

DESCRIPTION

Additive-free normal temperature yogurt and preparation method therefor

TECHNICAL FIELD

The invention relates to the technical field of dairy products, and particularly provides
5 an additive-free ambient-temperature yoghurt and a preparation method thereof.

BACKGROUND

There are many types of yogurt on the market, and most yogurts require the addition of food additives to maintain the stability of the yogurt system. Food additives can be divided, according to different sources, into: natural yogurt stabilizers and synthetic yogurt stabilizers.
10 For additive-free yogurt, natural yogurt stabilizers are preferred.

Natural yogurt stabilizers, due to their inherent properties or flavors, generally affect the flavor and taste of additive-free yogurt. Furthermore, natural yogurt stabilizers struggle to maintain consistent stabilization throughout the entire shelf life of additive-free ambient-temperature yogurt. Therefore, the research on natural yogurt stabilizers focus on optimizing
15 the combination effect of yogurt stabilizers and optimizing the addition method of yogurt stabilizers.

Natural yogurt stabilizers such as citrus fiber, a dietary fiber extracted from citrus peels, have the property of absorbing water and swelling. When combined with water, citrus fiber forms a viscous substance, thereby increasing yogurt viscosity. Since citrus fiber or other
20 natural yogurt stabilizers can serve as fermentation substrates for starters, the role of natural yogurt stabilizers during the shelf life of ambient-temperature yogurt as storage time increases remain unclear.

SUMMARY

In the prior art, citrus fiber, seaweed powder and physical starch are added to the yogurt
25 system, mainly for the purpose of obtaining yogurt with high stability and no syneresis during the shelf life. However, as the storage time increases, the use of citrus fiber will cause the viscosity of yogurt to rise significantly, seriously affecting the taste and stability of yogurt.

To overcome the defects of the prior art, the invention provides an additive-free
30 ambient-temperature yoghurt and a preparation method thereof.

In the first aspect, in the additive-free ambient-temperature yogurt provided by the invention is obtained by using slime-producing bacterium as a fermentation strain, and the addition amount of the fermentation strains is 200 DCU per ton, the stabilizers of the additive-free ambient-temperature yogurt comprise citrus fiber, seaweed powder, and glutinous rice starch, the citrus fiber is citrus fiber subjected to cryogenic grinding, comprising: soaking the coarsely ground citrus fiber in liquid nitrogen for 3-5 minutes to form an ice layer on its surface and then grinding until the fineness reaches 150-220 mesh.

The invention employs a novel approach to address the issue of viscosity re-increasing during the shelf life of ambient-temperature yogurt products with citrus fiber, seaweed powder and glutinous rice starch as stabilizers. Specifically, the invention is based on citrus fiber itself, wherein citrus fiber with significantly improved fineness is used as a raw material, and the modified citrus fiber is used in combination with seaweed powder and glutinous rice starch to effectively mitigate the viscosity re-increasing of ambient-temperature yogurt during its shelf life.

In the invention, citrus fiber is subjected to cryogenic grinding, thereby achieving substantial enhancement in its fineness and obtaining citrus fiber with significantly improved fluidity, dispersibility, and hydration properties for use as a stabilizer in yogurt production. Compared with other grinding methods, the citrus fiber subjected to liquid nitrogen cryogenic grinding can significantly alleviate the viscosity re-increasing defects of yogurt caused by citrus fiber, while providing beneficial effects in maintaining the stability of ambient-temperature yogurt during its shelf life and enhancing its organoleptic properties.

As an additive-free ambient-temperature yogurt, the raw materials used in the invention only consist of milk, citrus fiber subjected to cryogenic grinding, seaweed powder, glutinous rice starch, white granulated sugar, and a slime-producing bacterium.

Specifically, in the additive-free ambient-temperature yogurt provided by the invention, the mass ratio of the citrus fiber subjected to cryogenic grinding, seaweed powder, and glutinous rice starch is (1-4): (2-6): (14-20).

More specifically, the mass ratio of the citrus fiber subjected to cryogenic grinding, seaweed powder, and glutinous rice starch is 1:2:14 or 4:6:20.

In the additive-free ambient-temperature yogurt provided by the invention, there are 871-903 parts by weight of milk, 1-4 parts by weight of citrus fiber subjected to cryogenic

grinding, 2-6 parts by weight of seaweed powder, 12-20 parts by weight of glutinous rice starch, and 70-90 parts by weight of white granulated sugar.

In a second aspect, the invention provides a method of preparing the above-mentioned additive-free ambient-temperature yogurt, which comprises: sequentially adding white granulated sugar, citrus fiber subjected to cryogenic grinding, seaweed powder, and glutinous rice starch to the pre-treated milk to obtain a mixed liquid, fermenting the mixed liquid by slime-producing bacteria to obtain the additive-free ambient-temperature yogurt.

The pre-treatment involves heating milk to a temperature ranging from 55 to 60 °C to facilitate the mixing of the materials.

The invention is based on the combination of specific citrus fiber, seaweed powder and glutinous rice starch, which effectively simplifies the preparation method. The natural yogurt stabilizer and white granulated sugar can be mixed in a single step.

More specifically, the method of preparing additive-free ambient-temperature yogurt in the invention comprises:

(1) heating milk to a temperature ranging from 55 to 60 °C, sequentially adding white granulated sugar, citrus fiber subjected to cryogenic grinding, seaweed powder, and glutinous rice starch to the heated milk, followed by homogenization and sterilization to obtain a mixed liquid;

(2) after the mixed liquid obtained in step (1) is cooled to 40-42 °C, adding *Lactobacillus bulgaricus* and *Streptococcus thermophilus* for fermentation, when the pH value reaches 4-4.3 during fermentation, demulsifying, stirring and cooling to obtain fermented milk.

(3) pasteurizing and cooling the fermented milk obtained in step (2) to obtain the additive-free ambient-temperature yogurt.

In the preparation method provided by the invention, conditions of the homogenization in step (1) are as follows: the first-stage pressure is 110-150 bar, and the second-stage pressure is 50-80 bar; conditions of the sterilization in step (1) are: a temperature of 130-135 °C for 3-5 seconds.

In the preparation method provided by the invention, the rotation speed for demulsifying and stirring in step (2) is 35-40 revolutions per minute, and the stirring lasts for 10-12 minutes.

As a specific embodiment of the invention, the method of preparing the additive-free ambient-temperature yogurt comprises:

(1) After milk is taken from milk silo, it is directly pumped into the heating plate under a pressure of 10-15 bar to heat milk to 45-60 °C through cyclic heating, once the heating process is completed, the milk is pumped into the batching tank, and raw materials are added, during the process of adding raw materials, the milk is not heated through cyclic heating, therefore reducing the shearing on the product stabilizer and thus improving the product stability.

Raw materials are added in the following sequence: white granulated sugar, citrus fiber, seaweed powder, and glutinous rice starch. Following materials addition, the product is homogenized at pressures: the first-stage pressure of 110-150 bar, the second-stage pressure of 50-80 bar. After homogenization, sterilization is carried out at a temperature of 130-135 °C for 3-5 s, and then the mixed material liquid is obtained.

(2) After the mixed liquid is cooled to 40 °C, *Lactobacillus bulgaricus* and *Streptococcus thermophilus* are added for fermentation in a fermentation tank. When the pH value reaches 4-4.3, demulsification and stirring are performed at a stirring speed of 35-40 revolutions per minute for 10-12 minutes. After the stirring is completed, it is rapidly cooled in the fermentation tank to 20-25 °C to obtain the cooled fermented milk.

(3) The cooled fermented milk is pasteurized at a sterilization temperature of 95°C for 200-300 seconds. Then it is cooled to 20-25 °C to obtain the additive-free ambient-temperature yogurt.

In addition, the inventors found that the problem of tube fouling caused by citrus fiber and seaweed powder still exists during the ultra-high temperature instantaneous sterilization stage. To solve this problem, the present invention further provides the following technical solutions.

On one hand, the present invention provides a preparation method for ambient-temperature yogurt, comprising: adding white granulated sugar, citrus fiber, seaweed powder and glutinous rice starch into milk at 18~25°C for dissolution, homogenizing and sterilizing the mixture after dissolution to obtain a mixed feed liquid, inoculating and fermenting the mixed feed liquid to obtain fermented milk, and performing pasteurization to obtain the ambient-temperature yogurt;

the citrus fiber is citrus fiber subjected to cryogenic grinding, with the processing method thereof as described above.

As mentioned above, citrus fiber subjected to cryogenic grinding can improve the stickiness defect in yogurt during its shelf life caused by citrus fiber. However, in industrial production, during the ultra-high temperature sterilization stage, there is a problem of citrus fiber and seaweed powder sticking to the tubes. It may be due to the stickiness characteristic of citrus fiber as a natural raw material. Therefore, faced with this problem, the inventors first thought of replacing the citrus fiber or further modifying it, but after a series of attempts, they did not achieve the desired effect. However, during the research process, they unexpectedly discovered that using low-temperature (18~25 °C) dissolution during the mixing stage, instead of the 55-60 °C dissolution mentioned above, can effectively solve the problem of citrus fiber and seaweed powder sticking to the tubes during the ultra-high temperature sterilization stage, and has no significant negative impact on the stability and taste of the final product.

Herein, the fermentation strains are *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus* (i.e., *Lactobacillus bulgaricus* and *Streptococcus thermophilus*), with an addition amount of 200 dcu/ton.

Lactobacillus delbrueckii subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus* are slime-producing bacteria. When applied in a fermentation substrate comprising specific citrus fiber subjected to cryogenic grinding, seaweed powder, and glutinous rice starch, they facilitate achieving excellent fermentation efficiency and product stability.

In some embodiments of the present invention, the mass ratio of citrus fiber subjected to cryogenic grinding, seaweed powder, and glutinous rice starch is (1-4):(2-6):(10-20).

Control of the citrus fiber subjected to cryogenic grinding, seaweed powder, and glutinous rice starch within the ratio range is conducive to improving the post-thickening defect of yogurt while maintaining the stability and texture of the yogurt during the shelf life. Furthermore, it has been found in the research of the present invention that after the improvement to low-temperature material dissolution, the dosage of glutinous rice starch can be reduced to a certain extent without significantly affecting the final result.

According to the preparation method of ambient-temperature yogurt provided by the

present invention, based on parts by weight, except for the fermentation strains, the raw materials of the ambient-temperature yogurt comprise: 880-917 parts of milk, 1-4 parts of citrus fiber subjected to cryogenic grinding, 2-6 parts of seaweed powder, 10-20 parts of glutinous rice starch, and 70-90 parts of white granulated sugar.

5 In some embodiments of the present invention, the preparation method of the ambient-temperature yogurt comprises the following steps:

(1) heating milk to a temperature ranging from 18 to 25 °C, sequentially adding white granulated sugar, citrus fiber, seaweed powder, and glutinous rice starch to the heated milk, followed by homogenization and sterilization to obtain a mixed liquid;

10 (2) after the mixed liquid is cooled to 40-42°C, adding *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus* for fermentation; when the pH value reaches 4-4.3, demulsifying, stirring, and cooling are performed to obtain fermented milk;

(3) pasteurizing and cooling the fermented milk obtained in step (2) to obtain the additive-free ambient-temperature yogurt.

Further, in step (1), the homogenization conditions are: first-stage pressure of 110-150 bar, second-stage pressure of 50-80 bar; the sterilization conditions are: 125-135°C for 3-5 seconds.

Further, in step (2), the rotation speed of demulsification and stirring is 35-40 revolutions per minute, and the stirring time is 10-12 minutes.

Further, in step (3), the pasteurization conditions are: 95°C for 200-300 seconds, optionally 300 seconds.

In a specific embodiment of the present invention, the preparation method of the ambient-temperature yogurt comprises:

25 Milk is taken from a milk silo, heated to 20°C via a heating plate, and directly pumped into a batching tank. White granulated sugar, citrus fiber (subjected to cryogenic grinding), seaweed powder, and glutinous rice starch are added. After feeding of materials is completed, the product undergoes homogenization at pressures: first-stage pressure of 110 bar, second-stage pressure of 70 bar, after homogenization, sterilization is conducted at a temperature of 30 130°C for 5 seconds. The liquid is cooled to 40-42°C, and the strains (*Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*) are added

for fermentation in a fermentation tank. When the pH value reaches 4.3, demulsifying and stirring are performed at a rotation speed of 35 rpm for 10 minutes. After stirring, the mixture is rapidly cooled to 20°C in the fermentation tank to obtain cooled fermented milk. The cooled fermented milk is subjected to pasteurization at 95°C for 300 seconds, then cooled to 25°C and filled.

In another aspect, the present invention provides an ambient-temperature yogurt subjected to the aforementioned preparation method. The raw material composition of the ambient-temperature yogurt includes: 880-917 parts of milk, 1-4 parts of citrus fiber subjected to cryogenic grinding, 2-6 parts of seaweed powder, 10-20 parts of glutinous rice starch, 70-90 parts of white granulated sugar, and the fermentation strains *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*.

Further, the raw material composition of the ambient-temperature yogurt comprises: 888.1~917 parts of milk, 1-4 parts of citrus fiber subjected to cryogenic grinding, 2-6 parts of seaweed powder, 10-11.9 parts of glutinous rice starch, 70-90 parts of white granulated sugar, and the fermentation strains *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*.

The present invention not only provides an ambient-temperature yogurt free of food additives, which constructs a stable product system entirely using raw materials, but also enables a reduced dosage of glutinous rice starch in the product of the present invention by adopting low-temperature material dissolution.

The ambient-temperature yogurt of the present invention shows no syneresis when stored at 38°C for 6 months.

The beneficial effects of the invention:

The invention provides an ambient-temperature yogurt without any food additives, and completely utilizes raw materials to construct a stable system of the product. The invention pre-treats citrus fiber to obtain liquid nitrogen frozen and ground citrus fiber, and combines seaweed powder and glutinous rice starch as stabilizers, thereby improving the viscosity-reducing defect of ambient-temperature yogurt caused by the citrus fiber during the shelf life while maintaining the stability of the yogurt system.

In the invention, fermentation strains *Lactobacillus bulgaricus* and *Streptococcus thermophilus* are applied to a specific fermentation substrate containing citrus fiber, seaweed

powder, and glutinous rice starch, achieving excellent yogurt fermentation results. Additionally, it simplifies the stabilizer addition method, thereby simplifying the yogurt preparation method.

Furthermore, the present invention has unexpectedly found that low-temperature material dissolution at a low temperature of 18~25°C can effectively solve the problem of pipe fouling caused by citrus fiber and seaweed powder during the ultra-high temperature instantaneous sterilization and pasteurization stages, and has no significant negative impact on the stability and texture of the final product. Further, under the condition of low-temperature material dissolution, the ambient-temperature yogurt of the present invention can also reduce the dosage of glutinous rice starch, resulting in a cleaner formula.

DETAILED DESCRIPTION

To clarify the objects, technical solutions, and advantages of the invention, the technical solutions in the invention will be clearly and completely described below. Obviously, the described examples are some of the examples of the invention, rather than all of them. Based on the examples of the invention, all other examples obtained by those of ordinary skill in the art without making creative efforts fall within the scope of protection of the invention.

In the invention, the terms "comprise" or "include" are open-ended expressions, which encompass the specified components or steps as described, as well as other specified components or steps that do not substantially affect the invention.

The endpoints of ranges and any values disclosed herein are not limited to the precise range or value, but these ranges or values are to be understood to include values approaching such ranges or values. For numerical ranges, the endpoint values of each range, the endpoint values of each range and individual point values, and the individual point values can be combined with each other to obtain one or more new numerical ranges. These numerical ranges shall be deemed as specifically disclosed herein.

If specific techniques or conditions are not specified in the examples, the techniques or conditions described in literature in the art shall be followed, or the product instructions shall be followed. Reagents or equipment with manufacturer not specified are commercially available conventional products obtainable through regular channels.

Example 1

This example provides a formula and a preparation method for additive-free yogurt as

follows:

The formula for the additive-free yogurt is as follows:

903 parts by weight of milk, 1 part by weight of citrus fiber subjected to cryogenic grinding, 2 parts by weight of seaweed powder, 14 parts by weight of glutinous rice starch,
5 and 80 parts by weight of white granulated sugar; the amount of fermentation bacteria is 200 DCU per ton.

The method for cryogenic grinding of citrus fiber is liquid nitrogen treatment: soaking the coarsely ground 60 – mesh citrus fiber in liquid nitrogen for 3-5 minutes to form an ice layer on its surface and then grinding until the fineness reaches 200 mesh.

10 The preparation method for the additive-free yogurt is as follows:

(1) After milk is taken from milk silo, it is directly pumped into the heating plate under a pressure of 10 bar to heat milk to 55°C through cyclic heating, once the heating process is completed, the milk is pumped into the batching tank; raw materials are added, during the process of adding raw materials, the milk is not heated through cyclic heating, therefore
15 reducing the shearing on the product stabilizer and thus improving the product stability.

Raw materials are added in the following sequence: white granulated sugar, citrus fiber, seaweed powder, and glutinous rice starch, after feeding of materials is completed, the product undergoes homogenization at pressures: first-stage pressure of 110 bar, second-stage pressure of 70 bar, after homogenization, sterilization is conducted at a temperature of 130°C
20 for 5 seconds.

(2) after the mixed liquid in step (1) is cooled to 40 °C, *Lactobacillus bulgaricus* and *Streptococcus thermophilus* are added for fermentation in a fermentation tank, when the pH value reaches 4.3, demulsification and stirring are performed at a stirring speed of 35 revolutions per minute for 10-12 minutes, after the stirring is completed, it is rapidly cooled
25 in the fermentation tank to 20 °C to obtain the cooled fermented milk.

(3) the cooled fermented milk is pasteurized at a sterilization temperature of 95°C for 300 seconds. Then it is cooled to 25 °C to obtain the additive-free ambient-temperature yogurt.

Example 2

30 This example provides a formula and a preparation method for additive-free yogurt as follows:

The formula for the additive-free yogurt is as follows:

888 parts by weight of milk, 4 part by weight of citrus fiber subjected to cryogenic grinding, 6 parts by weight of seaweed powder, 20 parts by weight of glutinous rice starch, and 82 parts by weight of white granulated sugar; the amount of fermentation bacteria is 200 DCU per ton.

The method for cryogenic grinding of citrus fiber by rapid freezing in liquid nitrogen is the same as that in Example 1. The fineness of the citrus fiber used is 180 mesh.

The preparation method is as follows: (1) after milk is taken from milk silo, it is directly pumped into the heating plate under a pressure of 15 bar to heat the milk to 60°C through cyclic heating, once the heating process is completed, the milk is pumped into the batching tank, and raw materials are added, during the process of adding raw materials, the milk is not heated through cyclic heating, therefore reducing the shearing on the product stabilizer and thus improving the product stability.

Raw materials are added in the following sequence: white granulated sugar, citrus fiber, seaweed powder, and glutinous rice starch. After feeding of materials is completed, the product undergoes homogenization under the following pressures: first-stage pressure 120 bar, second-stage pressure 50 bar. After homogenization, sterilization is conducted at a temperature of 130°C for 5 seconds.

(2) after the mixed liquid is cooled to 40 °C, *Lactobacillus bulgaricus* and *Streptococcus thermophilus* are added for fermentation in a fermentation tank. When the pH value reaches 4.3, demulsification and stirring are performed at a stirring speed of 35 revolutions per minute for 10-12 minutes, after the stirring is completed, it is rapidly cooled in the fermentation tank to 20 °C to obtain the cooled fermented milk.

(3) the cooled fermented milk is pasteurized at a sterilization temperature of 95°C for 300 seconds. Then it is cooled to 25 °C to obtain the additive-free ambient-temperature yogurt.

Example 3

This example provides a formula and a preparation method for additive-free yogurt as follows:

In this example, the formula used is the same as that in Example 2. The method for freeze-grinding of citrus fiber by rapid freezing in liquid nitrogen is the same as that in

Example 1. The fineness of the citrus fiber used is 150 mesh, and the method of preparing the citrus fiber is the same as that in Example 1.

Example 4

5 This example is the same as Example 2, except that the fineness of the citrus fiber used is 220 mesh.

Example 5

This example provides a formula for ambient-temperature yogurt as follows:

900.1 parts by weight of milk, 85 parts by weight of white granulated sugar, 1 part by weight of citrus fiber subjected to cryogenic grinding, 2 parts by weight of seaweed powder, 10 and 11.9 parts by weight of glutinous rice starch; the fermentation strains are *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*, with a total addition amount of 200 dcu/ton.

The preparation method is as follows:

15 Milk is taken from a milk silo, heated to 20°C via a heating plate, and directly pumped into a batching tank. White granulated sugar, citrus fiber, seaweed powder, and glutinous rice starch are added. After feeding of materials is completed, the product undergoes homogenization under the following pressures: first-stage pressure 110 bar, second-stage pressure 70 bar, after homogenization, sterilization is conducted at a temperature of 130°C for 5 seconds. The liquid is cooled to 40°C, and the strains (*Lactobacillus delbrueckii* subsp. 20 *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*) are added for fermentation in a fermentation tank. When the pH value reaches 4.3, demulsifying and stirring are performed at a rotation speed of 35 rpm for 10 minutes. After stirring, the mixture is rapidly cooled to 20°C in the fermentation tank to obtain cooled fermented milk. The cooled fermented milk is subjected to pasteurization at 95°C for 300 seconds, then cooled to 25°C 25 and filled.

Example 6

This example provides a formula for ambient-temperature yogurt as follows:

898.1 parts by weight of milk, 85 parts by weight of white granulated sugar, 3 parts by weight of citrus fiber, 3 parts by weight of seaweed powder, and 10.9 parts by weight of 30 glutinous rice starch; the fermentation strains are *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*, with a total addition amount of 200

dcu/ton.

The preparation method is as follows:

Milk is taken from a milk silo, heated to 20°C via a heating plate, and directly pumped into a batching tank. White granulated sugar, citrus fiber, seaweed powder, and glutinous rice starch are added. After feeding of materials is completed, the product undergoes homogenization under the following pressures: first-stage pressure 110 bar, second-stage pressure 70 bar. After homogenization, sterilization is conducted at a temperature of 125°C for 5 seconds. The liquid is cooled to 40°C, and the strains (*Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*) are added for fermentation in a fermentation tank. When the pH value reaches 4.3, demulsifying and stirring are performed at a rotation speed of 35 rpm for 10 minutes. After stirring, the mixture is rapidly cooled to 20°C in the fermentation tank to obtain cooled fermented milk. The cooled fermented milk is subjected to pasteurization at 95°C for 300 seconds, then cooled to 25°C and filled.

Example 7

This example provides a formula for ambient-temperature yogurt as follows:

899 parts by weight of milk, 85 parts by weight of white granulated sugar, 2 parts by weight of citrus fiber, 4 parts by weight of seaweed powder, and 10 parts by weight of glutinous rice starch; the fermentation strains are *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*, with a total addition amount of 200 dcu/ton.

The preparation method is as follows:

Milk is taken from a milk silo, heated to 20°C via a heating plate, and directly pumped into a batching tank. White granulated sugar, citrus fiber, seaweed powder, and glutinous rice starch are added sequentially. After feeding of materials is completed, the product undergoes homogenization under the following pressures: first-stage pressure 110 bar, second-stage pressure 70 bar. After homogenization, sterilization is conducted at a temperature of 130°C for 5 seconds. The liquid is cooled to 40°C, and the strains (*Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*) are added for fermentation in a fermentation tank. When the pH value reaches 4.3, demulsifying and stirring are performed at a rotation speed of 35 rpm for 10 minutes.

After stirring, the mixture is rapidly cooled to 20°C in the fermentation tank to obtain cooled fermented milk. The cooled fermented milk is subjected to pasteurization at 95°C for 300 seconds, then cooled to 25°C and filled.

Comparative Example 1

- 5 This example is the same as Example 4, except that in step (2) of this comparative example, the feed liquid from step (1) is cooled to 40°C, and *Lactobacillus bulgaricus* and *Streptococcus thermophilus* are added as fermentation strains at 300 DCU per ton.

Comparative Example 2-5

- 10 In Comparative Example 2, materials and preparation methods are the same as those in Example 4, except that seaweed powder is not used in the formula of this comparative example.

In Comparative Example 3, materials and preparation methods are the same as those in Example 4, except that citrus fiber is not used in this comparative example.

- 15 In Comparative Example 4, materials and preparation methods are the same as those in example 4, except that citrus fiber is not subjected to cryogenic grinding by rapid freezing in liquid nitrogen in this comparative example, and the fineness of the used citrus fiber is 220 mesh.

In Comparative Example 5, materials and preparation methods are the same as those in example 4, except that corn starch is used instead of glutinous rice starch.

- 20 Comparative Example 6

This comparative example provides an ambient-temperature yogurt, the formula of which is the same as that in Example 5, and the preparation method adopts a conventional hot dissolution process, specifically as follows:

- 25 (1) After milk is taken from a milk silo, it is directly pumped into a heating plate (heating plate temperature) at a pressure of 15 bar to circulate and heat the milk to 60°C. After heating is completed, it is directly pumped into a batching tank, and raw materials are added. During the raw material addition process, the milk is not subjected to circulating heating to reduce the shearing of product stabilizers, thereby improving product stability.

- 30 The raw materials white granulated sugar, citrus fiber, seaweed powder, and glutinous rice starch are added sequentially. After feeding of materials is completed, the product is homogenized with a first-stage homogenization pressure of 120 bar and a second-stage

pressure of 50 bar. After homogenization, sterilization is performed at a temperature of 130°C for 5 seconds to obtain a mixed liquid.

(2) The mixed liquid is cooled to 40°C, and *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus* are added for fermentation in a fermentation tank. When the pH value reaches 4.3, demulsifying and stirring are performed at a rotation speed of 35 revolutions per minute for 10 minutes. After stirring is completed, the mixture is rapidly cooled to 20°C in the fermentation tank to obtain cooled fermented milk.

(3) The cooled fermented milk is subjected to pasteurization at a temperature of 95°C for 300 seconds, then cooled to 25°C to obtain ambient-temperature yogurt.

Comparative Example 7

This comparative example provides an ambient-temperature yogurt, the formula of which is as follows:

900.1 parts by weight of milk, 85 parts by weight of white granulated sugar, 3 parts by weight of seaweed powder, 11.9 parts by weight of glutinous rice starch; the fermentation strains are *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*, with a total addition amount of 200 dcu/ton. The preparation method is the same as that in Example 5.

Comparative Example 8

This comparative example provides an ambient-temperature yogurt, the formula of which is as follows:

899 parts by weight of milk, 85 parts by weight of white granulated sugar, 2 parts by weight of citrus fiber, 4 parts by weight of seaweed powder, 10 parts by weight of corn starch; the fermentation strains are *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus salivarius* subsp. *thermophilus*, with a total addition amount of 200 dcu/ton. The preparation method is the same as that in Example 7.

Experimental Example 1 Comparison of product viscosities of Examples 1-4 and Comparative Examples 1-5

A rheometer was used to measure the viscosities (unit: mPa·s) of the products of examples 1-4 and comparative examples 1-5 at 25 °C with a cc27 probe under a speed increasing and decreasing of 75 s⁻¹. The results are shown in Table 1. The target viscosity

range is 220~380.

Table 1 Product viscosities of Examples 1-4 and Comparative Examples 1-5

	freshly prepared	first month	second month	third month	fourth month	fifth month
Example 1	257.2	246.8	246.2	306.4	336.4	350.6
Example 2	263.8	275.3	294.2	307.6	325.4	343.6
Example 3	249.5	246.9	243.2	318.5	325.3	353.2
Example 4	259.6	267.8	289.6	290.4	300.6	310.5
Comparative Example 1	180.6	200.4	223.5	245.8	264.3	283.5
Comparative Example 2	122.6	155.2	164.2	171.2	188.4	195.2
Comparative Example 3	184.3	192.5	189.4	183.3	190.6	187.3
Comparative Example 4	253.5	347.9	408.3	446.5	479.6	553.2
Comparative Example 5	200.8	201.9	231.2	269.3	296.3	322.1

Experimental Example 2 Comparison of product stability during the shelf life of Examples 1-4 and Comparative Examples 1-5

- 5 The products from the examples 1-4 and comparative examples 1-5 were incubated at 38°C for stability observation, and the stability results during the shelf life are shown in Table 2.

Table 2 Comparison of product stability during the shelf life of Examples 1-4 and Comparative Examples 1-5

	freshly prepared	first month	second month	third month	fourth month	fifth month
Example 1	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis
Example 2	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis
Example 3	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis
Example 4	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis
Comparative Example 1	no syneresis	pattern appears	slight syneresis	syneresis	syneresis	syneresis
Comparative Example 2	no syneresis	pattern appears	slight syneresis	syneresis	syneresis	syneresis
Comparative Example 3	no syneresis	slight syneresis	syneresis	syneresis	syneresis	syneresis
Comparative Example 4	no syneresis	no syneresis	a pattern	syneresis	syneresis	syneresis

Comparative Example 5	no syneresis	slight syneresis	syneresis	syneresis	syneresis	syneresis
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Experimental Example 3 Comparison of product evaluation of Examples 1-4 and Comparative Examples 1-5

In this example, a sensory evaluation was conducted on the products of the Examples 1-4 and Comparative Examples 1-5.

5 Twenty tasters were randomly selected to perform a product flavor test (also referred to as a 'taste test'). The flavor test utilized a scoring method, where numerical scores are assigned to evaluate product characteristics, and the superiority or inferiority are determined by the ranking of average scores. The scoring criteria are as follows: scores range from 0 to 10, with 0–2 points considered poor, 3–5 points average, 6–8 points good, and 9–10 points excellent. Evaluation items include color, flavor, and texture. The flavor test results are presented in Table 3.

Table 3 Comparison of product evaluation of Examples 1-4 and Comparative Examples 1-5

	freshly prepared	first month	second month	third month	fourth month	fifth month
Example 1	8	8	7	6	6	6
Example 2	8	8	7	7	6	6
Example 3	9	8	8	7	7	7
Example 4	8	8	7	6	6	6
Comparative Example 1	7	6	6	5	5	4
Comparative Example 2	7	6	5	5	4	4
Comparative Example 3	7	6	5	5	4	4
Comparative Example 4	6	5	4	4	3	3
Comparative Example 5	4	4	4	4	4	3

As can be seen from tables 1-3, compared with Example 4, in comparative examples 2, 3 and 5, after omitting or changing the types of stabilizers (citrus fiber, seaweed powder, glutinous rice starch), although the ambient-temperature yogurt basically did not have the viscosity re-increasing defect within the shelf-life, the initial viscosity and stability of the ambient-temperature yogurt prepared in Comparative Examples 2, 3 and 5 all failed to meet the requirements.

For example, the product obtained in Comparative Example 2 without using seaweed powder developed a pattern within one month and started to exhibit syneresis from the second month, indicating poor stability during its shelf-life. This indicates that seaweed powder is an indispensable stabilizer, and the absence of seaweed powder will greatly affect the stability of the product during its shelf life.

The product obtained in Comparative Example 3 without using citrus fiber began to exhibit slight syneresis from the second month, indicating poor stability during its shelf life. The viscosity remained persistently at a low level throughout the shelf life, which suggests that citrus fiber is a key factor influencing viscosity and also the primary cause of viscosity re-increasing during the shelf life. To address the issue of viscosity re-increasing during the shelf life, in-depth research into citrus fiber is necessary.

Similarly, the product prepared in Comparative Example 5 using corn starch instead of glutinous rice starch also started to exhibit slight syneresis from the second month, indicating poor stability during its shelf-life. This also indicates that the product of the present invention needs to use high-viscosity glutinous rice starch instead of low-viscosity corn starch. The maintenance of product viscosity is also a key reason for the maintenance of product stability. In other words, the product of the present invention must not only have a certain viscosity to maintain stability, but also avoid viscosity re-increasing during the shelf life.

Compared with Example 4, the ambient-temperature yogurt prepared in Comparative Example 1 failed to meet the initial viscosity and stability requirements after increasing the amount of starter culture. This confirmed that altering the starter culture dosage in a yogurt system using citrus fiber, seaweed powder, and glutinous rice starch as stabilizers severely impacts both the fermentation efficiency and stability performance of ambient-temperature yogurt.

Compared with Example 4, 220-mesh citrus fiber without prior liquid nitrogen grinding was employed in Comparative Example 4 (Products ground with liquid nitrogen do not encounter problems such as agglomeration and thermal denaturation caused by high-temperature grinding). The result shows that, despite having the same fineness, the untreated stabilizer citrus fiber induced viscosity re-increasing in the yogurt system. Furthermore, based on the simplified preparation method, the 220-mesh citrus fiber without

prior liquid nitrogen treatment in combination with seaweed powder and glutinous rice starch as stabilizers provided substantially limited stabilization effects. As shown in Table 1, the viscosity of Comparative Example 4 at one month, two months, three months, four months, and five months was 30%, 41%, 54%, and 78% higher than that of Example 4, respectively, indicating that the viscosity of the comparative example increased month by month, and the rate of viscosity increase accelerated month by month compared with Example 4; as shown in Table 2, the product prepared in Comparative Example 4 developed patterns at two months and exhibited syneresis at three months; as shown in Table 3, its taste was significantly inferior to that of Example 4.

Experimental Example 4

A rheometer was used to measure the viscosities (unit: mPa·s) of the products of examples 5-7 and comparative examples 6-8 at 25 °C with a cc27 probe under a speed increasing and decreasing of 75 s⁻¹. The results are shown in Table 4.

Table 4

	freshly prepared	first month	second month	third month	fourth month	fifth month	sixth month
Example 5	238.6	249.5	277.8	289.4	306.7	319.8	332.5
Example 6	257.8	264.6	281.6	296.6	305.7	314.6	332.8
Example 7	259.4	266.9	283.2	299.5	315.3	323.2	341.2
Comparative Example 6	283.5	294.9	308.3	319.5	325.6	333.6	345.7
Comparative Example 7	184.2	205.2	222.6	241.2	268.4	288.2	309.6
Comparative Example 8	156.7	171.3	201.9	238.7	269.3	296.9	314.5

Experimental Example 5

The product formulations of Examples 5-7 and Comparative Examples 6-8 were subjected to tube disassembly during the first sterilization (ultra-high temperature instantaneous sterilization) stage to observe whether tube fouling occurred. The results are shown in Table 5.

Table 5

	tube fouling phenomenon
Example 5	No
Example 6	No
Example 7	No
Comparative Example 6	Yes
Comparative Example 7	No
Comparative Example 8	No

Experimental Example 6

The products of Examples 5-7 and Comparative Examples 6-8 were placed at 38°C for incubation observation, and the stability results of the products during the shelf life are shown in Table 6.

Table 6

	freshly prepared	first month	second month	third month	fourth month	fifth month	sixth month
Example 5	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis
Example 6	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis
Example 7	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis
Comparative Example 6	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis	no syneresis
Comparative Example 7	no syneresis	pattern appears	slight syneresis	syneresis	syneresis	syneresis	syneresis

Comparative Example 8	no syneresis	no syneresis	slight syneresis	pattern appears	slight syneresis	syneresis	syneresis
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Experimental Example 7

Twenty tasters were randomly selected to perform a product flavor test (also referred to as a "taste test"). Among them, the flavor test adopted the scoring method: the scoring method evaluates products or product characteristics through numerical scoring, and finally determines the ranking based on the average score. The scoring criteria use a scale of 0-10 points: 0-2 points are rated as poor, 3-5 points as fair, 6-8 points as good, and 9-10 points as excellent. The evaluation items include: color, flavor, and taste. The results of the flavor test are shown in Table 7.

Table 7

	freshly prepared	first month	second month	third month	fourth month	fifth month
Example 5	8	8	7	6	6	6
Example 6	8	8	7	7	6	6
Example 7	9	8	8	7	7	7
Comparative Example 6	4	4	4	4	4	3
Comparative Example 7	6	5	4	4	3	3
Comparative Example 8	3	3	2	2	2	2

It can be seen from Tables 4-7 that only appropriate raw materials and processes can ensure the stability and taste of the product. The improvement of the product dissolution process can effectively improve the tube fouling phenomenon during product production and significantly reduce the amount of starch added to the product. Starches from different sources will affect the viscosity, stability and texture of the product.

Finally, it should be noted that the above examples are merely intended to illustrate the technical solution of the invention, but not to limit it; although the invention has been described in detail with reference to the foregoing examples, it should be understood by

those skilled in the art that they may still modify the technical solutions described in the foregoing examples or make equivalent substitutions for some of the technical features thereof; however, these modifications or substitutions do not cause the essence of the corresponding technical solutions to deviate from the spirit and scope of the technical solutions of the examples of the invention.

CLAIMS

1. An additive-free ambient-temperature yogurt, wherein, the additive-free ambient-temperature yogurt is obtained by using slime-producing bacteria as fermentation strains at the addition amount of 200 DCU per ton; stabilizers of the additive-free ambient-temperature yogurt comprise: citrus fiber, seaweed powder, and glutinous rice starch, and the citrus fiber is citrus fiber through cryogenic grinding, wherein the freezing and grinding comprises: soaking the coarsely ground citrus fiber in liquid nitrogen to form an ice layer on its surface and then grinding until the fineness reaches 150-220 mesh, optionally, the slime-producing bacteria are *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.

2. The additive-free ambient-temperature yogurt according to claim 1, wherein, the raw materials of the yogurt consist of milk, citrus fiber subjected to cryogenic grinding, seaweed powder, glutinous rice starch, white granulated sugar, and slime-producing bacteria.

3. The additive-free ambient-temperature yogurt according to claim 2, wherein, in the additive-free ambient-temperature yogurt, the mass ratio of the citrus fiber subjected to cryogenic grinding, seaweed powder, and glutinous rice starch is (1-4): (2-6): (14-20).

4. The additive-free ambient-temperature yogurt according to claim 3, wherein, in the additive-free ambient-temperature yogurt, the mass ratio of the citrus fiber subjected to cryogenic grinding, seaweed powder, and glutinous rice starch is 1: 2: 14 or 4: 6: 20.

5. The additive-free ambient-temperature yogurt according to claim 4, wherein, in the additive-free ambient-temperature yogurt, there are 871-903 parts by weight of milk, 1-4 parts by weight of citrus fiber subjected to cryogenic grinding, 2-6 parts by weight of seaweed powder, 12-20 parts by weight of glutinous rice starch, and 70-90 parts by weight of white granulated sugar.

6. A method of preparing the additive-free ambient-temperature yogurt as described in any one of claims 1 to 5, comprising: sequentially adding white granulated sugar, citrus fiber subjected to cryogenic grinding, seaweed powder, and glutinous rice starch to pre-treated milk to obtain a mixed liquid, fermenting the mixed liquid by slime-producing bacteria to

obtain the additive-free ambient-temperature yogurt, optionally, the slime-producing bacteria are *Lactobacillus bulgaricus* and *Streptococcus thermophilus*; optionally, the pretreatment involves heating milk to 55-60°C; optionally, after taken from milk tank, the milk is pumped into the heating plate using pressure for circular heating to 55-60°C; optionally, the pressure is 10-15 bar.

7. The method of preparing the additive-free ambient-temperature yogurt according to claim 6, wherein, comprises:

(1) heating milk to a temperature ranging from 55 to 60 °C, sequentially adding white granulated sugar, citrus fiber subjected to cryogenic grinding, seaweed powder, and glutinous rice starch to the heated milk, followed by homogenization and sterilization to obtain a mixed liquid,

(2) after the mixed liquid obtained in step (1) is cooled to 40-42 °C, adding slime-producing bacteria for fermentation, when the pH value reaches 4-4.3 during fermentation, demulsifying, stirring and cooling to obtain fermented milk, optionally, cooling to 20-25°C;

(3) pasteurizing and cooling the fermented milk obtained in step (2) is to obtain the additive-free ambient-temperature yogurt, optionally, cooling to 20-25°C.

8. The method of preparing the additive-free ambient-temperature yogurt according to claim 7, wherein, conditions of the homogenization in step (1) are as follows: the first-stage pressure is 110-150 bar, the second-stage pressure is 50-80 bar; conditions of the sterilization in step (1) are: a temperature of 130-135 °C for 3-5 seconds.

9. The method of preparing the additive-free ambient-temperature yogurt according to claim 7, wherein, the rotation speed for demulsifying and stirring in step (2) is 35-40 revolutions per minute, and the stirring lasts for 10-12 minutes.

10. The method of preparing the additive-free ambient-temperature yogurt according to claim 7, wherein, the temperature of pasteurization in step (3) is 95°C and the time is 200-300 seconds.

11. A method of preparing the ambient-temperature yogurt, comprising: adding white

granulated sugar, citrus fiber, seaweed powder and glutinous rice starch into milk at 18~25°C for material dissolution, performing homogenization and sterilization after material dissolution to obtain a mixed liquid, inoculating and fermenting the mixed liquid to obtain fermented milk, and obtaining the ambient-temperature yogurt after pasteurization;
5 optionally, the fermentation strains are *Lactobacillus delbrueckii subsp. bulgaricus* and *Streptococcus salivarius subsp. Thermophilus*;

the citrus fiber is citrus fiber subjected to cryogenic grinding, and the cryogenic grinding conditions are as follows: soaking the coarsely ground citrus fiber in liquid nitrogen to form an ice layer on its surface and then grinding until the fineness reaches 150-220 mesh.

10 12. The method of preparing the ambient-temperature yogurt according to claim 11, wherein, in parts by weight, except for the fermentation strains, the raw materials of the ambient-temperature yogurt are: 880-917 parts of milk, 1-4 parts of citrus fiber subjected to cryogenic grinding, 2-6 parts of seaweed powder, 10-20 parts of glutinous rice starch, and 70-90 parts of white granulated sugar.

15 13. The method of preparing the ambient-temperature yogurt according to claim 11 or 12, wherein, the method comprising:

(1) heating milk to a temperature ranging from 18 to 25°C, adding white granulated sugar, citrus fiber, seaweed powder and glutinous rice starch for homogenization and sterilization to obtain a mixed liquid;

20 (2) cooling the mixed liquid to 40-42°C, adding *Lactobacillus delbrueckii subsp. bulgaricus* and *Streptococcus salivarius subsp. thermophilus* for fermentation, demulsifying and stirring when the pH value reaches 4.3, then cooling to obtain fermented milk;

(3) subjecting the cooled fermented milk to pasteurization and cooling to obtain the ambient-temperature yogurt.

25 14. The method of preparing the ambient-temperature yogurt according to claim 13, wherein, the homogenization conditions are: first-stage pressure 110-150 bar, second-stage pressure 50-80 bar; the sterilization conditions are: 125-135°C for 3-5 seconds.

15. The method of preparing the ambient-temperature yogurt according to claim 13,

wherein, in step (2), the rotation speed of demulsifying and stirring is 35-40 revolutions per minute, and the stirring time is 10-12 minutes.

16. The method of preparing the ambient-temperature yogurt according to claim 13, wherein, in step (3), the conditions for pasteurization are: 95°C for 200-300 seconds,
5 optionally 300 seconds.

17. An ambient-temperature yogurt, prepared by the preparation method according to any one of claims 11-16; the raw material composition of the ambient-temperature yogurt consists of: 888.1~917 parts of milk, 1-4 parts of citrus fiber subjected to cryogenic grinding, 2-6 parts of seaweed powder, 10-11.9 parts of glutinous rice starch, 70-90 parts of white
10 granulated sugar, fermentation strains *Lactobacillus delbrueckii subsp. bulgaricus* and *Streptococcus salivarius subsp. thermophilus*; optionally, the ambient-temperature yogurt shows no syneresis when stored at 38°C for 6 months.