey protein condensate can be obtained by mixing a whey protein concentrate with water and dissolving and/or dispersing the whey protein concentrate therein. Here, the water may be replaced with milk containing much water or another dairy product, or these may be used together. In the present invention, in order to reduce the fat content of the whey protein aggregate actually obtained, the whey protein solution is preferably skim milk. Here, the "whey protein concentrate" (WPC) is also referred to as a milk serum protein concentrate, and means a product obtained by concentrating whey protein by a membrane treatment or the like until the whey protein has a predetermined concentration. Examples of the WPC used in the present invention include a WPC derived from a cheese whey and a WPC derived from a lactic acid whey. A whey protein purified product (WP1) having

a higher degree of purification may be used in place of the WPC. These products may be produced according to a standard method or may be commercial products. The composition of the components of the whey protein concentrate (WPC) depends on a raw material of whey, a product, a preparation method, or the like. In the WPC used in the present invention, the WPC preferably has a fat content of 5 wt% or less, 3 wt% or less, or 1 wt% or less in terms that the final product as an object of the present invention is a low-fat or fat-free ice cream-like food product. The whey protein solution prepared in this way is subjected to a heating treatment and a shearing treatment.

[0080]

The heating treatment is not particularly limited as long as heating can be performed at the same time as the mechanical shearing treatment. For the heating treatment, a general heating treatment apparatus used in a food processing technique can be used.

Examples of the heating treatment apparatus include a tank with a jacket, a plate type heat exchanger, a tube type heat exchanger, a scraping type heat exchanger, a steam injection type heating apparatus, and a power supply type heating apparatus. The temperature of the heating treatment is preferably 55°C or higher, and is only necessary to be, for example, from 55 to 100°C, from 70 to 90°C, or from 75 to 85°C. The time for the heating treatment is only necessary to be from 5 to 20 minutes, from 5 to 15 minutes, or from 5 to 10 minutes.

[0081]

The mechanical shearing treatment is not particularly limited as long as shearing can be performed at the same time as the heating treatment. For the shearing treatment, a general mechanical shearing treatment apparatus used in a food processing technique can be used. Examples of the shearing apparatus include a homomixer (manufactured

by PRIMIX Corporation).

For example, when a homomixer (T. K. HOMO MI XER MARKII Mo d e 1 2. 5 manufactured by PRIMIX Corporation) is used, the shearing force in the mechanical shearing treatment preferably has the rotation number (rotational speed) of 100 to 10000 rpm, 200 to 8000 rpm, or 250 to 5000 rpm. When the homomixer is used, it is necessary to be careful such that the particle diameter of the whey protein condensate is not too small. Here, when the rotation number of the homomixer is from 100 to 10000 rpm, from 200 to 8000 rpm, or from 250 to 5000 rpm, the shearing force (shearing stress) corresponds to from 1.9 to 187.2 Pa, from 3.7 to 149.7 Pa, or from 4.7 to 93.6 Pa, respectively. The shearing force in the mechanical shearing treatment largely depends on the kind of a shearing treatment apparatus actually used and setting of the ability (operation conditions) thereof. Therefore, a person skilled in the art may obtain an effect of the present invention by appropriately changing the kind of the shearing treatment apparatus, operation conditions thereof, and the like.

[0082]

In the present invention, the "whey protein aggregate" is an aggregate of particles containing whey protein as a main component, obtained by subjecting a whey protein solution to the heating treatment and the mechanical shearing treatment simultaneously or alternately. In the whey protein aggregate, the average particle diameter is from 2 to 10 μm.

[0083]

Here, the "average particle diameter" means a value of an average particle diameter (D_{50}) determined in conformity with JIS Z8819-2 by measuring a particle diameter by a laser diffraction scattering method (Mie scattering method) in conformity with JIS Z8825-1. The particle diameter is only necessary to be measured using a

laser diffraction scattering particle size distribution measuring apparatus LS230 (manufactured by Beckman Coulter, Inc.).

[0084]

Here, the average particle diameter is also referred to as an average fat globule diameter in a dairy product such as milk or a milk beverage. In the present invention, the "average particle diameter" also means an expression of the average fat globule diameter.

[0085]

The whey protein aggregate used in the present invention, including many particles having a particle diameter of 1 μm or less, deteriorates stability of the overrun of an air bubble-containing emulsion actually obtained and cannot maintain a shape retention property. Therefore, in the whey protein aggregate, the average particle diameter is preferably from 2 to 10 μm.

[0086]

Such a whey protein aggregate is prepared within the pH of a whey protein solution preferably of 5.5 to 7, more preferably of 6 to 7. That is, the whey protein aggregate is desirably prepared within a neutral region of the pH.

[0087]

By adding the "whey protein condensate" prepared as described above to an ice cream mix, a high overrun can be secured and a shape retention property of a final product can be maintained sufficiently without adding a stabilizer required conventionally.

[0088]

[2-3. Cooling and solidifying]

The low-fat or fat-free ice cream-like food product of the present invention is

obtained by cooling and solidifying the ice cream mix prepared as described above. An ice cream mix solution may be homogenized before the ice cream mix is cooled and solidified.

[0089]

First, in a treatment for homogenization, the ice cream mix solution is filtered to remove impurities, if necessary. Thereafter, the particle diameter of fat or the like of the ice cream mix is adjusted, for example, using a homogenizer, for example, at a temperature of 50 to 70°C, by reducing the particle diameter of the fat, for example, to 2 μm or less. Thereafter, the ice cream mix having a particle diameter adjusted is heated, for example, to 68°C or higher and 75°C or lower, and is held for 30 minutes to be sterilized. The ice cream is thereby homogenized.

[0090]

Thereafter, the homogenized ice cream mix solution is cooled, for example, to a temperature of 0 to 10°C. Here, the ice cream mix solution is not frozen but is held while having a certain degree of fluidity. To the ice cream mix solution in the cooling state, a publicly known flavor (for example, a vanilla flavor, a chocolate flavor, a strawberry flavor, or a cocoa flavor) may be added appropriately.

[0091]

Thereafter, the ice cream mix in the cooling state is subjected to aging for a predetermined time. Aging is only necessary to be performed at a temperature of 0 to 30°C, preferably of 0 to 20°C, more preferably of 0 to 15°C, and still more preferably of 0 to 10°C. By aging, fat is crystallized, protein is hydrated, and an ice cream mix can be stabilized.

[0092]

Thereafter, the ice cream mix which has been subjected to the aging treatment

completely is subjected to freezing. Freezing is performed by stirring the ice cream mix, for example, at a temperature of -2°C to -10°C for a predetermined time. By freezing, the ice cream mix is cooled, and water or the like is frozen and solidified. An ice cream-like food product having an ice cream mix cooled and solidified can be thereby produced.

[0093]

In the present invention, in the freezing step, an extrusion apparatus is preferably used. As the extrusion apparatus, a publicly known apparatus can be used appropriately. For example, the extrusion apparatus is disclosed in JP 2013-162758 A.

[0094]

The extrusion apparatus is a continuous freezer which freezes water in an ice cream mix as a raw material of an ice cream-like food product while the air is mixed into the ice cream mix, and discharges the ice cream mix from a nozzle having an opening of a desired shape. The ice cream mix discharged from the nozzle is cut perpendicularly to the discharge direction, and is molded into a desired shape and size.

[0095]

The extrusion apparatus can cool an ice cream mix at a lower temperature, for example, than freezing by a publicly known Biter method. Therefore, use of the extrusion apparatus makes it possible to reduce the size of an ice crystal included in the ice cream-like food product.

[0096]

For example, the ice cream-like food product is preferably prepared such that the average particle diameter of an ice crystal is 60 μm or less. More specifically, the average particle diameter of an ice crystal included in the ice cream-like food product is preferably from 20 to 60 μm or from 30 to 50 μm. In this way, by freezing an ice

cream mix with an extrusion apparatus to reduce the size of an ice crystal, an ice cream-like food product having a smoother mouth feeling can be produced. For example, in general, an ice cream having a particle diameter of an ice crystal of 35 μm or less has a smooth texture, and an ice cream having a particle diameter of an ice crystal of more than 60 μm generates roughness easily and has a rough tissue. In this point, as described above, use of the extrusion apparatus makes it possible to adjust the average particle diameter of an ice crystal included in the ice cream-like food product to 60 μm or less and to impart a smooth texture.

[0097]

In the present invention, in order to suppress growth of an ice crystal during storage, a thickening polysaccharide such as locust bean gum, guar gum, tamarind, carrageenan, pectin, or polysaccharide thickeners, such as Processed starch can be used.

[0098]

The "particle diameter of an ice crystal" is a diameter (circle-equivalent diameter) of a cross section when the ice crystal is assumed to be a sphere based on an area value of the ice crystal measured by process analysis (unit: μm). The "particle diameter of an ice crystal" is a median diameter of circle-equivalent diameters of 100 ice crystals obtained from a photomicrograph.

[Examples]

[0099]

Subsequently, in order to confirm the fat texture of the low-fat or fat-free ice cream-like food product obtained using the starter according to the present invention, an ice cream-like food product was produced under the following conditions. A Lactobacillus bulgaricus starter and a Streptococcus thermophilus starter were subcultured three times in a 10% powdered skim milk medium at 37°C to be activated.

[0100]

1. Blending of fermented milk (solid not fat 19%)

Raw material	Blending ratio(%)
Nonfat dry milk	20
Lactic acid bacteria starter	0.2
Water	79.8
Total	100

Lactic acid bacteria starter	Blending ratio(%)
Lactobacillus bulgaricus starter	0.18%
Streptococcus thermophiles starter	0.02%
Total	0.20%

Strain (Lactobacillus bulgaricus)	Strain (Streptococcus thermophile)
Lactobacillus bulgaricus OLL1251	Streptococcus thermophile OLS3272
Lactobacillus bulgaricus OLL1073R-1	Streptococcus thermophile OLS3290
Lactobacillus bulgaricus OLL1247	Streptococcus thermophile OLS3618
Lactobacillus bulgaricus OLL1256	Streptococcus thermophile OLS3078
Lactobacillus bulgaricus OLL1255	Streptococcus thermophile OLS3294

[0101]

2. Conditions for producing fermented milk

A 20% nonfat dry milk solution (solid not fat 19%) was heated while being stirred, was sterilized by the temperature reaching 95°C, and was cooled to 37°C. A lactic acid bacteria starter to be used was added thereto at the above blending ratio, and was stirred for one minute. Thereafter, the resulting mixture was cultured at 37°C. The acidity of lactic acid and the pH were measured with time. Stirring and cooling were started at the pH of 4.7 to 4.8. The temperature was lowered to 10°C or lower. The pH after cooling was set to 4.5 to 4.7. The fermented milk obtained in this way was blended into an ice cream mix according to the following conditions. This time, the viscosity of the fermented milk was examined while the blending ratio of nonfat dry milk in the raw material was 20%. However, it was confirmed that there was no problem in growth of lactic acid bacteria of a starter even when the blending ratio of

nonfat dry milk was raised to 27%. A saccharide (sugar, starch syrup, or the like) can be added to a raw material within a range having no influence on the growth of lactic acid bacteria of a starter. As a control, fermented milk was prepared with a starter formed by a combination of Lactobacillus bulgaricus and Streptococcus thermophilus separated from "Meiji Bulgaria Yogurt" (commercial product isolated strain). Furthermore, as a control, milk from which fermented milk was not prepared with a starter (skim milk) was used.

[0102]

3. Blending of ice cream mix

Raw material	Blending ratio(%)
Sugar	8
Starch syrup	17.5
Fermented milk (Solid not fat of 19%)	66
Water	8.5
Total	100

Composition	Blending ratio(%)
Solid not fat	13
Solid content	34
Overrun	40

[0103]

4. Conditions for producing ice cream-like food product

In preparing an ice cream, the temperature of a raw material obtained by adding sugar and starch syrup to water was raised to 70°C while the raw material was stirred. Thereafter, the raw material was stirred and mixed using a mixer for two minutes, and was cooled to 10°C or lower. Thereafter, the raw material and fermented milk were mixed to obtain an ice cream mix. The resulting ice cream mix was frozen using a freezer, was poured into a cup, and then was frozen rapidly at -35°C. The ice cream-like food product was thereby produced. A too low solid content makes the size

of an ice crystal large and easily generates a crunchy texture. Therefore, the solid content is preferably 33 wt% or more.

[0104]

The viscosity, the acidity, and the pH were measured for each of various low-fat or fat-free ice cream-like food products obtained according to the above conditions. Five ice cream expert panelists performed sensory evaluation of a flavor and a texture for various ice cream-like food products.

[0105]

Conditions for measuring the viscosity were described above, but will be described again below.

[Measurement of viscosity]

A 20% nonfat dry milk solution (Solid not fat 19%) was heated while being stirred, was sterilized by the temperature reaching 95°C, and was cooled to 37°C. A lactic acid bacteria starter to be used was added thereto at the above blending ratio, and was stirred for one minute. Thereafter, the resulting mixture was cultured at 37°C. The acidity of lactic acid and the pH were measured with time. Stirring and cooling were started at the pH of 4.7 to 4.8. The temperature was lowered to 10°C or lower. The pH after cooling was set to 4.5 to 4.7. Thereafter, using a rotary B type viscometer, the viscosity was measured at a temperature of the fermented milk of 5°C by the rotor No. 4 at 60 rpm.

[0106]

Presence of the fat texture in each ice cream-like food product was evaluated based on results of the above sensory evaluation of a flavor and a texture. Here, a case where the fat texture is present, that is, a case where the fat texture is "○" refers to a case where a firm elastic force (elasticity) is felt when an ice cream-like food product is

crushed by the tongue and the upper jaw, and adhesion (viscosity) to the whole inside of the mouth is felt when the ice cream-like food product is dissolved in the mouth. A case where the fat texture is absent refers to a case where neither elasticity nor viscosity is felt or a case where one of elasticity and viscosity is not felt. That is, a case where one of elasticity and viscosity is not felt, the fat texture is "×", and a case where neither elasticity nor viscosity is felt, the fat texture is "××". When determination of a strong sour taste is made in addition to the fat texture "××" in a flavor evaluation, the fat texture is "×××". Results of the above sensory evaluation are indicated in Table 1. As a control sample (Comparative Example 11), a sample having no starter added was also evaluated below. The control sample (Comparative Example 11) is useful as data to infer the need for fermented milk.

[0107]

[Table 1]

	Strain used	Viscosity	Acidity	pH	Sensory evaluation		Evaluation for fat texture
	OLL + OLS				flavor	Texture	
Comparative Example 1	1251+3272	2890	1.44	4.6	Strong yoghurt-like texture	Melting well in the mouth	× ×
Comparative Example 2	1251+3290	4400	1.39	4.7	Weak sour taste	Melting well in the mouth	× ×
Comparative Example 3	1251+3618	4770	1.39	4.6	Weak sour taste	Slightly adhesive and elastic	×
Comparative Example 4	1251+3078	4590	1.32	4.7	Insufficient yoghurt-like texture	Melting well in the mouth but slightly adhesive	×
Comparative Example 5	1073+3272	2800	1.48	4.5	Little sour taste felt, bad taste masked slightly	Melting well in the mouth, slightly viscous but not adhesive	× ×
Comparative Example 6	1073+3290	4750	1.50	4.5	Strong sour taste	Viscous but not adhesive	×
Comparative Example 7	1073+3618	3530	1.50	4.5	Strange sour taste and bitterness	Adhesive	×
Example 1	1073+3078	5270	1.36	4.7	Strong yoghurt-like texture and little off- flavor	Adhesive and elastic	○
Comparative Example 8	1247+3272	2820	1.44	4.6	Strong yoghurt-like texture	Adhesive	×
Comparative Example 9	1247+3290	4270	1.42	4.7	Strong yoghurt-like texture	Dry feeling on the tongue	× ×
Example 2	1247+3618	5670	1.45	4.6	Strong sour taste but little off- flavor	Elastic and slightly sticky	○
Example 3	1247+3078	5110	1.40	4.7	Mild yoghurt-like texture	Elastic and adhesive	○
Comparative Example 10	Control (use of commercial product isolated strain)	1790	1.54	4.5	Yoghurt-like texture having sharp sour taste	Slightly rough and melting well in the mouth	× × ×
Comparative Example 11	Control (nonfat milk)	—	1.35	4.7	Weak yoghurt-like texture	Melting well in the mouth and not elastic	× × ×

[0108]

From Table 1 above, it has been confirmed that the ice cream-like food products according to Example 1 of the present invention (Lactobacillus bulgaricus OLL1073R-1 + Streptococcus thermophilus OLS3078 strain), Example 2 (Lactobacillus bulgaricus OLL1247 + Streptococcus thermophilus OLS3618 strain), and Example 3

(Lactobacillus bulgaricus OLL1247 + Streptococcus thermophilus OLS3078 strain) have a sufficient fat texture although the ice cream-like food products are low-fat or fat-free. That is, from the above results, it has been found that the fermented milk produced by a combination of each of Examples 1 to 3 improves the palatability of a fat-free or low-fat ice cream-like food product.

[0109]

In Examples above, the blending ratio of fermented milk with respect to the total weight of an ice cream mix was 66%. However, it has been also confirmed that the blending ratio of fermented milk of 30% or more brings about an effect on the fat texture in conformity with the above test results.

[0110]

Hereinabove, here, in order to describe the contents of the present invention, the embodiments of the present invention have been described with reference to the drawings. However, the present invention is not limited to the above embodiments, but includes modified forms or improved forms obvious to a person skilled in the art based on the matters described here.

Industrial Applicability

[0111]

The present invention relates to a starter for fermented milk, a low-fat or fat-free ice cream-like food product, and a method for producing the low-fat or fat-free ice cream-like food product. Therefore, the present invention can be used suitably in an industry for producing ice creams, or the like.

CLAIMS

1. A starter added to raw milk for fermented milk, comprising:

Lactobacillus bulgaricus and Streptococcus thermophilus, wherein

the viscosity (measured with a B-type viscometer) of fermented milk is 5000 mPa·s or more when raw milk including the starter is cultured to the pH of 4.5 to 5.0 at 37°C and is cooled to 5°C.

2. The starter according to claim 1, formed by any one of:

a combination of Lactobacillus delbrueckii subsp. bulgaricus OLL1247 strain (deposition number: NITE BP-01814) and Streptococcus thermophilus OLS3618 strain (deposition number: NITE BP-01815);

a combination of Lactobacillus delbrueckii subsp. bulgaricus OLL1247 strain (deposition number: NITE BP-01814) and Streptococcus thermophilus OLS3078 strain (deposition number: NITE BP-01697); and

a combination of Lactobacillus delbrueckii ssp. bulgaricus OLL1073R-1 strain (deposition number: FERM BP-10741) and Streptococcus thermophilus OLS3078 strain (deposition number: NITE BP-01697).

3. The starter according to claim 1, wherein

the Lactobacillus bulgaricus is

Lactobacillus delbrueckii subsp. bulgaricus OLL1247 strain (deposition number: NITE BP-01814) or

Lactobacillus delbrueckii ssp. bulgaricus OLL1073R-1 strain (deposition number: FERM BP-10741), and

the Streptococcus thermophilus is

Streptococcus thermophilus OLS3618 strain (deposition number: NITE BP-01815) or

Streptococcus thermophilus OLS3078 strain (deposition number: NITE BP-01697).

4. The starter according to claim 1, wherein

the fermented milk includes no stabilizer, or includes a stabilizer in an amount of 0.05 wt% or less.

5. A low-fat or fat-free ice cream-like food product, which is obtained by cooling and solidifying an ice cream mix, having a milk fat content of less than 8 wt%, wherein

the ice cream mix includes fermented milk obtained by adding the starter according to any one of claims 1 to 4 to raw milk and fermenting the raw milk, and

the ice cream mix has a solid not fat of 11 wt% or more.

6. The food product according to claim 5, wherein

the viscosity (measured with a B-type viscometer) of the fermented milk is 5000 mPa·s or more when the fermented milk is cooled to 5°C.

7. The food product according to claim 5, wherein

the ice cream mix further includes a whey protein condensate, and

the whey protein condensate is a condensate of particles having an average particle diameter of 2 to 10 μm and containing whey protein as a main component.

8. The food product according to claim 5, wherein

the ice cream mix includes no stabilizer, or includes a stabilizer in an amount of 0.05 wt% or less.

9. A method for producing a low-fat or fat-free ice cream-like food product, comprising:

obtaining fermented milk by adding the starter according to any one of claims 1 to 4;

obtaining an ice cream mix using the fermented milk; and

obtaining a low-fat or fat-free ice cream-like food product having a milk fat content of less than 8 wt% by cooling and solidifying the ice cream mix.