

Title: CONCENTRATED MILK AND METHOD FOR PRODUCING THE SAME

Technical Field

[0001]

The present invention relates to concentrated milk that has high solids content but low viscosity, and a process for producing such concentrated milk.

Background Art

[0002]

It is said that there are three elements that consumers desire for milk (and the like), that is, 'naturalness', 'palatability', and 'nutrition/function'. The characteristics that conventional milk has in these respects are as follows.

'Normal milk' has a good image in terms of being natural/inartificial and a reputation for being tasty, but there is a view that there should be more nutrients such as calcium.

'Low-fat milk' has a good reputation in terms of calories being low and it being light, but there is a view that the taste is weak and that it should be more nutritious.

'Specially rich (concentrated) milk' has a reputation for being rich and tasty, but there is a view that the fat content is high and that it might cause weight gain.

'Milk beverage' has a good reputation in terms of nutrients such as calcium being abundant, but there is a view that it is artificial and that the taste is unpleasant.

[0003]

As described above, there is no milk that simultaneously satisfies the three important elements of 'naturalness', 'palatability', and 'nutrition/function' that consumers desire. Furthermore, the values that consumers desire for milk are diverse, and it is necessary to provide new values.

For example, as a method for improving the flavor of milk, a method in which a deoxygenation treatment is applied before or after thermal

pasteurization to thus reduce the odor of overheated milk has been proposed (Patent Publication 1, Patent Publication 2).

On the other hand, a category 'composition modified milk' is produced as a result of the revision of the Ministerial Ordinance on Milk and Milk Products Concerning Compositional Standards, etc. The composition modified milk referred to here is one formed by removing a specific component (water content, etc.) from raw milk alone (100% raw milk) by a technique such as a membrane treatment, but excludes 'fat-free milk (skim milk)' and 'low-fat milk (partially skimmed milk)'. Composition modified milk has the possibility of satisfying the three important elements that consumers desire for milk and answering the diversification of values that consumers desire for milk.

[0004]

As a process for producing such composition modified milk, processed milk (concentrated milk) in which nutritious components such as protein and calcium are enhanced by subjecting starting milk to a membrane concentration treatment, and a process for producing same (Patent Publication 3, Patent Publication 4) have been proposed, but such concentrated milk is not always satisfactory in terms of texture on the tongue, etc. since the solids content concentration is increased.

[Prior Art Documents]

[Patent Publication]

[0005]

[Patent Publication 1] JP, A, 2001-078665

[Patent Publication 2] JP, A, 2003-144045

[Patent Publication 3] JP, A, 2002-051699

[Patent Publication 4] JP, A, 2002-253116

Summary of Invention

Problems to be Solved by the Invention

[0006]

It is therefore an object of the present invention to provide

concentrated milk that has higher concentrations of protein, calcium, etc. than conventional milk, high nutritional value, and good texture on the tongue.

Means for Solving the Problems

[0007]

During an intensive investigation by the present inventors in order to attain the above-mentioned object, it has been found that, while noting that concentrated milk having a high content of milk solids-not-fat has high viscosity, the texture on the tongue can be improved by reducing the viscosity of concentrated milk, and as a result of further investigation the present invention has been accomplished.

[0008]

That is, the present invention relates to concentrated milk comprising 10 to 14 wt. % milk solids-not-fat and having a shear viscosity of 20 to 100 mPa·s at a shear rate of 0.5 s^{-1} .

Furthermore, the present invention relates to the concentrated milk wherein the milk fat content is no greater than 3 wt. %.

Moreover, the present invention relates to a process for producing concentrated milk that includes a step of subjecting starting milk to a deoxygenation treatment before and/or after subjecting the starting milk to a concentration treatment, and subsequently carrying out a pasteurization treatment.

[0009]

Furthermore, the present invention relates to the production process, wherein it further includes a step of carrying out a homogenization treatment.

Moreover, the present invention relates to the production process, wherein it includes a step of adjusting the milk fat content of concentrated milk to no greater than 3 wt. %.

Furthermore, the present invention relates to the production process, wherein the concentration treatment is a membrane concentration treatment.

Effects of the Invention

[0010]

In accordance with the present invention, there can be provided concentrated milk having a desirable texture on the tongue, even if it contains 10 to 14 wt. %, more preferably 10 to 13.5 wt. %, yet more preferably 10 to 13 wt. %, and still more preferably 10 to 12 wt. % of milk solids-not-fat, by adjusting the shear viscosity at a shear rate of 0.5 s^{-1} so as to be 20 to 100 mPa·s.

Furthermore, in accordance with another embodiment of the present invention, with regard to low-fat or fat-free concentrated milk, which has milk fat content of no greater than 3 wt. %, preferably less than 3 wt. %, more preferably no greater than 2.5 wt. %, and yet more preferably no greater than 1.5 wt. %, by adjusting the shear viscosity at a shear rate of 0.5 s^{-1} so as to be 20 to 100 mPa·s there can be provided concentrated milk that is excellent for beauty and health and has a desirable texture on the tongue and richness since it is low-fat (low calorie) while being concentrated milk that is high in nutritious components. Such concentrated milk has a completely new flavor and texture as a result of a combination of richness due to the high milk solids-not-fat content, a refreshing feel due to its low viscosity in spite of the high concentration, and a light feel due to the low fat content.

[0011]

Moreover, in accordance with yet another embodiment of the present invention there can be provided, by a production process that includes a step of concentrating the milk solids-not-fat content of starting milk, a step of subjecting the concentrated starting milk to a deoxygenation treatment, and subsequently a step of carrying out a pasteurization treatment, concentrated milk having milk solids-not-fat of preferably 10 to 14 wt. %, more preferably 10 to 13.5 wt. %, yet more preferably 10 to 13 wt. %, and still more preferably 10 to 12 wt. %, and having a relatively low viscosity, that is, a shear viscosity of 20 to 100 mPa·s at a shear rate of 0.5 s^{-1} .

[0012]

Furthermore, in accordance with still another embodiment of the present invention, while taking into consideration the balance between the

viewpoint of little loss in nutritious components such as protein, lactose, vitamins, and minerals and the viewpoint of improvement in flavor of concentrated milk, when subjecting starting milk to a membrane concentration treatment, an MF membrane treatment, a UF membrane treatment, an RO membrane treatment, or an NF membrane treatment is for example suitable, a UF membrane treatment, an RO membrane treatment, or an NF membrane treatment is preferably suitable, an RO membrane treatment or an NF membrane treatment is more preferably suitable, and an NF membrane treatment is yet more preferably suitable. By carrying out nonthermal concentration by appropriately selecting these membrane concentration treatments, it is possible to provide concentrated milk having excellent flavor and a desirable texture on the tongue without losing the original nutritious components or flavor of the milk.

Modes for Carrying Out the Invention

[0013]

The 'starting milk' referred to in the present specification is a liquid containing milk components, such as raw milk, crude milk, whole fat milk, skim milk, and whey.

The 'concentrated milk' referred to in the present specification is a liquid obtained by subjecting the above-mentioned starting milk to a concentration treatment such as a membrane separation method or a vacuum evaporation method and, furthermore, the 'concentrated milk' includes a liquid obtained by additionally carrying out in some cases a pasteurization treatment, a homogenization treatment, a centrifugation treatment, a fat concentration adjustment treatment, etc. as a pre-step or a post-step of the above-mentioned concentration treatment. That is, the 'concentrated milk' includes, for example, composition modified milk whose milk fat concentration has been adjusted by subjecting concentrated milk obtained from whole fat milk to a centrifugation treatment and composition modified milk whose milk fat content has been adjusted by adding cream, etc. to concentrated milk obtained from skim milk.

[0014]

In the present invention, for example, in order to prepare composition modified milk, raw milk is subjected to a centrifugation treatment to thus obtain skim milk and cream, and this skim milk is subjected as starting milk to an NF membrane treatment, thus preparing concentrated milk having a milk solids-not-fat content of about 12 wt. %. Subsequently, the milk fat content is adjusted to about 1.5 wt. % by mixing (adding) a part of the cream obtained in the centrifugation treatment into the concentrated milk, and this concentrated milk having milk solids-not-fat content of about 12 wt. % and a milk fat content of about 1.5 wt. % is subjected to a deoxygenation treatment and then to a pasteurization treatment. During this process, a homogenization treatment is not essential, but it may be carried out before the pasteurization treatment or after the pasteurization treatment.

In this way, by subjecting concentrated milk, whose milk solids-not-fat content has been adjusted so as to be higher than that of raw milk and whose milk fat content has been adjusted to be low as necessary, to a pasteurization treatment after a deoxygenation treatment, there can be provided composition modified milk that has richness due to the high milk solids-not-fat content, a refreshing feel due to the low viscosity in spite of the high concentration, and a light feel due to the low fat content.
[0015]

That is, in the present invention, it has been found that, compared with a case in which a pasteurization treatment is carried out without a deoxygenation treatment, there is an effect in lowering the viscosity when subjecting concentrated milk, whose milk solids-not-fat content has been increased to a predetermined concentration, to a pasteurization treatment after a deoxygenation treatment, and by utilizing this effect it is possible to provide concentrated milk having a refreshing feel in spite of it having a high milk solids-not-fat content or a high overall concentration. Furthermore, in the present invention, by further reducing the milk fat content, it is possible to provide composition modified milk having a light feel and richness in spite of it being low-fat or fat-free.

In the conventional art a dairy product may be pasteurized after a deoxygenation treatment, but the object and effect thereof are only to improve

flavor (taste, odor, etc.). On the other hand, in the present invention, by pasteurizing a dairy product after a deoxygenation treatment, the physical properties and texture (flowability, swallowing, texture on the tongue, etc.) are improved, that can be said to be new effects and actions that are different from the conventional art.

[0016]

The concentrated milk according to the present invention has milk solids-not-fat content that is higher than that of normal milk, and has milk solids-not-fat content of for example 10 to 17 wt. %, preferably 10 to 15 wt. %, more preferably 10 to 14 wt. %, and yet more preferably 11 to 12 wt. %.

For conventional composition modified milk (concentrated milk), processed milk, etc., the higher the milk solids-not-fat content, the richer it is, but the refreshing feel disappears, and if an attempt is made to impart a refreshing feel, the richness disappears. In the present invention, the higher the milk solids-not-fat content, the higher the effect of reducing viscosity by a deoxygenation treatment, and since the viscosity becomes low even though the milk solids-not-fat content and the overall concentration is high, it is possible to impart a refreshing feel while having richness. Therefore, in order to impart a refreshing feel and stronger richness in terms of flavor, the milk solids-not-fat content may be set so as to be relatively high. On the other hand, from the viewpoint of concentration ratio, etc., which is easily set by a membrane concentration treatment, it is desirable to set the milk solids-not-fat content at 10 to 14 wt. %, etc.

[0017]

Furthermore, the milk fat content of the concentrated milk according to the present invention is not particularly limited, but the effects of the present invention can easily be exhibited for concentrated milk that is classified as low-fat or fat-free.

For conventional composition modified milk (concentrated milk), processed milk, etc., the higher the milk fat content, the more that richness is imparted, but the light feel disappears, so that if an attempt is made to impart richness, the light feel disappears. Furthermore, since fat-free milk does not contain milk fat content, which is one of the factors that

brings out the richness of milk, it has the problems that the taste is slightly weak and it does not have strong milk characteristics. In the present invention, the composition modified milk having a high milk solids-not-fat concentration has richness as well as low viscosity, and in order to achieve a balance between a light feel and richness in terms of flavor, the milk fat content may be set at a low level. In the present invention, by setting the upper limit of the milk fat content at, for example, 3.0 wt. %, preferably 2.5 wt. %, more preferably 2.0 wt. %, and yet more preferably 1.5 wt. %, the light feel and the richness due to milk fat can be enhanced. On the other hand, by setting the lower limit of the milk fat content at, for example, 0.0 wt. %, preferably 0.1 wt. %, more preferably 0.2 wt. %, yet more preferably 0.3 wt. %, and most preferably 0.5 wt. %, while taking into consideration countermeasures against an evaluation of a 'slightly weak taste' and 'weak milk characteristics' possessed by conventional fat-free milk, the light feel can be enhanced, and concentrated milk having a new flavor and texture can be provided.

[0018]

In the process for producing concentrated milk according to the present invention, the concentration treatment includes, but is not particularly limited to, a membrane separation method, a vacuum evaporation method and the like, and a membrane separation method is preferable since it is nonthermal and causes hardly any denaturing of nutritious components such as protein.

In the process for producing concentrated milk according to the present invention, the membrane separation method is preferably, but is not particularly limited to, an ultrafiltration membrane (UF) method, a reverse osmosis membrane (RO) method, and a nanofiltration membrane (NF) method since there is little loss of nutritious components such as protein. The reverse osmosis membrane (RO) method and the nanofiltration membrane (NF) method are more preferable since there is little loss of nutritious components such as protein, lactose, vitamins, and minerals. The nanofiltration membrane (NF) method is yet more preferable since there is little loss of nutritious components such as protein, lactose, vitamins, and minerals, and the flavor

of concentrated milk can be improved due to removal of a part of the urea, lactic acid, minerals (sodium, potassium, chlorine, etc.), etc. In this process, for example, it is possible to use the nanofiltration membrane (NF) method and the reverse osmosis membrane (RO) method in combination, and they may be arranged in series or in parallel to each other. Moreover, the membrane areas thereof and the ratio thereof may be set freely in accordance with the formulation of composition modified milk that is to be produced.

[0019]

In the present invention, the deoxygenation treatment typically involves, but is not particularly limited to, injecting (bubbling) an inert gas such as nitrogen gas or argon gas into concentrated milk, or charging into a tank in a low-pressure or vacuum state concentrated milk after it has been atomized, made into a thin film, etc. In this process, from the viewpoint of simplicity of actual equipment, ease of control, etc., it is preferable to utilize an inert gas. In this case, for example, injecting (bubbling) an inert gas into concentrated milk and charging concentrated milk into a tank in a low-pressure or vacuum state after it has been atomized, made into a thin film, etc. may be employed in combination, and they may be arranged in series or in parallel to each other. In this deoxygenation treatment, for example, the concentration of dissolved oxygen in concentrated milk is preferably no greater than 5 ppm, more preferably no greater than 3 ppm, and yet more preferably no greater than 2 ppm.

The deoxygenation treatment may be provided either before the concentration treatment or after the concentration treatment. It is preferable from the viewpoint of work efficiency to provide the deoxygenation treatment after the concentration treatment.

[0020]

In the present invention, the pasteurization treatment includes, but not particularly limited to, a low temperature long time pasteurization method (LTLT method), a high temperature short time pasteurization method (HTST method), an ultrahigh temperature pasteurization method (UHT method), an ohmic heating pasteurization method (Joule thermal pasteurization method), a alternating current high electrical field pasteurization method, etc.,

and an ultrahigh temperature pasteurization method is preferable from the viewpoint of obtaining composition modified milk, etc. having excellent storage properties, improving the effect of reducing viscosity by a deoxygenation treatment, etc. In the ultrahigh temperature pasteurization method, heating may be carried out at, for example, at 110°C or higher for at least 1 sec., and heating is typically carried out at a temperature of 120°C to 150°C or 130°C to 140°C for a retention time of 1 to 5 sec or 1 to 3 sec.

[0021]

Furthermore, in the present invention, the homogenization treatment includes, but not particularly limited to, a homogenizer, a homomixer, and homodisperser, etc., and from the viewpoint of high efficiency in atomization, etc. a homogenizer (homogenizing machine) is preferable.

In this process, the homogenization treatment is not essential, but by providing it before the pasteurization treatment and/or after the pasteurization treatment it is also possible to suppress oxidation of milk fat or milk protein, to reduce the viscosity of concentrated milk, etc. When the homogenization treatment is provided before the pasteurization treatment, since milk fat can be stabilized by atomizing in a deoxygenated state, oxidation of milk fat or milk protein can be suppressed effectively, and it is preferable from the viewpoint of flavor. On the other hand, when the homogenization treatment is provided after the pasteurization treatment, since milk fat or milk protein is heated, they undergo some denaturing, but even if the viscosity increases, the viscosity can be reduced again, and it is preferable from the viewpoint of physical properties. It is therefore also preferable to carry out the homogenization treatment before the pasteurization treatment and further carry out the homogenization treatment after the pasteurization treatment.

[0022]

In the present invention, the viscosity means, for example, shear viscosity at a shear rate of 0.5 s^{-1} obtained using a dynamic viscoelastometer (Physica MCR301, Anton Paar), and this can be said to express a representative dynamic viscoelasticity at a similar shear rate to that in the stage before

milk is drunk and swallowed (immediately after being placed in the mouth), as explained below. For example, in New Food Industry, 2001, Vol. 43, No. 4, P.24 to 30, the maximum speed of water at the stage when water is drunk and swallowed is measured to be about 0.7 m/s using ultrasound. In this case, as one example, the diameter of the human pharyngeal region is about 14 mm, and it can be estimated therefrom that the shear rate at the stage when water is drunk and swallowed is about 50 s^{-1} . While taking into consideration some difference in viscosity between milk and water, it can be estimated that the shear rate at the stage when milk is drunk and swallowed is a few tens of s^{-1} . That is, a shear rate of 0.5 s^{-1} is clearly smaller than the shear rate at the stage when milk is drunk and swallowed, and it is appropriate to think of it as the shear rate immediately after milk is placed in the mouth.

[0023]

With regard to the viscosity of concentrated milk according to the present invention, the shear viscosity at a shear rate of 0.5 s^{-1} is preferably 20 to 100 mPa·s, more preferably 20 to 55 mPa·s, and yet more preferably 20 to 45 mPa·s.

In this case, in accordance with the process for producing concentrated milk according to the present invention, compared with the conventional production process in which a pasteurization treatment is carried out without a deoxygenation treatment, the shear viscosity at a shear rate of 0.5 s^{-1} is reduced by at least 5 mPa·s, preferably by at least 10 mPa·s, more preferably by at least 20 mPa·s, and yet more preferably by at least 50 mPa·s, and as a result the concentrated milk according to the present invention has a shear viscosity at a shear rate of 0.5 s^{-1} of 20 to 100 mPa·s.

[0024]

The present invention is explained in further detail below by reference to Examples, but the present invention is not limited to these Examples and may be modified in a variety of ways as long as the modification do not depart from the technical scope of the present invention.

[Example 1]

[0025]

[Test Example 1]

Skim milk was subjected to a treatment by a nanofiltration membrane (NF) method so as to be 1.2 times (milk solids-not-fat content: about 10 wt. %), 1.3 times (milk solids-not-fat content: about 11 wt. %), and 1.4 times concentration (milk solids-not-fat content: about 12 wt. %), and cream was added so as to give 1.5 wt. % and 3.0 wt. % cream content, thus preparing samples with predetermined concentrations (formulations). Two samples having the cream content of 3.0 wt. % were prepared, and the concentration rate is 1.3 times for one sample and 1.4 times for the other. After the samples were subjected to a homogenization treatment, each was divided equally into two, that is, one that was subjected to a deoxygenation treatment with nitrogen flushing and one that was not subjected thereto. In those (samples) subjected to the deoxygenation treatment with nitrogen flushing, the dissolved oxygen concentration was 3 ppm. The samples were subjected to a thermal pasteurization treatment (autoclave, 120°C, 1 min), thus preparing concentrated milk (composition modified milk).

Concentrated milk that had been subjected to the pasteurization (heating) treatment was stored at no greater than 10°C, and dynamic viscoelasticity at a shear rate of 0.5 s^{-1} of the concentrated milk and normal milk were each measured at 10°C using a dynamic viscoelastometer (Physica MCR301, Anton Paar).

[0026]

With regard to concentrated milk having the same concentration (same formulation) and subjected to a homogenization treatment before the pasteurization treatment, the shear viscosity was compared for those on which the deoxygenation treatment had been carried out and those on which it had not, as shown in Table 1, and it was confirmed that the shear viscosity decreased for concentrated milk subjected to the deoxygenation treatment. Furthermore, concentrated milk that had not been subjected to the deoxygenation treatment had a higher shear viscosity than that of normal milk, whereas concentrated milk that had been subjected to the deoxygenation treatment had a lower shear viscosity than that of normal milk.

For concentrated milk that had not been subjected to the deoxygenation

treatment, the texture on the tongue was slightly undesirable, whereas concentrated milk that had been subjected to the deoxygenation treatment had richness at the same time as a refreshing feel and a desirable texture on the tongue. Furthermore, concentrated milk that had been subjected to the deoxygenation treatment and had a low milk fat content (Examples 1A, 1B, and 1C) had increased light feel and a new flavor and texture compared with concentrated milk that had been subjected to the deoxygenation treatment and had a relatively high milk fat content (Examples 1D and 1E).

[0027]

[Table 1]

Table 1: Influence of deoxygenation treatment on viscosity of concentrated milk

Sample No.	Concentration ratio	Milk fat content (%)	Deoxygenation treatment carried out	Shear viscosity (mPa·s)	Difference in shear viscosity (mPa·s)
Comp. Ex. 1A	1.2	1.5	No	134.1	64.2
Ex. 1A	1.2	1.5	Yes	69.9	
Comp. Ex. 1B	1.3	1.5	No	188.9	99.3
Ex. 1B	1.3	1.5	Yes	89.6	
Comp. Ex. 1C	1.4	1.5	No	322.6	293.2
Ex. 1C	1.4	1.5	Yes	29.4	
Comp. Ex. 1D	1.3	3.0	No	205.6	111.9
Ex. 1D	1.3	3.0	Yes	93.7	
Comp. Ex. 1E	1.4	3.0	No	157.5	135.5
Ex. 1E	1.4	3.0	Yes	22.0	
Ref. Ex. (normal milk)	1.0	3.5	No	120.7	—

[Example 2]

[0028]

[Test Example 2]

Skim milk was subjected to a treatment by a nanofiltration membrane (NF) method so as to be 1.3 times (milk solids-not-fat content: about 11 wt. %) and 1.4 times concentration (milk solids-not-fat content: about 12 wt. %), and cream was added so as to give 1.5 wt. % and 3.0 wt. %, thus preparing

samples with predetermined concentrations (formulations). The samples were subjected to a deoxygenation treatment with nitrogen flushing and a thermal pasteurization treatment (autoclave, 120°C, 1 min), and then to a homogenization treatment, thus preparing concentrated milk (composition modified milk). In those (samples) subjected to the deoxygenation treatment with nitrogen flushing, the dissolved oxygen concentration was 3 ppm.

Concentrated milk that had been subjected to the pasteurization (heating) treatment was stored at no greater than 10°C, and dynamic viscoelasticity at a shear rate of 0.5 s⁻¹ of each concentrated milk was measured at 10°C using a dynamic viscoelastometer (Physica MCR301, Anton Paar). With regard to concentrated milk having the same concentration (same formulation), the shear viscosities of the Comparative Examples in Table 1, which are shear viscosities without the deoxygenation treatment, were compared with the shear viscosities with the deoxygenation treatment when a homogenization treatment was carried out after the pasteurization treatment, as shown in Table 2, and it was confirmed that the shear viscosity of concentrated milk subjected to the deoxygenation treatment was decreased by carrying out the homogenization treatment after the pasteurization treatment.

[0029]

[Table 2]

Table 2: Influence of homogenization treatment after pasteurization treatment on viscosity of concentrated milk

Sample No.	Concentration ratio	Milk fat content (%)	Deoxygenation treatment carried out	Shear viscosity (mPa·s)
Ex. 2A	1.3	1.5	Yes	43.6
Ex. 2B	1.4	1.5	Yes	31.6
Ex. 2C	1.3	3.0	Yes	54.5
Ex. 2D	1.4	3.0	Yes	21.8

[Example 3]

[0030]

[Test Example 3]

Skim milk was subjected to a treatment by a nanofiltration membrane

(NF) method so as to be 1.3 times concentration, and cream was added so as to give 1.5 wt. % and 3.0 wt. %, thus preparing samples with predetermined concentrations (formulations). The samples were subjected to a deoxygenation treatment with nitrogen flushing. Concentrated milk (composition modified milk) was prepared by carrying out a thermal pasteurization treatment (autoclave, 120°C, 1 min) after a homogenization treatment and by carrying out a homogenization treatment after a thermal pasteurization treatment (autoclave, 120°C, 1 min). In those (samples) subjected to the deoxygenation treatment with nitrogen flushing, the dissolved oxygen concentration was 3 ppm.

Concentrated milk that had been subjected to the pasteurization (heating) treatment was stored at no greater than 10°C, and dynamic viscoelasticity at a shear rate of 0.5 s⁻¹ of each concentrated milk was measured at 10°C using a dynamic viscoelastometer (Physica MCR301, Anton Paar). With regard to concentrated milk having the same concentration (same formulation), the shear viscosity was compared with respect to difference in the order of the pasteurization treatment and homogenization treatment steps, as shown in Table 3, and it was confirmed that the shear viscosity was decreased by carrying out the homogenization treatment after the pasteurization treatment even for concentrated milk having a concentration (formulation) that gave relatively high viscosity even by carrying out the deoxygenation treatment in Test Example 1.

[0031]

[Table 3]

Table 3: Influence of homogenization treatment on viscosity of concentrated milk

Sample No.	Concentration ratio	Milk fat content (%)	Homogenization treatment	Shear viscosity (mPa·s)	Difference in shear viscosity (mPa·s)
Ex. 1A	1.3	1.5	Before pasteurization	89.6	46.0
Ex. 2A	1.3	1.5	After pasteurization	43.6	
Ex. 1C	1.3	3.0	Before pasteurization	93.7	39.2

Ex. 2C	1.3	3.0	After pasteurization	54.5	
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[Example 4]

[0032]

[Test Example 4]

Skim milk was subjected to a treatment by a nanofiltration membrane (NF) method so as to be 1.2 times (milk solids-not-fat content: about 10 wt. %) and 1.4 times concentration (milk solids-not-fat content: about 12 wt. %), and cream was not added, thus preparing samples as fat-free milk. Each sample was divided equally into two, one being subjected to a deoxygenation treatment with nitrogen flushing and one not being subjected thereto. In those (samples) subjected to the deoxygenation treatment with nitrogen flushing, the dissolved oxygen concentration was 3 ppm. The samples were subjected to a thermal pasteurization treatment (autoclave, 120°C, 1 min), thus preparing concentrated milk (composition modified milk).

Concentrated milk that had been subjected to the pasteurization (heating) treatment was stored at no greater than 10°C, dynamic viscoelasticity at a shear rate of 0.5 s^{-1} of the concentrated milk and normal milk was measured at 10°C using a dynamic viscoelastometer (Physica MCR301, Anton Paar).

[0033]

With regard to the concentrated milk having the same concentration (same formulation) and subjected to a homogenization treatment before the pasteurization treatment, the shear viscosity was compared for those on which the deoxygenation treatment had been carried out and those on which it had not, as shown in Table 4, and it was confirmed that the shear viscosity decreased for concentrated milk subjected to the deoxygenation treatment. Furthermore, concentrated milk that had not been subjected to the deoxygenation treatment had a higher shear viscosity than that of normal milk or concentrated milk that contained milk fat but had not been subjected to the deoxygenation treatment shown in Test Example 1, whereas concentrated milk that had been subjected to the deoxygenation treatment had a lower shear viscosity than that of normal milk.

For concentrated milk that had not been subjected to the deoxygenation treatment, the texture on the tongue was slightly undesirable, whereas concentrated milk that had been subjected to the deoxygenation treatment had richness at the same time as a refreshing feel and a desirable texture on the tongue.

[0034]

[Table 4]

Table 4: Influence of deoxygenation treatment of fat-free milk on viscosity of concentrated milk

Sample No.	Concentration ratio	Milk fat content (%)	Deoxygenation treatment carried out	Shear viscosity (mPa·s)	Difference in shear viscosity (mPa·s)
Comp. Ex. 3A	1.2	0.0	No	223.0	167.5
Ex. 3A	1.2	0.0	Yes	55.5	
Comp. Ex. 3B	1.4	0.0	No	290.0	279.5
Ex. 3B	1.4	0.0	Yes	10.5	

Industrial Applicability

[0035]

In accordance with the present invention, even for concentrated milk having a high milk solids-not-fat content, by adjusting the shear viscosity at a shear rate of 0.5 s^{-1} so as to be 20 to 100 mPa·s, concentrated milk having a desirable texture on the tongue can be obtained, and milk and the like that satisfy all of the three important elements that consumers desire for milk (and the like), that is, 'naturalness', 'palatability', and 'nutrition/function' can be provided.

Claims

[Claim 1]

Concentrated milk having milk solids-not-fat content of 10 to 14 wt % and having a shear viscosity of 20 to 100 mPa·s at a shear rate of 0.5 s^{-1} .

[Claim 2]

The concentrated milk according to Claim 1, wherein the milk fat content is no greater than 3 wt. %.

[Claim 3]

A process for producing concentrated milk, comprising a step of subjecting starting milk to a deoxygenation treatment before and/or after subjecting starting milk to a concentration treatment, and subsequently carrying out a pasteurization treatment.

[Claim 4]

The production process according to Claim 3, wherein it further comprises a step of carrying out a homogenization treatment.

[Claim 5]

The production process according to Claim 3 or 4, wherein it further comprises a step of adjusting the milk fat content to no greater than 3 wt. %.

[Claim 6]

The production process according to any one of Claims 3 to 5, wherein the concentration treatment is a membrane concentration treatment.

[Claim 7]

The production process according to Claim 6, wherein the membrane concentration treatment is an NF membrane treatment.