

Description

Title of Invention: PROCESS FOR PRODUCING PACKAGED MILK-CONTAINING DRINK AND PRODUCING SYSTEM

Technical Field

[0001] The present invention relates to a method and a system of producing a packaged milk-containing drink.

Background Art

[0002] Heretofore, it has been known that a concentration of dissolved oxygen in a milk-containing liquid substance such as cow's milk is reduced to suppress deterioration of taste and flavor of the milk-containing liquid substance with the lapse of time.

For example, there is known a method of producing a drink, which contains a reduced amount of dimethyl sulfide generated by heating and which has taste and flavor similar to those of raw milk or an unheated milk-containing liquid, which includes, prior to heating, subjecting milk or an unheated milk-containing liquid substance to replacement of dissolved oxygen with an inert gas such as nitrogen gas to reduce a concentration of dissolved oxygen in the liquid substance to 5 ppm or less, and then heating the milk or unheated milk-containing liquid substance (Patent Literature 1).

There is also known a method of producing a milk product, which

includes the steps of: subjecting raw milk to heat pasteurization treatment; storing the heat-pasteurized milk in a sterile tank having an inside space charged with an inert gas; and filling the heat-pasteurized milk stored in the sterile tank into a packaging container (Patent Literature 2).

[0003] On the other hand, it is known that, in order to suppress deterioration of a liquid food or drink owing to oxygen gas, a paper container having an excellent barrier property capable of inhibiting passage of oxygen gas or the like is used to store a liquid food or drink.

For example, there is known a paper container having a barrier property which is formed of a composite material, wherein the composite material is obtained by laminating a polylactic acid resin layer on the outside of a paper base layer and laminating a sealant having a barrier property on the inside of the paper base layer, in which the sealant is formed of a polylactic acid resin layer, an adhesive layer, a barrier layer, an adhesive layer, and a polylactic acid resin layer wherein the barrier layer is made of any one kind of an ethylene-vinyl alcohol copolymer, 6-nylon, 6-66 copolymer nylon and MXD-6 meta-xylenediamine and the adhesive layers on the both sides of the barrier layer are made of an acid-denatured resin (Patent Literature 3).

Citation List

Patent Literatures

[0004] [Patent Literature 1] JP 3083798 B2

[Patent Literature 2] JP 3490428 B2

[Patent Literature 3] JP 2010-69766 A

Summary of the Invention

Problems to be Solved by the Invention

[0005] As described above, heretofore, it has been known that a concentration of dissolved oxygen in a milk-containing liquid substance (or milk-containing drink) such as cow's milk is reduced to suppress deterioration of taste and flavor of the milk-containing liquid substance with the lapse of time.

However, even milk produced so as to have a reduced concentration of dissolved oxygen may cause a problem in that the concentration of dissolved oxygen in the milk may increase with the lapse of time, resulting in deterioration of taste and flavor or proliferation of contaminating microorganisms, when the milk is stored in a container for a long period of time after packaging.

An object of the present invention is to provide a method and a system of producing a packaged milk-containing drink, which can suppress deterioration of taste and flavor of a milk-containing drink such as cow's milk after packaging for a long period of time, and which can suppress proliferation of contaminating microorganisms in the milk-containing drink for a long period of time.

Means for Solving the Problem

[0006] The inventors of the present invention have made intensive investigations to solve the problem, and as a result, have found that deterioration of taste and flavor of a milk-containing drink after packaging and proliferation of contaminating microorganisms in the milk-containing drink can be suppressed for a long period of time by removing at least a part of dissolved oxygen contained in a milk-containing liquid substance (i.e. a liquid which contains milk) to prepare a milk-containing liquid substance having a reduced concentration of dissolved oxygen, and then charging the milk-containing liquid substance into a container formed of a laminated sheet including a paper base layer and a nylon resin layer, thus completing the present invention.

[0007] That is, the present invention provides the following items [1] to [9].

[1] A method of producing a packaged milk-containing drink (i.e. a product which includes a drink containing milk and a container thereof), including:

 a deoxygenation treatment step of removing at least a part of dissolved oxygen contained in a milk-containing liquid substance (such as unheated raw milk) to prepare a milk-containing liquid substance having a reduced concentration of dissolved oxygen; and

 a packaging step of charging the milk-containing liquid substance after being treated in the deoxygenation treatment step into a container formed of a laminated sheet including a paper base layer and a nylon resin layer to prepare a packaged milk-containing

drink.

[2] The method of producing a packaged milk-containing drink according to the above item [1], in which the deoxygenation treatment step is performed by replacing at least a part of dissolved oxygen contained in the milk-containing liquid substance with an inert gas (such as nitrogen gas) and/or (i.e. "and" or "or") by removing at least a part of dissolved oxygen contained in the milk-containing liquid substance through deaeration (for example, a reduced-pressure or vacuum atmosphere, an addition of an oxygen-removing agent, an oxygen-removing membrane such as a hollow fiber membrane, or heating).

[3] The method of producing a packaged milk-containing drink according to the above item [1] or [2], wherein in the packaging step, the concentration of dissolved oxygen in the milk-containing liquid substance before the charging into the container is 8 ppm or less.

[4] The method of producing a packaged milk-containing drink according to any one of the above items [1] to [3], wherein in the packaging step, the nylon resin layer for forming the container includes one or more kinds selected from the group consisting of nylon MXD6, nylon 6, nylon 6,6, and nylon 4,6.

[5] The method of producing a packaged milk-containing drink according to any one of the above items [1] to [4], further including a pasteurization step of pasteurizing the milk-containing liquid substance by heating at one or more timings selected from before,

after, and during the deoxygenation treatment step.

[6] The method of producing a packaged milk-containing drink according to any one of the above items [1] to [5], further including a storage step of storing the milk-containing liquid substance in a surge tank before the packaging step.

[7] The method of producing a packaged milk-containing drink according to the above item [6], wherein the storage step includes controlling stirring of the milk-containing liquid substance in the surge tank so that an amount of increase in concentration of dissolved oxygen in the milk-containing liquid substance is 3 ppm or less in terms of a difference between before and after the storing.

[8] The method of producing a packaged milk-containing drink according to any one of the above items [1] to [7], wherein in the packaging step, the container is a gable top-type paper container (i.e. a gable-top type container which is made of paper).

[9] A system of producing a packaged milk-containing drink, including:

deoxygenation treatment means for removing at least a part of dissolved oxygen contained in a milk-containing liquid substance to prepare a milk-containing liquid substance having a reduced concentration of dissolved oxygen; and

packaging means for charging the milk-containing liquid substance after being treated by the deoxygenation treatment means into a container formed of a laminated sheet including a paper base layer and a nylon resin layer to prepare a packaged milk-containing

drink.

Advantageous Effects of the Invention

[0008] According to the present invention, the deterioration of taste and flavor of the milk-containing drink (i.e. the milk-containing liquid substance) after packaging for a long period of time, and the proliferation of contaminating microorganisms in the milk-containing drink (i.e. the milk-containing liquid substance) can be suppressed for a long period of time.

Embodiments of the Invention

[0009] An example of a method of producing a packaged milk-containing drink of the present invention includes: (A) a deoxygenation treatment step of removing at least a part of dissolved oxygen contained in an unheated milk-containing liquid substance to prepare a milk-containing liquid substance having a reduced concentration of dissolved oxygen; (B) a pasteurization step of pasteurizing the milk-containing liquid substance obtained in the step (A) by heating; (C) a storage step of storing the milk-containing liquid substance obtained in the step (B) in a surge tank; and (D) a packaging step of charging the milk-containing liquid substance stored in the step (C) into a container formed of a laminated sheet including a paper base layer and a nylon resin layer to prepare a packaged milk-containing liquid drink.

The steps in the production method of the present invention

are hereinafter described in detail.

[0010] [Step (A): Deoxygenation Treatment Step]

The step (A) is a deoxygenation treatment step of removing at least a part of dissolved oxygen contained in an unheated milk-containing liquid substance to prepare a milk-containing liquid substance having a reduced concentration of dissolved oxygen.

Examples of the milk-containing liquid substance include raw milk and liquid materials to be used as raw materials for various drinks each containing raw milk or a processed product of raw milk (such as condensed milk, skimmed milk, partially skimmed milk, skimmed condensed milk, partially skimmed condensed milk, cream, whey, permeate, reconstituted milk, reconstituted condensed milk, reconstituted skimmed milk, reconstituted partially skimmed milk, reconstituted cream, reconstituted whey, reconstituted permeate, processed milk, a milk drink, a fermented milk drink, a whey drink, a lactic acid bacteria drink, and a milk-containing soft drink).

The milk-containing liquid substance only needs to be a liquid substance containing milk in at least a part. Therefore, a material other than a material originating from milk may optionally be added.

The "liquid substance" in the term "milk-containing liquid substance" includes not only a general liquid substance having all or a part of solid contents dissolved, suspended, or dispersed in its liquid, but also one containing precipitate components (for example, components such as minerals, tea leaves, coffees, lactose, and insoluble insoluble dietary fiber, and solid contents such as

flesh of fruit, juice sack, and crush jelly) in its liquid.

[0011] Examples of the raw milk include: milk derived from mammals (i.e. animal milk) such as cow's milk, ewe's milk, sheep's milk, buffalo's milk, goat's milk, or whale's milk; vegetable milk such as soybean milk; and artificial milk emulsified with water, oil, an emulsifier; and the like.

The lower limit of the liquid temperature of the milk-containing liquid substance in the step (A) (i.e. deoxygenation treatment step) is not particularly limited as long as the liquid substance does not freeze and become solidified to lose its flowability. For example, the lower limit of the liquid temperature is preferably -10°C , more preferably -5°C , more preferably 0°C , and even more preferably 1°C . When the liquid temperature is less than -10°C , the milk-containing liquid substance may freeze and become solidified.

The upper limit of the liquid temperature of the milk-containing liquid substance in the step (A) (i.e. deoxygenation treatment step) is not particularly limited as long as the liquid temperature does not cause excessive deterioration of fats, excessive denaturation of proteins, and excessive browning (i.e. Maillard reaction) of carbohydrates in the liquid substance. The upper limit of the liquid temperature is preferably 60°C , more preferably 50°C , and even more preferably 40°C . When the liquid temperature exceeds 60°C , excessive deterioration of fats, excessive denaturation of proteins, and excessive browning (i.e. Maillard

reaction) of carbohydrates may be liable to occur.

[0012] That is, the liquid temperature of the milk-containing liquid substance in the step (A) (i.e. deoxygenation treatment step) is preferably from -10°C to 60°C , more preferably from -5°C to 60°C , more preferably from 0°C to 60°C , more preferably from 1°C to 60°C , more preferably from 1°C to 50°C , more preferably from 1°C to 40°C , more preferably from 1°C to 30°C , more preferably from 1°C to 20°C , more preferably from 1°C to 15°C , more preferably from 1°C to 12°C , more preferably from 1°C to 10°C , more preferably from 1°C to 8°C , more preferably from 1°C to 7°C , more preferably from 1°C to 6°C , more preferably from 1°C to 5°C , more preferably from 2°C to 5°C , and even more preferably from 2°C to 4°C .

[0013] The step (A) (i.e. deoxygenation treatment step) may be performed by one or more methods selected from (a) a method of replacing at least a part of dissolved oxygen contained in a milk-containing liquid substance with an inert gas, and (b) a method of removing at least a part of dissolved oxygen contained in a milk-containing liquid substance through deaeration (for example, placement of the liquid substance in a reduced-pressure or vacuum atmosphere, addition of an oxygen-removing agent, passing of the liquid substance through an oxygen-removing membrane such as a hollow fiber membrane, or heating).

In the step (A) (i.e. deoxygenation treatment step), the method (a) and/or (b) may be performed simultaneously or successively in combination.

[0014] An example of the method of replacing at least a part of dissolved oxygen contained in a milk-containing liquid substance with an inert gas is a method of blowing an inert gas into a milk-containing liquid substance. In this case, the liquid temperature of the milk-containing liquid substance at the time of the blowing of the inert gas is not particularly limited as long as formation of bubbles due to replacement with the inert gas can be suppressed, and is for example, 60°C or less, preferably 50°C or less, more preferably 40°C or less, more preferably 30°C or less, more preferably 25°C or less, more preferably 20°C or less, more preferably 15°C or less, more preferably 12°C or less, and even more preferably 10°C or less.

Examples of the inert gas include nitrogen gas and argon gas. Of those, nitrogen gas is preferred from the viewpoints of its safety, inexpensiveness, and easy availability.

[0015] Examples of the method of removing at least a part of dissolved oxygen contained in a milk-containing liquid substance under reduced pressure include a method of placing the milk-containing liquid substance under a pressure (i.e. a reduced pressure) of preferably from 1 to 50 kPa, more preferably from 3 to 40 kPa, more preferably from 5 to 30 kPa, and even more preferably from 5 to 25 kPa. In this case, the liquid temperature of the milk-containing liquid substance is not particularly limited as long as formation of bubbles due to reduced pressure can be suppressed, and is for example, 60°C or less, preferably 50°C or less, more

preferably 40°C or less, more preferably 30°C or less, more preferably 25°C or less, more preferably 20°C or less, more preferably 15°C or less, more preferably 12°C or less, and even more preferably 10°C or less.

[0016] The concentration of dissolved oxygen in the milk-containing liquid substance after the treatment of the step (A) is preferably 8 ppm or less, more preferably 7 ppm or less, more preferably 6 ppm or less, more preferably 5 ppm or less, more preferably 4 ppm or less, more preferably 3 ppm or less, more preferably 2 ppm or less, and even more preferably 1 ppm or less, from the viewpoint of reducing the concentration of dissolved oxygen in the packaged milk-containing drink obtained in the step (D) (i.e. packaging step).

In the present invention, the step (B) may be performed before the step (A). In this case, the object to be treated in the step (A) is not an unheated milk-containing liquid substance but a milk-containing liquid substance after heat pasteurization. In the present invention, the step (B) may be performed simultaneously with the step (A). In the present invention, the step (A) may be performed during the step (B). In this case, the object to be treated in the step (A) is not an unheated milk-containing liquid substance but a milk-containing liquid substance during heat pasteurization.

The step (A) (i.e. deoxygenation treatment step) may be performed at once for a milk-containing liquid substance prepared in advance. Alternatively, liquid materials (for example, skimmed

milk and cream) used as materials of the milk-containing liquid substance may be separately subjected to the deoxygenation treatment (step (A)), followed by mixing.

[0017] [Step (B): Pasteurization Step]

The step (B) is a step of pasteurizing the milk-containing liquid substance obtained in the step (A) by heating.

The heat pasteurization method is not particularly limited, and examples thereof include low-temperature long-time pasteurization method (LTLT method), high-temperature short-time pasteurization method (HTST method), ultra-high-temperature pasteurization method (UHT method), electrical heating pasteurization method (Joule heat pasteurization method), and AC high electric field pasteurization method. For example, the heat pasteurization may be performed under generally known heat pasteurization conditions, for example, at from 110 to 150°C for from 1 to 5 seconds, at from 70 to 75°C for 15 seconds, or at from 62 to 65°C for 30 minutes.

The concentration of dissolved oxygen in the milk-containing liquid substance hardly increases in the step (B).

In the present invention, the step (B) may be performed both before and after the step (A). In other words, the step (A) may be performed between the steps (B). In this case, the object to be treated in the step (A) is not an unheated milk-containing liquid substance but a milk-containing liquid substance during heat pasteurization.

[0018] In the present invention, the step (B) may be performed only before the step (A). In this case, the object to be treated in the step (B) is not a milk-containing liquid substance having a reduced concentration of dissolved oxygen but a milk-containing liquid substance having not been subjected to the step (A) and having a usual level of concentration of dissolved oxygen.

In the present invention, the step (A) may be performed simultaneously with the step (B). For example, there may be given a step of consistently performing a deoxygenation treatment during the step (B).

The step (B) is an optional step that may be included in the production method of the present invention as necessary, and is not an essential step. For example, when a milk-containing liquid substance obtained by an unheated pasteurization and/or sterilization step such as filtration sterilization or ultraviolet irradiation is used as the object to be treated, it is not necessary to further perform heat pasteurization in the step (B).

[0019] [Step (C): Storage Step]

The step (C) is a step of storing the milk-containing liquid substance obtained in the step (B) in a surge tank. The step (C) is an optional step that may be included in the production method of the present invention as necessary, and is not an essential step.

The surge tank is a tank for temporarily storing the milk-containing liquid substance before the milk-containing liquid substance is charged into a container in the step (D) (i.e. packaging

step).

The surge tank includes a tank main body having an inlet for pouring the milk-containing liquid substance into the tank and an outlet for discharging the milk-containing liquid substance, a jacket for adjusting the liquid temperature of the milk-containing liquid substance stored in the tank main body, and a stirring device (such as stirring blade) for stirring the milk-containing liquid substance stored in the tank main body. The stirring device (such as stirring blade) is used for uniformizing the composition of components and/or liquid temperature of the milk-containing liquid substance.

[0020] The surge tank is used, for example, by: (i) a method (i.e. batch method) of performing only pouring of a milk-containing liquid substance into a tank main body at the beginning of storage until a certain volume of the milk-containing liquid substance is charged into the tank main body, performing only discharge of the milk-containing liquid substance charged into the tank main body, performing only pouring of the milk-containing liquid substance thereinto in the same manner as above when the volume of the residual milk-containing liquid substance in the tank main body is reduced to a certain level or less or zero, and repeating the discharge and pouring procedures in the same manner as above; or (ii) a method (i.e. continuous method) of performing only pouring of a milk-containing liquid substance into a tank main body at the beginning of storage until a certain volume of the milk-containing

liquid substance is charged into the tank main body, and then simultaneously performing both pouring of the milk-containing liquid substance into the tank main body and discharge of the milk-containing liquid substance while maintaining the volume of the milk-containing liquid substance in the tank main body to a certain level.

[0021] The operation of the stirring blade of the surge tank is controlled so that an amount of increase in concentration of dissolved oxygen in the milk-containing liquid substance during storage in terms of a difference between before and after storage is, for example, 8 ppm or less, preferably 7 ppm or less, more preferably 6 ppm or less, more preferably 5 ppm or less, more preferably 4 ppm or less, more preferably 3 ppm or less, more preferably 2 ppm or less, more preferably 1 ppm or less, and even more preferably 0.5 ppm or less.

The milk-containing liquid substance obtained in the step (A) and the step (B) may further be deoxygenated in the surge tank. In this case, the operation of the stirring blade of the surge tank is controlled so that an amount of increase in concentration of dissolved oxygen in the milk-containing liquid substance during storage in terms of a difference between before and after storage is, for example, 0 ppm or more, preferably -1 ppm or more (in other words, an amount of decrease in concentration of dissolved oxygen is 1 ppm or more), more preferably -2 ppm or more, more preferably -3 ppm or more, more preferably -4 ppm or more, more preferably -5 ppm or more, more preferably -6 ppm or more, more preferably

-7 ppm or more, and even more preferably -8 ppm or more.

The term "difference between before and after storage" as used herein refers to a value calculated by subtracting a value of the concentration of dissolved oxygen in the milk-containing liquid substance immediately before pouring into the surge tank from a value of the concentration of dissolved oxygen in the milk-containing liquid substance immediately after discharge from the surge tank.

[0022] When the amount of increase or decrease in concentration of dissolved oxygen in the step (C) falls within the above-mentioned preferred range, the concentration of dissolved oxygen in the packaged milk-containing drink prepared in the step (D) (i.e. packaging step) can readily be reduced to a predetermined level or less.

As a method of operating a stirring blade so as to reduce the amount of increase or decrease in concentration of dissolved oxygen as described above, there is given, for example, a method involving, in both (i) and (ii), charging a certain volume of the milk-containing liquid substance into a tank main body without operating a stirring blade at the beginning of storage, and then gently rotating the stirring blade at a position far from the liquid surface of the milk-containing liquid substance so as to prevent the liquid surface of the milk-containing liquid substance from swirling or deeply surging.

When such method of operating a stirring blade is employed, the amount of increase or decrease in concentration of dissolved

oxygen in the milk-containing liquid substance can be adjusted to fall within the above-mentioned preferred range in the presence of air (i.e. oxygen-containing gas) in the inside space of the surge tank even when an inert gas such as nitrogen gas is not supplied to the inside space of the surge tank.

It goes without saying that the amount of increase or decrease in concentration of dissolved oxygen in the milk-containing liquid substance can be surely adjusted to fall within the above-mentioned preferred range by adding a deoxygenation device and/or step to a surge tank or before or after the tank, such as a method of feeding an inert gas to the inside space of the surge tank and/or into the milk-containing liquid substance in the surge tank, or a method of deaerating the milk-containing liquid substance in the surge tank.

[0023] [Step (D): Packaging Step]

The step (D) is a step of charging the milk-containing liquid substance stored in the step (C) into a container formed of a laminated sheet including a paper base layer and a nylon resin layer to prepare a packaged milk-containing liquid substance (i.e. milk-containing drink).

The laminated sheet is formed by, for example, laminating a polyethylene layer, a paper base layer, a nylon resin layer, an adhesive layer, and a polyethylene layer in this order from the outside to the inside of the container. Of those, the nylon resin layer has a high ability to inhibit passing of oxygen gas and can

effectively suppress, for example, deterioration of taste and flavor of a packaged milk-containing drink owing to oxygen gas.

As a resin for forming the nylon resin layer, there are given various nylons (i.e. polyamide resins) such as nylon MXD6, nylon 6, nylon 6,6, and nylon 4,6.

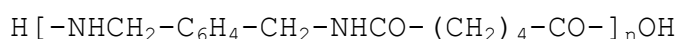
In the present invention, the nylon resin layer may be formed as a single layer made of one kind (for example, nylon MXD6) selected from various nylons, or as a laminate of two layers including a layer made of one kind (for example, nylon MXD6) selected from various nylons and a layer made of another kind of nylon (for example, nylon 6). The nylon resin layer may be formed as a laminate including three or more layers (for example, a laminate including a layer made of nylon 6, a layer made of nylon MXD6, and a layer made of nylon 6).

The container to be used in the step (D) is not limited to a container formed of a laminated sheet including the paper base layer and the nylon resin layer. It goes without saying that the container is not limited by the quality of the material of the container as long as the container has a higher oxygen barrier property than a container formed of only the paper base material.

[0024] Of the various nylons, nylon MXD6 is preferably used in the present invention from the viewpoint of being capable of particularly and remarkably suppressing deterioration of taste and flavor of a milk-containing liquid substance (i.e. milk-containing drink) and proliferation of contaminating microorganisms in the

milk-containing liquid substance for a long period of time by a synergistic effect provided by a combination with a decrease in concentration of dissolved oxygen of the milk-containing liquid substance.

Nylon MXD6 is a polyamide resin obtained through a polycondensation reaction of meta-xylenediamine (MXDA) and adipic acid and has the following chemical formula.



The two bonding sites of the "-C₆H₄-" (benzene ring) in the formula are located at the meta-position. "n" in the formula represents an integer.

The nylon resin layer in the laminated sheet preferably includes a layer made of nylon MXD6, for example. In this case, the layer made of nylon MXD6 has a thickness of preferably 1 μm or more, more preferably 3 μm or more, more preferably 5 μm or more, and even more preferably 7 μm or more. The upper limit of the thickness is not particularly limited. From the viewpoint of, for example, cost, the upper limit of the thickness is preferably 50 μm.

[0025] Examples of the container for being charged by the milk-containing liquid substance in the step (D) include a gable top-type paper container.

In particular, the gable top-type paper container is generally used for charging about 1 liter of a milk-containing liquid substance (i.e. milk-containing drink), has a small ratio of the air space to the liquid volume of the milk-containing liquid substance, and

has an enhanced effect of suppressing deterioration of taste and flavor of the milk-containing liquid substance and proliferation of contaminating microorganisms in the milk-containing liquid substance. Therefore, the gable top-type paper container is preferably used in the present invention. However, even a container other than the gable top-type paper container can be used in the present invention as long as the container has the air space at a ratio almost equal to or smaller than that of the gable top-type paper container because almost the same effect as that of the gable top-type paper container can be achieved.

The concentration of dissolved oxygen in the milk-containing liquid substance before charging into the container is preferably 8 ppm or less, more preferably 7 ppm or less, more preferably 6 ppm or less, more preferably 5 ppm or less, more preferably 4 ppm or less, more preferably 3 ppm or less, more preferably 2 ppm or less, more preferably 1.5 ppm or less, and even more preferably 1 ppm or less.

The concentration of dissolved oxygen in the milk-containing liquid substance (i.e. milk-containing drink) after charging into the container as a value after 6 days from the time point of charging is preferably 8 ppm or less, more preferably 7 ppm or less, more preferably 6 ppm or less, more preferably 5.5 ppm or less, more preferably 5 ppm or less, more preferably 4.5 ppm or less, more preferably 4 ppm or less, more preferably 3.5 ppm or less, more preferably 3 ppm or less, more preferably 2 ppm or less, and still

more preferably 1 ppm or less. Those values are values in the case of storage in a refrigerator at 10°C or less (such as 5°C).

[0026] A system of producing a packaged milk-containing drink of the present invention includes, for example, (a) deoxygenation treatment means for removing at least a part of dissolved oxygen contained in a milk-containing liquid substance to prepare a milk-containing liquid substance having a reduced concentration of dissolved oxygen (for example, means for blowing an inert gas into a milk-containing liquid substance, or means for placing a milk-containing liquid substance under a reduced pressure condition), (b) pasteurization means (i.e. heating means) for pasteurizing the milk-containing liquid substance treated by the deoxygenation treatment means (a) by heating, (c) storage means (i.e. surge tank) for storing the milk-containing liquid substance treated by the pasteurization means (b), and (d) packaging means (for example, a filling machine) for charging (i.e. filling) the milk-containing liquid substance stored by the storage means (c) into a container formed of a laminated sheet including a paper base layer and a nylon resin layer to prepare a packaged milk-containing drink. Another means such as deoxygenation means may optionally be added to all or a part of the means (a) to (d).

Examples

[0027] [Example 1]

Unheated cow's raw milk (concentration of dissolved oxygen:

12 ppm) was charged into a tank, and nitrogen gas was blown into the raw milk at 10°C or less (liquid temperature: 5°C) to decrease the concentration of dissolved oxygen in the raw milk to 1.5 ppm.

Subsequently, the raw milk was pasteurized by heating at 130°C for 2 seconds.

The resultant pasteurized milk was transferred to a surge tank, and pouring of the milk into the surge tank and discharge thereof were performed continuously by the above-mentioned method (ii). In this procedure, at the beginning of the pouring of the milk into the surge tank, the stirring blade in the surge tank was not rotated until a certain volume of the milk was charged into the surge tank. During pouring of the milk into the surge tank and discharge thereof simultaneously, the stirring blade in the surge tank was gently rotated at the lower portion of the surge tank so as to prevent the liquid surface of the milk in the tank from swirling or deeply surging.

[0028] A gable top-type paper container (volume: 1 liter) was filled with the milk discharged from the surge tank. In this procedure, the concentration of dissolved oxygen in the milk before filling into the paper container was found to be 1.5 ppm. The laminated sheet for forming the paper container was obtained by laminating a polyethylene layer, a paper base layer, a nylon resin layer made of nylon MXD6 (thickness: 10 μ m), an adhesive layer, and a polyethylene layer in this order from the outside to the inside of the paper container.

The resultant packaged milk was stored in a refrigerator for 6 days at a temperature of 5°C, and then the concentration of dissolved oxygen in the milk in the container was measured and found to be 3.3 ppm. The milk stored in the refrigerator was subjected to sensory evaluation, and was found to have strong fresh milk taste and flavor, and clean aftertaste (i.e. refreshing aftertaste or invigorating aftertaste).

[0029] [Example 2]

An experiment was performed in the same manner as in Example 1 except that the final value of the decrease in concentration of dissolved oxygen in raw milk achieved by blowing of nitrogen gas was changed from 1.5 ppm to 3.0 ppm.

As a result, the concentration of dissolved oxygen in milk before filling into the paper container was found to be 2.7 ppm. The concentration of dissolved oxygen in milk after being stored in the refrigerator for 6 days was found to be 3.6 ppm. The milk stored in the refrigerator was subjected to sensory evaluation, and was found to have strong fresh milk taste and flavor, and clean aftertaste.

[Example 3]

An experiment was performed in the same manner as in Example 1 except that the final value of the decrease in concentration of dissolved oxygen in raw milk achieved by blowing of nitrogen gas was changed from 1.5 ppm to 5.0 ppm.

As a result, the concentration of dissolved oxygen in milk

before filling into the paper container was found to be 4.9 ppm. The concentration of dissolved oxygen in milk after being stored in the refrigerator for 6 days was found to be 5.1 ppm. The milk stored in the refrigerator was subjected to sensory evaluation, and was found to have strong fresh milk taste and flavor and clean aftertaste.

[0030] [Example 4]

An experiment was performed in the same manner as in Example 1 except that the final value of the decrease in concentration of dissolved oxygen in raw milk achieved by blowing of nitrogen gas was changed from 1.5 ppm to 3.0 ppm, the material of the nylon resin layer in the laminated sheet for forming the paper container was changed from nylon MXD6 to nylon 6, and the timing of measuring the concentration of dissolved oxygen in the milk after storage in the refrigerator was changed from the time point after storage for 6 days to the time point after storage for 7 days.

As a result, the concentration of dissolved oxygen in milk before filling into the paper container was found to be 2.8 ppm. The concentration of dissolved oxygen in milk after being stored in the refrigerator for 7 days was found to be 4.9 ppm. The milk stored in the refrigerator was subjected to sensory evaluation, and was found to have strong fresh milk taste and flavor and clean aftertaste.

[Example 5]

An experiment was performed in the same manner as in Example

1 except that the material of the nylon resin layer in the laminated sheet for forming the paper container was changed from nylon MXD6 to nylon 6, and the timing of measuring the concentration of dissolved oxygen in the milk after storage in the refrigerator was changed from the time point after storage for 6 days to the time points after storage for 7 days and 14 days.

As a result, the concentration of dissolved oxygen in milk before filling into the paper container was found to be 1.5 ppm. The concentrations of dissolved oxygen in milk after being stored in the refrigerator for 7 days and 14 days were found to be 6.5 ppm and 6.4 ppm, respectively. The milk stored in the refrigerator for 14 days was subjected to sensory evaluation, and was found to have strong clean aftertaste.

[0031] [Comparative Example 1]

An experiment was performed in the same manner as in Example 1 except that the nylon resin layer (thickness: 10 μ m) made of nylon MXD6 was changed to a polyethylene layer (thickness: 10 μ m).

As a result, the concentration of dissolved oxygen in the milk after being stored in the refrigerator for 6 days was found to be 8.2 ppm. The milk stored in the refrigerator was subjected to sensory evaluation and found to have fresh milk taste and flavor, and clean aftertaste, which are weaker as compared to those of Example 1, and egg-like odor (i.e. sulfurous odor).

[Comparative Example 2]

An experiment was performed in the same manner as in Example

2 except that the nylon resin layer (thickness: 10 μm) made of nylon MXD6 was changed to a polyethylene layer (thickness: 10 μm).

As a result, the concentration of dissolved oxygen in the milk after being stored in the refrigerator for 6 days was found to be 8.2 ppm. The milk stored in the refrigerator was subjected to sensory evaluation, and was found to have fresh milk taste and flavor, and clean aftertaste, which are weaker as compared to those of Example 2, and egg-like odor (i.e. sulfurous odor).

[0032] [Comparative Example 3]

An experiment was performed in the same manner as in Example 3 except that the nylon resin layer (thickness: 10 μm) made of nylon MXD6 was changed to a polyethylene layer (thickness: 10 μm).

As a result, the concentration of dissolved oxygen in the milk after being stored in the refrigerator for 6 days was found to be 8.4 ppm. The milk stored in the refrigerator was subjected to sensory evaluation, and was found to have fresh milk taste and flavor, and clean aftertaste, which are weaker as compared to those of Example 3, and egg-like odor (i.e. sulfurous odor).

[Comparative Example 4]

An experiment was performed in the same manner as in Example 4 except that the nylon resin layer (thickness: 10 μm) made of nylon 6 was changed to a polyethylene layer (thickness: 10 μm).

As a result, the concentration of dissolved oxygen in the milk after being stored in the refrigerator for 7 days was found to be 9.3 ppm. The milk stored in the refrigerator was subjected to sensory

evaluation, and was found to have fresh milk taste and flavor, and clean aftertaste, which are weaker as compared to those of Example 4, and egg-like odor (i.e. sulfurous odor).

[0033] [Comparative Example 5]

An experiment was performed in the same manner as in Example 5 except that the nylon resin layer (thickness: 10 μ m) made of nylon 6 was changed to a polyethylene layer (thickness: 10 μ m).

As a result, the concentrations of dissolved oxygen in the milk after being stored in the refrigerator for 7 days and 14 days were found to be 9.8 ppm and 10.0 ppm, respectively. The milk stored in the refrigerator was subjected to sensory evaluation, and was found to have clean aftertaste which is weaker as compared to that of Example 5.

[0034] [*Pseudomonas* Inoculation Test]

In the same manner as a method described in JP 3091752 B2, a part of dissolved oxygen in unheated cow's raw milk (concentration of dissolved oxygen: 12 ppm) was replaced with nitrogen gas to reduce the concentration of dissolved oxygen in the raw milk, and the raw milk was continuously pasteurized by heating at 130°C for 2 seconds. The resultant pasteurized milk was transferred to a surge tank, and pouring of the milk into the surge tank and discharge thereof were performed continuously by the above-mentioned method (ii). In this procedure, at the time of beginning of pouring of the milk into the surge tank, the stirring blade in the surge tank was not rotated until a certain volume of milk was charged into the surge

tank. During pouring of the milk into the surge tank and discharge thereof simultaneously, the stirring blade in the surge tank was gently rotated at the lower portion of the surge tank so as to prevent the liquid surface of the milk in the tank from swirling or deeply surging.

[0035] The milk discharged from the surge tank was filled into a gable top-type paper container (volume: 1 liter). In this procedure, the concentration of dissolved oxygen in the milk before filling into the paper container was found to be 2.0 ppm. As a laminated sheet for forming the paper container, there were used the following two kinds of sheets: a sheet (i.e. a product of the present invention, which is abbreviated as an invented product hereinafter) obtained by laminating a polyethylene layer, a paper base layer, a nylon resin layer (thickness: 10 μm) made of nylon MXD6, an adhesive layer, and a polyethylene layer in this order from the outside to the inside of the paper container; and a sheet (i.e. a comparative product which is for being compared to an invented product) obtained in the same manner as the invented product except that the nylon resin layer (thickness: 10 μm) was changed to a polyethylene layer (thickness: 10 μm). The resultant packaged milk products (i.e. the invented product and the comparative product) were separately transported for 1 day at 10°C or less. After that, a bacterial liquid containing *Pseudomonas* cells was aseptically injected into each of the packaged milk products to inoculate the *Pseudomonas* cells in the milk at 1.0×10^4 cfu/ml using a syringe without opening the

packaged milk products, and the injection port was aseptically sealed. The resultant products were stored in a refrigerator for 6 days at a temperature of 10°C. The concentrations of dissolved oxygen immediately before inoculation of *Pseudomonas* cells were found to be 7.0 ppm in the comparative product and 6.6 ppm in the invented product. The increase in concentration of dissolved oxygen was considered to be caused by dissolution of oxygen in the headspace into the milk during transportation.

[0036] The living *Pseudomonas* cells were counted after being stored at 10°C for 6 days. As a result, the numbers of *Pseudomonas* cells in the comparative product and the invented product (i.e. nylon MXD6) were found to be 2.6×10^7 cfu/ml and 3.9×10^6 cfu/ml, respectively, indicating that proliferation of contaminating microorganisms was suppressed greatly in the invented product compared to the comparative product.

An experiment was performed in the same manner as that of the above-mentioned invented product (i.e. nylon MXD6) except that nylon MXD6 was changed to nylon 6. As a result, the number of living *Pseudomonas* cells in the invented product (i.e. nylon 6) after being stored at 10°C for 6 days was found to be 5.8×10^6 cfu/ml, indicating that proliferation of contaminating microorganisms was suppressed greatly as compared to the comparative product.

[0037] The results described above reveal the following matters in all the cases where the concentrations of dissolved oxygen in the raw milk after blowing of nitrogen gas were 1.5 ppm, 3.0 ppm,

and 5.0 ppm. In Comparative Examples 1 to 3, the concentrations of dissolved oxygen in the milk after being stored in the refrigerator for 6 days were almost the same (8.2 to 8.4 ppm) and high. In contrast, in Examples 1 to 3, the concentrations of dissolved oxygen of the milk after being stored in the refrigerator for 6 days were from 3.3 to 5.1 ppm which are lower than those in Comparative Examples 1 to 3.

In particular, in Examples 1 and 2 in which the concentrations of dissolved oxygen in the raw milk after blowing of nitrogen gas were from 1.5 to 3.0 ppm, the concentrations of dissolved oxygen in the milk after being stored in the refrigerator for 6 days were from 3.3 to 3.6 ppm, which were less than 4 ppm and very excellent results.

The results of Example 4, Comparative Example 4, Example 5, and Comparative Example 5 reveal that the effect of the present invention can be achieved even when the kind of the nylon was changed.

It was found that the results of Examples 1 to 5 were better than those of Comparative Examples 1 to 5 from the viewpoint of taste and flavor, and that in the proliferation test of contaminating microorganisms, the invented products achieved better results than those of the comparative products.

Claims

1. A method of producing a packaged milk-containing drink, comprising:

a deoxygenation treatment step of removing at least a part of dissolved oxygen contained in a milk-containing liquid substance to prepare a milk-containing liquid substance having a reduced concentration of dissolved oxygen; and

a packaging step of charging the milk-containing liquid substance treated in the deoxygenation treatment step into a container formed of a laminated sheet including a paper base layer and a nylon resin layer to prepare the packaged milk-containing drink.

2. The method of producing a packaged milk-containing drink according to claim 1, wherein the deoxygenation treatment step is performed by replacing at least a part of dissolved oxygen contained in the milk-containing liquid substance with an inert gas, and/or by removing at least a part of dissolved oxygen contained in the milk-containing liquid substance through deaeration.

3. The method of producing a packaged milk-containing drink according to claim 1 or 2, wherein in the packaging step, a concentration of dissolved oxygen in the milk-containing liquid substance before the charging into the container is 8 ppm or less.

4. The method of producing a packaged milk-containing drink according to any one of claims 1 to 3, wherein in the packaging

step, the nylon resin layer for forming the container comprises one or more kinds selected from the group consisting of nylon MXD6, nylon 6, nylon 6,6, and nylon 4,6.

5. The method of producing a packaged milk-containing drink according to any one of claims 1 to 4, further comprising a pasteurization step of pasteurizing the milk-containing liquid substance by heating at one or more timings selected from before, after, and during the deoxygenation treatment step.

6. The method of producing a packaged milk-containing drink according to any one of claims 1 to 5, further comprising a storage step of storing the milk-containing liquid substance in a surge tank before the packaging step.

7. The method of producing a packaged milk-containing drink according to claim 6, wherein the storage step comprises controlling stirring of the milk-containing liquid substance in the surge tank so that an amount of increase in concentration of dissolved oxygen in the milk-containing liquid substance is 3 ppm or less in terms of a difference between before and after the storing.

8. The method of producing a packaged milk-containing drink according to any one of claims 1 to 7, wherein in the packaging step, the container comprises a gable top-type paper container.

9. A system of producing a packaged milk-containing drink, comprising:

deoxygenation treatment means for removing at least a part of dissolved oxygen contained in a milk-containing liquid substance

to prepare a milk-containing liquid substance having a reduced concentration of dissolved oxygen; and

packaging means for charging the milk-containing liquid substance treated by the deoxygenation treatment means into a container formed of a laminated sheet including a paper base layer and a nylon resin layer to prepare the packaged milk-containing drink.