

DESCRIPTION

Title of Invention: VISCOUS NUTRITIONAL COMPOSITION

Technical Field

[0001]

The present invention relates to a viscous nutritional composition. More specifically, the present invention relates to a nutritional composition having a flow characteristic that is preferable in managing the dosing rate.

Background Art

[0002]

Liquid foods with low viscosity are known to cause gastroesophageal reflux in feeding by percutaneous endoscopic gastrostomy tube, by which food is directly administered into the stomach. As a countermeasure for this, a method of administering a semi-solid liquid food having a viscosity of 4000 to 20,000 mPa·s (12 rpm) in a short time is often implemented. In fact, there is an increasing number of patients who experience symptomatic improvement after attempts of such a feeding method, and it has also been widely recognized that direct feeding of liquid into the stomach may not be physiologically preferable.

[0003]

On the other hand, the conventional technique of free-fall feeding is not applicable when such high-viscosity semi-solid liquid food is administered. In such cases, it is necessary to administer the composition through procedures such as injection by syringe which is burdensome and laborious. Accordingly, there was a problem that the burden imposed on nurses and caregivers was heavy.

[0004]

In percutaneous endoscopic gastrostomy (PEG), which is one of the methods of enteral feeding, a dosing rate of 100 to 200 ml/hr is presumed to be desirable from the viewpoint of preventing diarrhea and reflux of liquid foods. In this regard, a technique involving pushing

down a liquid food having an extremely high viscosity by hand is alternatively used. However, the possibility of the risk of medical accidents is pointed out due to lack of a method defined by guidelines.

[0005]

In view of the above, there is a need for a liquid food that can be fed by free-fall feeding, which is a widely implemented technique, and has a more physiologically favorable viscous property than a liquid food having very low viscosity.

[0006]

However, there is a problem of the occurrence of diarrhea with feeding of a rich liquid food through a tube. Causes of diarrhea include dosing rate, osmotic pressure, bacterial infection, composition, and the like. It is also reported that even when a liquid food with high osmotic pressure is administered, occurrence of diarrhea can be prevented by adjusting the dosing rate (Non Patent Literature 1). As shown above, management of the dosing rate plays a key role in maintaining QOL in patients receiving liquid foods.

[0007]

It should be noted that Non Patent Literature 1 states that because the incidence rate of diarrhea is high at 400 ml/hour, which is faster than the standard rate, it is necessary to select a food containing a dietary fiber. However, this description is based on an assumption that tube feeding is given at a rate higher than the standard rate. Furthermore, the above description is directed to the addition of a dietary fiber with the intention to reduce the incidence rate of diarrhea, and therefore, the description is totally irrelevant to the changes in the flow characteristics of nutritional agents. Moreover, Non Patent Literature 1 lacks specific descriptions as to what type of dietary fiber should be added.

[0008]

With regard to a semi-solidifying agent for nutritional agents given to patients with PEG by enteral feeding, JP Patent Publication (Kokai) No. 2010-065013 A (Patent Literature 1) describes a semi-solidifying agent for nutritional agents given to patients with PEG by enteral feeding, characterized by containing kappa carrageenan in which a part of the molecule is replaced by iota carrageenan. This literature discloses, as the definition of "semi-

solidified", that "Semi-solidified used herein refers to the state in which an agent is gel-like while standing but is formed into a homogeneous paste when deformed or subjected to a force". The above literature discloses that the semi-solid nutritional agent for enteral feeding described therein is characterized in that when 25 ml of the semi-solid nutritional agent for enteral feeding is put in a 50 ml syringe with an inner diameter of 30 mm and the syringe is connected to a tube with an inner diameter of 4 mm and a length of 300 mm, and the agent is pushed down by 35 mm into the tube at a rate of 5 mm/second using a jig, the stress applied is 20000 N/m² or less.

[0009]

JP Patent Publication (Kokai) No. 2007-295877 A (Patent Literature 2) describes a milk protein-containing gel-like nutritional composition, characterized by containing a gelling agent and a multivalent metal salt and being subjected to heat-sterilization treatment.

[0010]

JP Patent Publication (Kokai) No. 2004-261063 A (Patent Literature 3) describes an emulsifier for a milk component-containing gel-like food, containing organic acid esters of glycerol such as citric and fatty acid esters of glycerol. This literature also describes a method for producing a milk component-containing gel-like food as exemplified by milk pudding, including the step of adding an emulsifier prior to the heat sterilization step and then applying heat sterilization, and then solidifying a milk component-containing gel-like food by slow cooling.

[0011]

JP Patent Publication (Kokai) No. 2007-289164 A (Patent Literature 4) describes, as a method for producing a liquid food, a method for producing a liquid food having a certain viscosity. According to this document, the method includes producing a preparation having a certain viscosity in which a thickening agent is homogeneously dispersed and then subjecting the solution thus prepared to retort sterilization by heating. In this literature, tamarind gum is primarily used as the thickening agent.

[0012]

JP Patent Publication (Kokai) No. 2000-262239 A (Patent Literature 5) describes a liquid seasoning prepared with a combination of an alpha starch, a polysaccharide thickener, and an insoluble plant fiber and a method for producing the same. According to this literature, a liquid obtained by subjecting the above liquid seasoning and a base to heat sterilization at 80 to 95°C for three to 90 minutes has a viscous property close to a Newtonian fluid (Claims 1 and 3, paragraph [0010]). In paragraph [0017], there is a description that unlike ordinary chemically modified starch, a seasoning having a viscous property close to a Newtonian fluid was obtained without developing a paste-like viscosity by using a coarse-particle alpha starch in combination with a porous, insoluble plant fiber. That is, in the seasoning described in this literature, an alpha starch is an essential component. In Working Examples, there is also a description that a liquid having a reduced thread-forming property was obtained. There is no description as to quantified physical property values or objective indexes of the Newtonian fluid properties of the seasoning disclosed therein.

[0013]

However, none of these Patent Literatures 1 to 5 either describes or suggests a flow characteristic that is preferable in managing the dosing rate.

[0014]

So far, as a food exhibiting the Newtonian fluidity, for example, foods in a solution state such as rapeseed oil (approximately 10^2 to 10^3 mPa·s), gum syrup (approximately 10^2 to 10^3 mPa·s), starch syrup (approximately 10^5 to 10^6 mPa·s), and glucose syrup (approximately 10^5 to 10^6 mPa·s) and a dispersion liquid food product with a low-density dispersion phase such as milk (approximately 0 to 10 mPa·s) are known (it is to be noted that the aforementioned viscosities were all measured under the conditions of a shear rate of 1 to 50s^{-1} and 20°C). However, many liquid food products exhibit non-Newtonian fluid behavior. For example, a dessert gel is known to exhibit pseudoplastic flow behavior (Non Patent Literature 2).

[0015]

Newtonian fluids are known to have a constant viscosity irrespective of a shear rate. In contrast, Non-Newtonian fluids have a high viscosity at a low shear rate but the viscosity

decreases with an increase in the shear rate. In other words, the viscosity of Non-Newtonian fluids is not constant but varies according to the shear rate. In general, this phenomenon is called shear thinning. Due to shear thinning, the viscosity of a non-Newtonian liquid food decreases when it is dripped at high speed, resulting in a rapid dose increase. As a result, inconveniently, one becomes prone to develop diarrhea, and also, the chance of esophageal reflux is increased. On the other hand, when a button type mount with a bumper to be fixed inside the stomach is used for feeding a non-Newtonian liquid food via percutaneous endoscopic gastrostomy (PEG), the liquid food rapidly slows down after hitting a backflow prevention valve in the button, while the viscosity rapidly increases correspondingly. As a result, inconveniently, the flow of the liquid food inside the mount becomes sluggish. There were further problems that as the remaining dose decreased, the flow rate decreased correspondingly or dripping stopped, etc.

Citation List

Patent Literature

[0016]

Patent Literature 1: JP Patent Publication (Kokai) No. 2010-065013 A

Patent Literature 2: JP Patent Publication (Kokai) No. 2007-295877 A

Patent Literature 3: JP Patent Publication (Kokai) No. 2004-261063 A

Patent Literature 4: JP Patent Publication (Kokai) No. 2007-289164 A

Patent Literature 5: JP Patent Publication (Kokai) No. 2000-262239 A

Non Patent Literature

[0017]

Non Patent Literature 1: Nihon Ryudoshoku Kyokai (Japan Liquid Food Association), [online], [Searched on March 9, 2011], How to use liquid food, Internet address < URL:http://www.ryudoshoku.org/tukaikata_1p.html>

Non Patent Literature 2: Supervised by Toshiaki Nakae, "Chapter 3, Food Industry", Rheology Engineering and Applied Technology, published by FUJITECHNOSYSTEM Co., Ltd., 450 to year 2001

Summary of Invention

Technical Problem

[0018]

An objective of the present invention is to provide a nutritional composition having a low shear thinning characteristic. That is, an objective of the present invention is to provide a composition having a flow characteristic closer to a Newtonian fluid, in which the viscosity does not readily decrease even when the shear rate increases.

Solution to Problem

[0019]

The present inventors achieved the objective above by preparing a nutritional composition with a rich nutritional formulation and emulsifying the resulting nutritional composition, and additionally using an adjuvant that imparts a viscous property but not a shear thinning characteristic in combination.

[0020]

While a nutritional composition having a rich nutritional formulation has a certain degree of viscosity by itself, when it is emulsified by homogenization treatment and the like, it attains a property such that it has a characteristic closer to a Newtonian fluid. However, designing a rich nutritional formulation alone is not enough to achieve a viscosity sufficient as a nutritional composition for nutritional agents given to patients with PEG by enteral feeding. In light of the above, the present inventors found that the combined use of the aforementioned rich nutritional composition and an adjuvant that imparts a viscous property but not a shear thinning characteristic enables increasing the viscosity of a heat-treated nutritional composition, while maintaining a characteristic closer to a Newtonian fluid, whereby a composition suitable as a nutritional agent for enteral feeding was successfully obtained. The present inventors accomplished inventing the present invention based on the foregoing findings.

[0021]

That is, the present invention enables a reduction in the amount of substance that imparts a shear thinning characteristic necessary for imparting a certain degree of viscosity (such as a thickening agent) by using a water-absorbing adjuvant that imparts a viscous property but not a shear thinning characteristic, which reduces free water in a composition. Alternatively, the present invention enables an increase in the viscosity of a nutritional composition while maintaining a characteristic close to a Newtonian fluid by using, among the aforementioned adjuvants, one that imparts viscosity to an aqueous solution while having a characteristic closer to a Newtonian fluid. By doing so, a shear thinning characteristic (also called pseudoplastic fluidity) attributable to a thickening agent and the like contained in a composition can be suppressed, whereby the provision of a nutritional composition having a low shear thinning characteristic was made possible. It is also possible to adjust the viscosity of the aforementioned composition post heat treatment by adjusting the homogenization treatment pressure.

[0022]

Thus, in a first aspect, the present invention refers to a nutritional composition having a fluidization characteristic comprising a water-absorbing dietary fiber in an amount of 0.10 to 1.50% by weight of the nutritional composition, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate 0.1/s to 1000/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index,

the value of n is 0.3 to 1.0 and the viscosity at a shear rate of 10/s (25°C) is 150 mPa·s or more, wherein the water-absorbing dietary fiber is an insoluble dietary fiber.

In a second aspect, the present invention refers to a nutritional composition having a fluidization characteristic comprising a water-absorbing dietary fiber in an amount of 0.10 to 1.50% by weight of the nutritional composition, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 100/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index,

the value of n is 0.4 to 0.8 and the viscosity at a shear rate of 10/s (25°C) is 150 to 1000 mPa·s or more, wherein the water-absorbing dietary fiber is an insoluble dietary fiber.

In a third aspect, the present invention refers to a nutritional composition having a fluidization characteristic comprising an adjuvant selected from the group consisting of a water-absorbing dietary fiber in an amount of 0.10 to 1.50% by weight of the nutritional composition, a thickening agent that does not have a network structure in an aqueous solution in an amount of 0.10 to 1.50% by weight of the nutritional composition, and a starch not having been subjected to pregelatinization treatment in advance in an amount of 0.10 to 1.50% by weight of the nutritional composition, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate 0.1/s to 1000/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index,

the value of n is 0.3 to 1.0 and the viscosity at a shear rate of 10/s (25°C) is 150 mPa·s or more,

wherein a homogenization treatment is performed prior to a heat treatment by adjusting the homogenization treatment pressure to 10 to 100 MPa, and wherein said heat treatment is used to produce the nutritional composition.

In a fourth aspect, the present invention refers to a nutritional composition having a fluidization characteristic comprising an adjuvant selected from the group consisting of a water-absorbing dietary fiber in an amount of 0.10 to 1.50% by weight of the nutritional composition, a thickening agent that does not have a network structure in an aqueous solution in an amount of 0.10 to 1.50% by weight of the nutritional composition, and a starch not having been subjected to pregelatinization treatment in advance in an amount of 0.10 to 1.50% by weight of the nutritional composition, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 100/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index,

the value of n is 0.4 to 0.8 and the viscosity at a shear rate of 10/s (25°C) is 150 to 1000 mPa·s or more,

wherein a homogenization treatment is performed prior to a heat treatment by adjusting the homogenization treatment pressure to 10 to 100 MPa, and wherein said heat treatment is used to produce the nutritional composition.

In a fifth aspect, the present invention refers to a method for producing a nutritional composition having a fluidization characteristic comprising an adjuvant, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 1000/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index,

the value of n is 0.3 to 1.0 and the viscosity at a shear rate of 10/s (25°C) is 150 mPa·s or more, comprising the steps of:

i) preparing an adjuvant selected from the group consisting of a water-absorbing dietary fiber, a thickening agent that does not have a network structure in an aqueous solution, and a starch not having been subjected to pregelatinization treatment in advance, wherein said adjuvant is 0.10 to 5.00% by weight relative to the nutritional composition,

ii) applying pressure treatment for homogenization, and

iii) applying heat treatment,

wherein the viscosity of the composition prior to the heat treatment is 5 to 300 mPa·s, wherein the viscosity of the composition prior to the heat treatment is measured at 45 to 85°C and 12 rpm using a spindle type rotational viscometer, and the homogenization treatment pressure in the step of applying pressure treatment for homogenization is 10 to 100 MPa, and the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature of 15 to 25°C for 1 to 90 days is 300 to 3000 mPa·s, wherein the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature of 15 to 25°C for 1 to 90 days is measured at 20°C and 12 rpm using a spindle type rotational viscometer.

In a sixth aspect, the present invention refers to a method for producing a nutritional composition having a fluidization characteristic, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 100/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index,

the value of n is 0.4 to 0.8 and the viscosity at a shear rate of 10/s (25°C) is 150 to 1000 mPa·s, comprising the steps of:

- i) preparing an adjuvant selected from the group consisting of a water-absorbing dietary fiber, a thickening agent that does not have a network structure in an aqueous solution, and a starch not having been subjected to pregelatinization treatment in advance, wherein said adjuvant is 0.10 to 5.00% by weight relative to the nutritional composition,
- ii) applying pressure treatment for homogenization, and
- iii) applying heat treatment,

wherein the viscosity of the composition prior to the heat treatment is 5 to 300 mPa·s, wherein the viscosity of the composition prior to the heat treatment is measured at 45 to 85°C and 12 rpm using a spindle type rotational viscometer, and the homogenization treatment pressure in the step of applying pressure treatment for homogenization is 10 to 100 MPa, and the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature of 15 to 25°C for 1 to 90 days is 300 to 3000 mPa·s, wherein the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature of 15 to 25°C for 1 to 90 days is measured at 20°C and 12 rpm using a spindle type rotational viscometer.

[0023]

1. Also described herein is a nutritional composition having a fluidization characteristic comprising an adjuvant that imparts a viscous property but not a shear thinning characteristic, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 1000/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index, the value of n is 0.3 to 1.0 and the viscosity at a shear rate of 10/s (25°C) is 150 mPa·s or more.
[0024]

2. Further described herein is a nutritional composition having a fluidization characteristic comprising an adjuvant that imparts a viscous property but not a shear thinning characteristic, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more

measurement points in a shear rate range of shear rate of 0.1/s to 100/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index, the value of n is 0.4 to 0.8 and the viscosity at a shear rate of 10/s (25°C) is 150 to 1000 mPa·s or more.

[0025]

3. Also described herein is the nutritional composition having a fluidization characteristic according to 1 or 2, wherein the adjuvant that imparts a viscous property but not a shear thinning characteristic is selected from the group consisting of a water-absorbing dietary fiber, a thickening agent that does not have a network structure in an aqueous solution, and a starch not having been subjected to pregelatinization treatment in advance.

[0026]

4. Also described herein is the nutritional composition having a fluidization characteristic according to any of 1 to 3, comprising the adjuvant that imparts a viscous property but not a shear thinning characteristic according to any of 1 to 3 in an amount of 0.10 to 5.00% by weight relative to the nutritional composition, and having a property such that viscosity thereof is increased by heat treatment.

[0027]

5. Also described herein is the nutritional composition having a fluidization characteristic according to any of 1 to 4, wherein the adjuvant that imparts a viscous property but not a shear thinning characteristic is a water-absorbing dietary fiber.

[0028]

6. Further described herein is the nutritional composition having a fluidization characteristic according to any of 3 to 5, wherein the water-absorbing dietary fiber is an insoluble dietary fiber.

[0029]

7. Also described herein is the nutritional composition having a fluidization characteristic according to any of 3 to 6, wherein the water-absorbing dietary fiber is an insoluble fiber of a *fusuma* bran dietary fiber of a cereal.

[0030]

8. Also described herein is the nutritional composition having a fluidization characteristic according to any of 3 to 7, wherein the water-absorbing dietary fiber is an insoluble fiber of soybean dietary fiber and/or soybean *fusuma* bran.

[0031]

9. Also described herein is the nutritional composition having a fluidization characteristic according to any of 1 to 4, wherein the adjuvant that imparts a viscous property but not a shear thinning characteristic is a thickening agent that does not have a network structure in an aqueous solution.

[0032]

10. Also described herein is the nutritional composition having a fluidization characteristic according to 9, wherein the thickening agent that does not have a network structure in an aqueous solution is a thickening agent selected from the group consisting of ι-carrageenan, λ-carrageenan, locust bean gum, guar gum, psyllium seed gum, and tamarind seed gum.

[0033]

11. Also described herein is the nutritional composition having a fluidization characteristic according to any of 1 to 4, wherein the adjuvant that imparts a viscous property but not a shear thinning characteristic is a starch not having been subjected to pregelatinization treatment in advance.

[0034]

12. Also described herein is the nutritional composition having a fluidization characteristic according to any of 1 to 11, comprising one or more from the group consisting of protein, lipid, and sugar, wherein the specific gravity of the composition is 1.06 to 1.5.

[0035]

13. Also described herein is the nutritional composition having a fluidization characteristic according to any of 1 to 12, comprising one or more from the group consisting of a thickening agent and an emulsifier.

[0036]

14. Also described herein is the nutritional composition having a fluidization characteristic according to any of 1 to 13, wherein the viscosity of the composition is 5 to 300 mPa·s, wherein the viscosity of the composition is measured at 45 to 85°C and 12 rpm using a spindle type rotational viscometer.

[0037]

15. Also described herein is the nutritional composition having a fluidization characteristic according to any of 1 to 14, wherein homogenization treatment is performed by adjusting the homogenization treatment pressure to 10 to 100 MPa.

[0038]

16. Also described herein is the nutritional composition having a fluidization characteristic according to any of 1 to 15, wherein the viscosity of the composition reaches 300 to 3000 mPa·s by subjecting the composition to heat treatment and then storing the composition at a temperature equal to or below normal temperature for 1 to 90 days, wherein the viscosity of the composition is measured at 20°C and 12 rpm using a spindle type rotational viscometer.

[0039]

17. Also described herein is a nutritional composition having a fluidization characteristic comprising an adjuvant that imparts a viscous property but not a shear thinning characteristic, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 1000/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index, the value of n is 0.3 to 1.0 and the viscosity at a shear rate of 10/s (25°C) is 150 mPa·s or more, and

wherein the composition has been subjected to heat treatment and then stored at a temperature equal to or below normal temperature for 1 to 90 days.

[0040]

18. Also described herein is a nutritional composition having a fluidization characteristic comprising an adjuvant that imparts a viscous property but not a shear thinning characteristic, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 100/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index, the value of n is 0.4 to 0.8 and the viscosity at a shear rate of 10/s (25°C) is 150 mPa·s or more, and

wherein the composition has been subjected to heat treatment and then stored at a temperature equal to or below normal temperature for 1 to 90 days.

[0041]

19. Also described herein is a method for producing a viscous nutritional composition, comprising the steps of:

- i) preparing an adjuvant that imparts a viscous property but not a shear thinning characteristic selected from the group consisting of a water-absorbing dietary fiber, a thickening agent that does not have a network structure in an aqueous solution, and a starch not having been subjected to pregelatinization treatment in advance, wherein said adjuvant is 0.10 to 5.00% by weight relative to the nutritional composition,
- ii) applying pressure treatment for homogenization, and
- iii) applying heat treatment,

wherein the viscosity of the composition prior to the heat treatment is 5 to 300 mPa·s, wherein the viscosity of the composition prior to the heat treatment is measured at 45 to 85°C and 12 rpm using a spindle type rotational viscometer, and the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature for 1 to 90 days is 300 to 3000 mPa·s, wherein the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature for 1 to 90 days is measured at 20°C and 12 rpm using a spindle type rotational viscometer.

[0042]

20. Also described herein is a method for producing a viscous nutritional composition, comprising the steps of:

- i) preparing an adjuvant that imparts a viscous property but not a shear thinning characteristic selected from the group consisting of a water-absorbing dietary fiber, a thickening agent that does not have a network structure in an aqueous solution, and a starch not having been

subjected to pregelatinization treatment in advance, wherein said adjuvant is 0.10 to 5.00% by weight relative to the nutritional composition,

ii) applying pressure treatment for homogenization, and

iii) applying heat treatment,

wherein the viscosity of the composition prior to the heat treatment is 5 to 300 mPa·s, wherein the viscosity of the composition prior to the heat treatment is measured at 45 to 85°C and 12 rpm using a spindle type rotational viscometer, and the homogenization treatment pressure in the step of applying pressure treatment for homogenization is 10 to 100 MPa, and the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature for 1 to 90 days is 300 to 3000 mPa·s, wherein the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature for 1 to 90 days is measured at 20°C and 12 rpm using a spindle type rotational viscometer.

[0043]

21. Also described herein is a method for producing a nutritional composition having a fluidization characteristic comprising an adjuvant that imparts a viscous property but not a shear thinning characteristic, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 1000/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index, the value of n is 0.3 to 1.0 and the viscosity at a shear rate of 10/s (25°C) is 150 mPa·s or more, comprising the steps of:

i) preparing an adjuvant that imparts a viscous property but not a shear thinning characteristic selected from the group consisting of a water-absorbing dietary fiber, a thickening agent that does not have a network structure in an aqueous solution, and a starch not having been subjected to pregelatinization treatment in advance, wherein said adjuvant is 0.10 to 5.00% by weight relative to the nutritional composition,

ii) applying pressure treatment for homogenization, and

iii) applying heat treatment,

wherein the viscosity of the composition prior to the heat treatment is 5 to 300 mPa·s, wherein the viscosity of the composition prior to the heat treatment is measured at 45 to 85°C and 12 rpm using a spindle type rotational viscometer, and the homogenization treatment pressure in the step of applying pressure treatment for homogenization is 10 to 100 MPa, and the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature for 1 to 90 days is 300 to 3000 mPa·s, wherein the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature for 1 to 90 days is measured at 20°C and 12 rpm using a spindle type rotational viscometer.

[0044]

22. Also described herein is a method for producing a nutritional composition having a fluidization characteristic, wherein the composition is prepared so that when results of measurement of viscosity at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 100/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index, the value of n is 0.4 to 0.8 and the viscosity at a shear rate of 10/s (25°C) is 150 to 1000 mPa·s, comprising the steps of:

i) preparing an adjuvant that imparts a viscous property but not a shear thinning characteristic selected from the group consisting of a water-absorbing dietary fiber, a thickening agent that does not have a network structure in an aqueous solution, and a starch not having been subjected to pregelatinization treatment in advance, wherein said adjuvant is 0.10 to 5.00% by weight relative to the nutritional composition,

ii) applying pressure treatment for homogenization, and

iii) applying heat treatment,

wherein the viscosity of the composition prior to the heat treatment is 5 to 300 mPa·s, wherein the viscosity of the composition prior to the heat treatment is measured at 45 to 85°C and 12 rpm using a spindle type rotational viscometer, and the homogenization treatment pressure in the step of applying pressure treatment for homogenization is 10 to 100 MPa, and the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature for 1 to 90 days is 300 to 3000 mPa·s, wherein the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature for 1 to 90 days is measured at 20°C and 12 rpm using a spindle type rotational viscometer.

[0045]

The present application encompasses the contents described in the specification and/or drawings of JP Patent Application No. 2011-108857, based on which the priority of the present application is claimed.

Advantageous Effects of Invention

[0046]

The use of an adjuvant that imparts a viscous property but not a shear thinning characteristic enables the provision of a nutritional composition which maintains a viscosity at which the production thereof is facilitated from the step of mixing raw materials to the step of filling a container with the resulting mixture, and which, after heat treatment, has a viscosity suitable for tube feeding by free fall. In other words, the nutritional composition of the present invention can be easily produced and administered by tube. Also, compared to a composition in which the viscosity is increased primarily by a thickening agent, the viscosity of the nutritional composition of the present invention before heat treatment can be kept low, whereby the production thereof is facilitated. Further, a water-absorbing dietary fiber and a starch not having been subjected to pregelatinization treatment in advance contained in the aforementioned adjuvant that imparts a viscous property but not a shear thinning characteristic can reduce free water in the nutritional composition by virtue of their water-absorbing action, whereby the content of a substance that imparts a shear thinning characteristic necessary for

imparting a certain degree of viscosity (such as a thickening agent) can be kept lower than that in conventional products. The thickening agent that does not have a network structure in an aqueous solution and starch not having been subjected to pregelatinization treatment in advance contained in the aforementioned adjuvant that imparts a viscous property but not a shear thinning characteristic do not have a network structure in an aqueous solution, thereby

capable of imparting viscosity to the aqueous solution, while attaining a characteristic closer to a Newtonian fluid.

[0047]

Also, by preparing the nutritional composition with a rich nutritional formulation and emulsifying this by homogenization treatment and the like, the resulting nutritional composition attains a characteristic closer to a Newtonian fluid, while retaining a certain degree of viscosity.

[0048]

By virtue of the aforementioned characteristics, also when a composition having a similar degree of viscosity to conventional products is produced, a shear thinning characteristic attributable to a substance that imparts a shear thinning characteristic such as a thickening agent can be reduced. Accordingly, a nutritional composition having a low shear thinning characteristic and is closer to the Newtonian viscous property can be obtained by the present invention. That is, due to the characteristic closer to a Newtonian fluid, the decrease of viscosity of the nutritional composition of the present invention is relatively low despite increase of shear rate, and consequently, the problem of occurrence of diarrhea and esophageal reflux associated with rapid dose increase caused by increased dripping rate is less likely to occur. Further, even at a low shear rate, the viscosity does not increase very much, and therefore, problems such as clogging of the liquid food inside the feeding apparatus are less likely to occur. In other words, the present invention provides an advantage that variation in time required for dripping attributable to the method of feeding by dripping or dripping apparatus is less likely to occur, whereby the procedure and management of feeding can be simplified. Moreover, there are economic advantages that some of the raw materials can be cut down.

Brief Description of Drawings

[0049]

[Figure 1] Figure 1 shows the relationship between the shear rate and viscosity of the Formulations 1, 2, 3, and 4 of the present invention and a commercially available liquid food

(the viscosity was measured under the conditions of a gap of 1 mm, 25°C, a shear rate of 1 to 100/s using the rheometer Physica MCR301 (Anton Paar) with a cone plate having a diameter of 25 mm). The commercially available liquid food is represented by black diamonds, Formulation 1 by white squares, Formulation 2 by white triangles, Formulation 3 by ×, and Formulation 4 by white circles, respectively.

[Figure 2] Figure 2 shows the relationship between the shear rate and sheer stress in the Formulations 1, 2, 3, and 4 of the present invention and a commercially available liquid food. The commercially available liquid food is represented by black diamonds, Formulation 1 by white squares, Formulation 2 by white triangles, Formulation 3 by ×, and Formulation 4 by white circles, respectively.

[Figure 3] Figure 3 shows a schematic diagram of the apparatus used in the dripping test.

[Figure 4] Figure 4 shows the results of measurement of the dripping rate of the Formulations 1 and 2 of the present invention and a commercially available liquid food. White squares, circles, and triangles represent the commercially available liquid food, Formulation 1, and Formulation 2, all were administered by tube, respectively. Black (solid) squares, circles, and triangles represent the commercially available liquid food, Formulation 1, and Formulation 2, all were administered via button, respectively.

Description of Embodiments

[0050]

The nutritional composition of the present invention is based on the novel finding that a low shear thinning characteristic is successfully obtained by using an adjuvant that imparts a viscous property but not a shear thinning characteristic. Further, the present invention is based on the novel finding that a nutritional composition having a high calorific value but a low shear thinning characteristic is successfully obtained by preparing a nutritional composition with a rich nutritional formulation and emulsifying this by means such as homogenization treatment with the use of an adjuvant that imparts a viscous property but not a shear thinning characteristic.

[0051]

The low shear thinning characteristic as used herein refers to a characteristic of a liquid such that when it is expressed by the viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), which is a value obtained by multiplying the viscosity value by the shear rate value, D represents a shear rate, μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index, and the viscosity (25°C, Pa·s) is measured under the conditions of a gap of 1 mm, 25°C, a shear rate of 0.1 to 1000/s, for example 1 to 100/s, using the rheometer Physica MCR301 (Anton Paar) with a cone plate having a diameter of 25 mm,

the non-Newtonian viscosity index n is relatively close to 1 and the liquid behaves in a manner similar to a Newtonian fluid. The non-Newtonian viscosity index n being close to 1 means that in comparison with n of conventional nutritional compositions, n of the nutritional composition of the present invention is closer to 1. For example, if n of a conventional nutritional composition is less than 0.3 while n of the nutritional composition of the present invention is 0.4 to 1.0, then it can be said that the non-Newtonian viscosity index n is relatively close to 1. Due to the shear thinning phenomenon, the viscosity of a non-Newtonian fluid is not constant but varies according to the shear rate. Accordingly, in the present specification, the fluidization characteristic of the nutritional composition of the present invention was expressed by a range of non-Newtonian viscosity index n obtained from the relationship between at least two points of shear rate and the shear stress calculated from the viscosity at those shear rates. This expression is merely provided for sake of facilitating the understanding of the present invention. For example, merely for the sake of convenience, the range of shear rate in which measurement is made can be from 0.1 to 100/s or 1 to 100/s according to the device used. Those skilled in the art will understand that an effect achieved by an embodiment of the present invention is indicated by the non-Newtonian viscosity index n obtained from the relationship between the shear rate and shear stress and is not limited by the range of shear rate exemplified as above. Also, the shear stress (Pa) is calculated by multiplying the viscosity (Pa·s) by the shear rate (1/s). However, when a commercially available rheometer equipped with automatic calculation function is used, the shear stress

value on the display may be used without any problem. It is also possible to use the value calculated by multiplying the viscosity (Pa·s) by the shear rate (1/s).

[0052]

Also, in the present invention, in the measurement of the viscosity, the shear rate and viscosity are measured using the rheometer Physica MCR301 (Anton Paar) with a cone plate having a diameter of 25 mm and a gap of 1 mm. However, this is no more than an example, and needless to say, any commercially available rheometer that can measure the shear stress or viscosity at a certain shear rate can be used.

[0053]

In the present specification, an adjuvant that imparts a viscous property but not a shear thinning characteristic refers to a substance that imparts a viscous property to the composition to which the substance is added without lowering the non-Newtonian viscosity index n very much. For example, the adjuvant that imparts a viscous property but not a shear thinning characteristic refers to an adjuvant such that when it is added to a nutritional composition in an amount of 0.10 to 5.00% by weight of the composition, it does not lower the non-Newtonian viscosity index n of the nutritional composition below 0.3 after heat treatment and storage. Examples of the adjuvant that imparts a viscous property but not a shear thinning characteristic of the present invention include, but are not limited to, a water-absorbing dietary fiber; a thickening agent that does not have a network structure in an aqueous solution, and a starch not having been subjected to pregelatinization treatment in advance. The adjuvant that imparts a viscous property but not a shear thinning characteristic of the present invention is preferably one in which water absorbency is increased by heat treatment.

[0054]

In the present specification, examples of heat treatment include not only heat sterilization to be described later, but also heat treatment at 70°C or higher for several minutes or longer or heat treatment at 80°C or higher for several minutes or longer. However, heat treatment is not limited to those mentioned above as long as the treatment is conducted under the conditions of a temperature and retention time that are as bactericidal as or more

bactericidal than the aforementioned heat treatments or a temperature and retention time that are known to be effective as thermal history by heating.

[0055]

The adjuvant that imparts a viscous property but not a shear thinning characteristic of the present invention may be subjected to heat treatment with protein, lipid, sugar, or the like. Alternatively, it is also possible to subject the adjuvant that imparts a viscous property but not a shear thinning characteristic of the present invention to heat treatment separately from protein, lipid, sugar, or the like, and then add the resulting adjuvant to heat-sterilized protein, lipid, sugar, or the like.

[0056]

According to an embodiment of the present invention, as the adjuvant that imparts a viscous property but not a shear thinning characteristic, a dietary fiber, particularly a water-absorbing dietary fiber can be used. A dietary fiber refers to a substance in food that is not hydrolyzed by human digestive enzymes, and is classified into a water-soluble dietary fiber and an insoluble dietary fiber based on its affinity to water. As the source of a dietary fiber, cell wall constituents (such as cellulose, hemicellulose, insoluble pectin, lignin, and chitin), non-cell wall constituents (such as water-soluble pectin, plant gum, adhesive materials, seaweed polysaccharides, and chemically modified polysaccharides) are known (edited by Satoshi Innammi et al., Dietary fiber, published by DAI-ICHI SHUPPAN Co. Ltd., 1982). An insoluble dietary fiber is a dietary fiber insoluble in water, and it swells by absorption of water. In contrast, a water-soluble dietary fiber is a dietary fiber soluble in water, and it turns into a gel-like form by inclusion of water.

[0057]

A water-absorbing dietary fiber that can be used in the present invention refers to a dietary fiber having water-absorbing property. It is particularly preferable that water-absorbing capacity of such water absorbing dietary fiber can be enhanced through heat treatment. When a water-absorbing dietary fiber is used in the nutritional composition of the present invention, free water in the composition decreases due to the water-absorbing action of the fiber, and consequently, the concentration of a thickening agent, emulsifier, or the like will

be increased relatively in the solution part of the composition. As a result, the viscosity attributable to a thickening agent, emulsifier, or the like will be increased. Moreover, when a dietary fiber whose water absorbency is increased by heat treatment is used, the viscosity attributable to a thickening agent, emulsifier, or the like will be further increased by heat treatment. Examples of the dietary fiber whose water absorbency is increased by heat treatment include fibrous cellulose and crystalline cellulose.

[0058]

As the water-absorbing dietary fiber of the present invention, an insoluble dietary fiber is preferably used. Examples of the aforementioned insoluble dietary fiber include cellulose, hemicellulose (such as xylan, mannan, galactan, glucan, glucomannan, and xyloglucan), holocellulose, matrix polysaccharide, an insoluble fiber of a dietary fiber derived from plants (such as vegetables (such as lettuce, celery, onions, burdock, radish, green peas, dried gourd, and tomatoes), fruits (such as apples and bananas), cereals (such as barley, wheat, common wild oat, corn, and *Amaranthus*), tubers (sweet potatoes, potatoes, and konjac potato), beans (such as peas, soybeans, adzuki beans, garbanzo beans, common beans, pinto beans, and mung beans), mushrooms (such as the Jew's ear and shiitake mushroom), chestnuts, almonds, peanuts, and sesames), an insoluble fiber of a dietary fiber derived from other natural products (such as animals, seaweed, and microorganisms), the aforementioned insoluble fiber derived from natural products that has been subjected to chemical modification, partial degradation, or purification, chemically synthesized edible insoluble fiber, soybean *fusuma* bran, wheat *fusuma* bran, barley *fusuma* bran, maize *fusuma* bran, oat *fusuma* bran, rye *fusuma* bran, job's tears (*C. lacryma-jobi* var. *ma-yuen*) *fusuma* bran, rice *nuka* bran, *fusuma* bran of miscellaneous cereals such as proso millet, foxtail millet, barnyard millet, and *Sorghum*, *Leguminosae fusuma* bran, *fusuma* bran of pseudocereals such as buckwheat *fusuma* bran, sesame *fusuma* bran, and *okara* (soy pulp). Preferable examples thereof include an insoluble fiber of soybean dietary fiber and soybean *fusuma* bran. Also, as the aforementioned insoluble dietary fiber, one from which hydrophobic components such as lignin have been removed, one having many side chains, and one that is amorphous can be favorably used.

[0059]

The aforementioned water-absorbing dietary fiber can be used alone or as a combination of plural types thereof, and it is also possible to use a food product containing a large amount of the aforementioned water-absorbing dietary fiber or additive containing a large amount of the aforementioned water-absorbing dietary fiber. Also, in the present invention, other dietary fibers can also be partly used in combination with the aforementioned water-absorbing dietary fiber. For example, at least an insoluble fiber of soybean dietary fiber and/or soybean *fusuma* bran can be contained in the water-absorbing dietary fiber to be used in the composition of the present invention. The insoluble fiber of soybean dietary fiber used in Examples of the present invention can be obtained by, for example, defatting soybean, extracting the defatted soybean with water, and drying the insoluble matters thus produced. Further, the insoluble fiber of soybean dietary fiber used in Examples of the present invention can also be obtained by drying soy pulp.

[0060]

According to STANDARD TABLES OF FOOD COMPOSITION IN JAPAN, 5th revised and enlarged edition (Ministry of Education, Culture, Sports, Science and Technology; http://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu3/toushin/05031802.htm), the total amount of dietary fibers, the amount of a water-soluble dietary fiber, and the amount of an insoluble dietary fiber contained in soybean (dry) is 17.1 g/100 edible part, 1.8 g/100 edible part, and 15.3 g/100 edible part, respectively. Also, the total amount of dietary fibers, the amount of a water-soluble dietary fiber, and the amount of an insoluble dietary fiber contained in soy pulp (old production method) is 9.7 g/100 edible part, 0.3 g/100 edible part, and 9.4 g/100 edible part, respectively, and the total amount of dietary fibers, the amount of a water-soluble dietary fiber, and the amount of an insoluble dietary fiber contained in soy pulp (new production method) is 11.5 g/100 edible part, 0.4 g/100 edible part, and 11.1 g/100 edible part, respectively.

[0061]

Also, the water-absorbing dietary fiber of the present invention does not contain a water-soluble dietary fiber, which increases the shear thinning characteristic (that is, reduces the non-Newtonian viscosity index) such as a soybean-derived polysaccharide thickener and

indigestible dextrin. A water-soluble dietary fiber may be used in combination partly in the nutritional composition of the present invention.

[0062]

The term "*fusuma* bran" refers to the residue remaining after milling of cereals and preparation of cereal products. For example, soybean *fusuma* bran refers to the residue after grinding soybean, and wheat *fusuma* bran, which is also called wheat feed, refers to the residue after the production of flour by grinding wheat. In the case of *Poaceae*, *fusuma* bran may also be called "*nuka*" (i.e., rice bran). *Nuka* refers to a part such as pericarp, seed coat, and germ that are obtained when cereals are polished. *Fusuma* Bran and *nuka* are used synonymously with each other in the present specification. Also, *fusuma* bran is used for cereals in general, and it is not limited to specific cereals such as wheat, corn, and oat. *Fusuma* bran that can be used in the present invention is not limited and examples thereof include chemically synthesized edible insoluble fiber, soybean *fusuma* bran, wheat *fusuma* bran, barley *fusuma* bran, corn *fusuma* bran, oat *fusuma* bran, rye *fusuma* bran, job's tears (*C. lacryma-jobi* var. *ma-yuen*) *fusuma* bran, rice *nuka* bran, *fusuma* bran of miscellaneous cereals such as proso millet, foxtail millet, barnyard millet, and *Sorghum*, *Leguminosae fusuma* bran, *fusuma* bran of pseudocereals such as buckwheat *fusuma* bran, sesame *fusuma* bran, and *okara* (soy pulp).

[0063]

The amount of a water-absorbing dietary fiber to be used in the nutritional composition of the present invention can be appropriately adjusted according to, for example, the viscosity of the nutritional composition to be produced, the type of the water-absorbing dietary fiber, the types and contents of other components such as a thickening agent, an emulsifier, and a starch, and homogenization treatment pressure. However, only for the sake of example, a water-absorbing dietary fiber can be used in an amount of 0.10 to 5.00% by weight (w/w%), preferably 0.10 to 3.00% by weight (w/w%), preferably 0.10 to 2.50% by weight (w/w%), preferably 0.10 to 2.20% by weight (w/w%), preferably 0.10 to 2.00% by weight (w/w%), preferably 0.10 to 1.50% by weight (w/w%), preferably 0.20 to 1.0% by weight, and more preferably 0.20 to 0.80% by weight of the nutritional composition. In the present invention,

when the aforementioned lower and upper limit values are set at any of the values specified above, the amount of a water-absorbing dietary fiber used can be described as "(lower limit value) to (upper limit value)."

[0064]

Also, the larger the water-absorbing dietary fiber particle, the better the water absorbency (edited by Satoshi Innami et al., Dietary fiber, published by DAI-ICHI SHUPPAN Co. Ltd., 1982). The size of the dietary fiber that can be preferably used in the present invention can be appropriately adjusted according to, for example, the viscosity of the nutritional composition to be produced, the type and content of the water-absorbing dietary fiber, the types and contents of other components such as a thickening agent, an emulsifier, and a starch, and homogenization treatment pressure. However, only for the sake of example, the size of a dry water-absorbing dietary fiber before absorbing water can be a size such that the fiber passes through a 20 mesh but not a 100 mesh, more preferably a size such that the fiber passes through a 60 mesh but not a 100 mesh.

[0065]

Soybean dietary fiber contains cellulose, hemicellulose, and the like, and depending on the degree of polymerization and three dimensional structure, soybean dietary fiber exists as a water-soluble dietary fiber or an insoluble dietary fiber. Since a water-soluble dietary fiber has a thickening property on its own, it is utilized as a thickening and stabilizing agent in practical applications. Meanwhile, an insoluble dietary fiber composed mainly of cellulose and hemicellulose hardly exhibits a thickening property on its own. Among insoluble dietary fibers of soybean dietary fiber, those having large three dimensional structures are excellent in water absorbency and have a property such that its water absorbency is increased by heating. Soybean *fusuma* bran is known to be a material rich in an insoluble dietary fiber of soybean dietary fiber.

[0066]

According to an embodiment of the present invention, as the adjuvant that imparts a viscous property but not a shear thinning characteristic, a thickening agent, for example a thickening agent that does not have a network structure in an aqueous solution can be used.

Examples of a thickening agent (also called a gelling agent, a stabilizer, a thickening and stabilizing agent, and a starch adhesive) that can be arbitrarily used in the present invention such as a thickening agent that does not have a network structure in an aqueous solution include locust bean gum, psyllium seed gum, ι-carrageenan, λ-carrageenan, κ-carrageenan in which a part of the molecule is replaced by ι-carrageenan, carrageenan in which a part of λ-carrageenan is replaced by ι-carrageenan, low-strength agar, guar gum, tamarind gum, and tamarind seed gum. Preferable examples thereof include a thickening agent composed mainly of polysaccharides. The aforementioned thickening agent can be used alone or as a combination of plural types thereof. Also, other thickening agents can be partly used in combination with the aforementioned thickening agent. For example, λ-carrageenan and/or low-strength agar can be contained in the thickening agent used in the composition of the present invention. The amount of a thickening agent to be used in the nutritional composition of the present invention can be appropriately adjusted according to, for example, the viscosity of the nutritional composition to be produced, the type of a thickening agent, the types and contents of other components such as a water-absorbing dietary fiber, a non-pregelatinized starch, and an emulsifier, and homogenization treatment pressure. However, only for the sake of example, the thickening agent can be used in an amount of 0.01 to 5.00% by weight (w/w%), preferably 0.01 to 3.00% by weight (w/w%), preferably 0.01 to 2.0% by weight (w/w%), preferably 0.02 to 1.0% by weight, and more preferably 0.05 to 0.5% by weight of the nutritional composition. In the present invention, when the aforementioned lower and upper limit values are set at any of the values specified above, the amount of a thickening agent used can be described as "(lower limit value) to (upper limit value)". A thickening agent that have a network structure in an aqueous solution can also be used in combination partly in the nutritional composition of the present invention.

[0067]

Carrageenan refers to salts of sulfuric acid esters of polysaccharides composed of galactose and anhydrogalactose, and is obtained by extracting the whole body of the algae *Hypnea charoides*, *Eucheuma muricatum*, *Iridaea*, *Gigartina tenella*, and *chondrus ocellatus* with water or an alkaline aqueous solution, and then performing purification (purified

carrageenan). Carrageenan may also be pronounced or expressed as carra-gee-nan, cara-ghe-nan, cara-ghe-nin, and Carrageenan. Carrageenan can also be used in the form of *Eucheuma* powder or processed *Eucheuma* algae, which is obtained by drying the whole body of the algae *Eucheuma muricatum* or subjecting the whole body of the algae *Eucheuma muricatum* to alkaline treatment, and then neutralizing and drying the algae. Depending on the ratio between galactose and anhydrogalactose and the number of sulfuric acid ester, carrageenan exists mainly in the following types; κ -carrageenan, ι -carrageenan, and λ -carrageenan. Also, besides κ -carrageenan in which a part of the molecule is replaced by ι -carrageenan and carrageenan in which a part of λ -carrageenan is replaced by ι -carrageenan, degraded carrageenan having non-dietary usage also exists. The κ - and ι -type carrageenan has a gelling property, and in an aqueous solution, the degree of viscosity is κ -carrageenan < ι -carrageenan. When these aqueous solutions are cooled, κ -carrageenan forms a hard but fragile gel, while ι -carrageenan forms a viscoelastic gel. Also, κ - and ι -type carrageenan forms a strong gel by reacting with salt and milk protein (Toru Hidaka et al., Food Additive Encyclopedia, FOOD CHEMICAL NEWSPAPER, Inc., published in 1997, p. 74 and Handbook of Natural Materials, 14th edition, SHOKUHIN TO KAGAKU (Food Science), published in 1998, p. 110 to 111).

[0068]

According to an embodiment of the present invention, as the adjuvant that imparts a viscous property but not a shear thinning characteristic, a thickening agent, for example a thickening agent that does not have a network structure in an aqueous solution can be used. The thickening agent that does not have a network structure in an aqueous solution as used herein encompasses low-strength agar. That is, although low-strength agar has a weak network structure in an aqueous solution due to partial cleavage of the molecule, a small amount of low-strength agar can be used as the adjuvant that imparts a viscous property but not a shear thinning characteristic of the present invention. Low-strength agar refers to agar that is adjusted to have a jelly strength (Nikkansui method) of 10 to 250 g/cm² at an agar concentration of 1.5% by cleaving the molecules of agar components by subjecting agar to heat treatment. Low-strength agar has a lower jelly strength than agar. Low-strength agar

can be produced by, for example, the method described in JP Patent No. 3414954. It should be noted that jelly strength (Nikkansui method) refers to the maximum weight (g) that can be supported for 20 seconds per cm^2 of the surface of a gel obtained by preparing a 1.5% agar solution and solidifying this by leaving it at 20°C for 15 hours.

[0069]

According to an embodiment of the present invention, as the adjuvant that imparts a viscous property but not a shear thinning characteristic, a starch not having been subjected to pregelatinization treatment in advance can be used. It is known that when a starch not having been subjected to pregelatinization treatment in advance is heated in an aqueous solution, the starch itself imparts a viscous property to the aqueous solution and its water absorbency increases. In the present specification, starch in a naturally occurring crystalline state is called β starch and starch in which sugar chains are freed by destruction of hydrogen bonds therebetween is called α starch. Starch is known to be pregelatinized by destruction of hydrogen bonds by heating, for example by a heat treatment step. Addition of a pregelatinized starch to the nutritional composition before heat treatment results in an unfavorable increase in the viscosity of the composition before heat treatment. Accordingly, a pregelatinized starch is excluded from the adjuvant that imparts a viscous property but not a shear thinning characteristic of the present invention. The amount of a starch not having been subjected to pregelatinization treatment in advance to be used in the nutritional composition of the present invention can be appropriately adjusted according to, for example, the viscosity of the nutritional composition to be produced, the types and contents of other components such as a thickening agent and an emulsifier, and homogenization treatment pressure. However, only for the sake of example, the starch not having been subjected to pregelatinization treatment in advance can be used in an amount of 0.10 to 5.00% by weight (w/w%), 0.50 to 5.00% by weight (w/w%), preferably 0.10 to 3.00% by weight (w/w%), preferably 0.10 to 2.50% by weight (w/w%), preferably 0.10 to 2.20% by weight (w/w%), preferably 0.10 to 2.00% by weight (w/w%), preferably 0.10 to 1.50% by weight (w/w%), preferably 0.20 to 1.0% by weight, and more preferably 0.20 to 0.80% by weight of the nutritional composition. In the present invention, when the aforementioned lower and upper

limit values are set at any of the values specified above, the amount of a starch not having been subjected to pregelatinization treatment in advance used can be described as "(lower limit value) to (upper limit value)".

[0070]

Examples of the type of a starch to be used in the present invention include wheat flour, rice flour, rye flour, corn starch, waxy corn starch, corn flour, potato starch (bareisho starch), bean starch, sweet potato starch (kansho starch), tapioca starch, potato starch (jagaimo starch), and sweet potato starch (satsumaimo starch). Also, when necessary, two or more of the aforementioned starches can be combined, and a processed starch can also be used as long as it is not a non-pregelatinized starch.

[0071]

Examples of the emulsifier that can be used in the present invention include fatty acid esters of glycerol (such as pentaglycerol monolaurate, hexaglycerol monolaurate, decaglycerol monolaurate, tetraglycerol monostearate, decaglycerol monostearate, decaglycerol distearate, diglycerol monooleate, decaglycerol monooleate, and erucic acid esters of decaglycerol), organic acid (such as acetic acid, lactic acid, citric acid, succinic acid, and diacetyl tartaric acid) monoglyceride, fatty acid esters of polyglycerol, fatty acid esters of propylene glycol, condensed ricinoleic acid esters of polyglycerol, fatty acid esters of sorbitan, fatty acid esters of sucrose (such as erucic acid esters of sucrose, stearic acid esters of sucrose, and myristic acid esters of sucrose), (*Brassica*, egg yolk, fractionated, milk, and the like) lecithin, and enzymatically degraded lecithin (such as enzymatically degraded *Brassica* lecithin). Preferable examples thereof include organic acid monoglyceride. The aforementioned emulsifier can be used alone or as a combination of plural types thereof, and it is also possible to use a hydrophilic emulsifier in combination with other emulsifiers. Also, in the present invention, the aforementioned emulsifier can partly contain an emulsifier other than those listed above, for example, in an amount less than that of the aforementioned emulsifier. For example, at least succinic acid monoglyceride and/or diacetyl tartaric acid monoglyceride can be contained in the emulsifier to be used in the composition of the present invention, and at least organic acid monoglyceride can be contained in the emulsifier to be used in the

composition of the present invention. The amount of an emulsifier to be added can be appropriately adjusted according to, for example, the viscosity of the nutritional composition to be produced, the type of emulsifier, the contents of other ingredients such as a dietary fiber and a thickening agent, and homogenization treatment pressure. However, only for the sake of example, the amount of an emulsifier to be added can be 0.02 to 2.0% by weight (w/w%), preferably 0.05 to 1.5% by weight, and more preferably 0.1 to 1.0% by weight of the nutritional composition. In the present invention, when the aforementioned lower and upper limit values are set at any of the values specified above, the amount of an emulsifier used can be described as "(lower limit value) to (upper limit value)".

[0072]

Monoglyceride refers to glycerol with fatty acid bound to one of its hydroxyl groups. Organic acid monoglyceride refers to the aforementioned monoglyceride with organic acid bound to the hydroxyl group thereof by ester linkage.

[0073]

Diacetyl tartaric acid monoglyceride refers to the aforementioned monoglyceride with a compound in which the hydroxyl group of tartaric acid is acetylated bound to the hydroxyl group thereof by ester linkage. Diacetyl tartaric acid monoglyceride is alternatively called TMG or diacetyl tartaric (acid) ester of monoglyceride (DATEM). Diacetyl tartaric acid monoglyceride may be used for O/W type emulsification.

[0074]

Succinic acid monoglyceride refers to the aforementioned monoglyceride with succinic acid bound to the hydroxyl group thereof by ester linkage. Also, succinic acid monoglyceride is alternatively called succinic acid esters of monoglyceride (SMG). Succinic acid monoglyceride may be used for O/W type emulsification.

[0075]

In the present invention, examples of fatty acid constituting organic acid monoglyceride include, but are not limited to, saturated fatty acid and unsaturated fatty acid such as caprylic acid, capric acid, lauric acid, myristic acid, palmitic acid, stearic acid, and oleic acid.

[0076]

In the present invention, food protein can be used as all or a part of protein. Examples of food protein that can be used in the present invention include milk-derived protein (such as casein, casein sodium, Milk Protein Concentrate (MPC), α -casein, β -casein, and κ -casein and degradation products thereof), soy-derived protein (such as glycinin and β -conglycinin), wheat-derived protein (such as gluten, gliadin, and glutelin), meat-derived protein (such as muscle constituting protein, myosin, and actin), fish meat (such as muscle fiber protein, actomyosin, myosin, and actin), chicken egg-derived protein (such as egg white albumin and egg yolk lipoprotein), and pig skin-derived protein (such as gelatin). Preferable examples thereof include casein sodium. In the present invention, food protein can be used alone or as a combination of plural types thereof. Also, in the present invention, other food proteins can also be partly used in combination with protein having a gelling property. For example, at least casein sodium can be contained in the food protein to be used in the composition of the present invention. The amount of food protein to be used in the nutritional composition of the present invention can be appropriately adjusted according to, for example, the viscosity of the nutritional composition to be produced, the type of food protein, the types and contents of other components such as a dietary fiber, a thickening agent, and an emulsifier, and homogenization treatment pressure. However, only for the sake of example, food protein can be used in an amount of 2.0 to 12.0% by weight (w/w%), preferably 4.0 to 10.0% by weight, and more preferably 5.0 to 8.0% by weight of the nutritional composition.

[0077]

The nutritional composition of the present invention can contain sugars. Examples of sugars that can be used in the present invention include polysaccharides such as a starch (preferably one that is not pregelatinized), dextrin, cellulose, glucomannan, and glucan, chitins, fructooligosaccharide, galactooligosaccharide, mannan oligosaccharide, low molecular weight polysaccharides, low molecular weight dextrin, low molecular weight cellulose, and low molecular weight glucomannan. For example, those that have a DE value of 12 to 50, 15 to 40, and 20 to 40 can be used. Also, sugars can be derived from any source such as plants, animals, and microorganisms, or can be chemically synthesized. For example, sugars

derived from, for example, plants (such as potatoes, rice, sweet potatoes, corn, wheat, beans (such as *vicia faba*, mung beans, and adzuki beans, and cassava), animals (such as Crustaceans, insects, and shell fish), and microorganisms (such as mushrooms and fungi) can be directly used, or sugars obtained by subjecting the above sugars to partial or entire degradation or modification by a means of enzymatic reaction, microbial reaction, heat, and chemical reaction may also be used. The amounts and types of sugars to be used in the nutritional composition of the present invention can be appropriately adjusted and selected according to, for example, the viscosity of the nutritional composition to be produced and the types and contents of other ingredients such as an emulsifier, a thickening agent, protein, and lipid.

[0078]

Dextrin refers to a product obtained by subjecting a starch to, for example, degradation by heat, acid, enzyme, and the like, and if necessary, performing purification. Dextrin is alternatively called or expressed as British gum, starch gum, or dextrine. Various types of dextrans exist depending on the production method, degree of degradation, and the like. Examples of the various types of dextrans include maltodextrin, indigestible dextrin (water-soluble dietary fiber), cyclodextrin, soluble starch, and branched corn syrup. Dextrin can be evaluated based on dextrose equivalent (DE). Those skilled in the art can determine DE by a conventional method. For example, the dextrose equivalent of maltodextrin is assumed to be 3 to 20. The dextrose equivalent (DE) of dextrin used in the present invention is normally 12 to 50, preferably 15 to 40, and more preferably 20 to 40. The above dextrin can be used in combination with dextrin having a DE outside the above-specified values.

[0079]

In the nutritional composition of the present invention, in addition to the aforementioned water-absorbing dietary fiber, a thickening agent, a non-pregelatinized starch, an emulsifier, food protein, and sugars, water, protein, carbohydrate, lipid, vitamins, minerals, organic acid, organic base, fruit juice, flavors, pH adjusters, and the like can be used. Examples of the protein include animal and plant-derived proteins and degradation products thereof such as milk-derived protein, enzyme degradation products of protein, whole milk powder, nonfat dry milk powder, casein, degradation products of casein, whey powder, whey

protein, whey protein concentrates, degradation products of whey protein, hydrolyzed products of whey protein, α -casein, β -casein, κ -casein, β -lactoglobulin, α -lactalbumin, lactoferrin, soybean protein, chicken egg protein, and meat protein; and various types of milk-derived components such as butter, milk serum mineral, cream, whey, non-protein nitrogen, sialic acid, phospholipid, and lacrosse. The nutritional composition of the present invention can contain peptide and amino acid such as casein phosphopeptide and lysine. Examples of the carbohydrate include sugars, processed starches (dextrin as well as soluble starch, British starch, oxidized starch, starch ester, starch ether, and the like), and a dietary fiber. Among those listed above, examples of substances that can be preferably used include a non-pregelatinized starch. Examples of the lipid include animal-derived fat such as lard and fish oil, and fractionated oil, hydrogenated oil, and ester-exchanged oil thereof; and plant-derived oil such as palm oil, safflower oil, corn oil, rapeseed oil, and coconut oil, and fractionated oil, hydrogenated oil, and ester-exchanged oil thereof. Examples of the vitamins include vitamin A, carotenes, vitamin B group, vitamin C, vitamin D group, vitamin E, vitamin K group, vitamin P, vitamin Q, niacin, nicotinic acid, pantothenic acid, biotin, inositol, choline, and folic acid. Examples of the minerals include calcium, potassium, magnesium, sodium, copper, iron, manganese, zinc, and serine. Examples of the organic acid include malic acid, citric acid, lactic acid, tartaric acid, and erythorbic acid. A combination of two or more of these components can be used, and a synthesized product and/or food containing large amounts of these components can also be used.

[0080]

The heat quantity(calorie) of the nutritional composition of the present invention can be adjusted by appropriately adding protein, lipid, and carbohydrate. The nutritional composition of the present invention can contain, for example, protein in an amount of 3 to 10 g/100g, preferably 4 to 8 g/100 g, and more preferably 5 to 7 g/100 g in terms of protein equivalent. The nutritional composition of the present invention can contain, for example, lipid in an amount equivalent to 2 to 10 g/100 g, preferably 3 to 8 g/100 g, and more preferably 3 to 6 g/100 g. The nutritional composition of the present invention can contain, for example, carbohydrate in an amount equivalent to 13 to 30 g/100 g, preferably 15 to 27

g/100 g, and more preferably 20 to 25 g/100 g. The nutritional composition of the present invention can contain the aforementioned amounts of protein, lipid, and carbohydrate while retaining certain fluidization characteristics as described above.

[0081]

The specific gravity of the nutritional composition of the present invention can be adjusted according to the usage. The specific gravity of the nutritional composition of the present invention can be set at, for example, 1.06 or more, 1.07 or more, 1.08 or more, 1.09 or more, 1.1 or more, less than 1.5, less than 1.4, less than 1.3, and less than 1.2, for example, 1.06 to 1.5, 1.07 to 1.5, 1.08 to 1.4, 1.09 to 1.3, 1.1 to 1.2, 1.1 to 1.15, 1.12 to 1.15, 1.13 to 1.15, preferably 1.135 to 1.145. Those skilled in the art can determine the specific gravity of the composition by appropriately adjusting each component. Although the specific gravity may vary depending on the temperature, for the sake of convenience, the specific gravity refers to a value obtained at 20°C in the present specification. The specific gravity of the composition can be calculated from the weight and volume of each component or by a conventional method, for example by using a density and specific gravity meter.

[0082]

In the present specification, a rich nutritional composition refers to a composition that appropriately contains protein, lipid, carbohydrate, and the like and has a specific gravity of 1.06 or more, for example 1.06 to 1.5, for example 1.07 to 1.5, for example 1.08 to 1.4, for example 1.09 to 1.3, for example 1.1 to 1.2, for example 1.1 to 1.15, for example 1.12 to 1.15, for example 1.13 to 1.15, and 1.135 to 1.145. Such a rich nutritional composition can be prepared as an emulsion by appropriately using the aforementioned emulsifier. A rich nutritional composition can also be prepared as an emulsion by appropriately performing homogenization treatment. Although homogenization treatment can be conducted before or after the addition of the aforementioned emulsifier, it is preferably conducted after the addition of an emulsifier. Homogenization will be described in detail below. Accordingly, in the present specification, an emulsion of a rich nutritional composition refers to a composition that appropriately contains protein, lipid, carbohydrate,

and the like and has a certain specific gravity as described above, and is emulsified by homogenization treatment. According to an embodiment of the present invention, a rich nutritional composition having a flow characteristic close to that of a Newtonian fluid can be obtained by using an emulsion of a rich nutritional composition in combination with an adjuvant that imparts a viscous property but not a shear thinning characteristic.

[0083]

As a substance that imparts a shear thinning characteristic to a composition, the aforementioned raw materials, gum arabic, alginic acid, casein, κ -carrageenan, xanthan gum, guar gum, gellan gum (native form, deacylated form, and the like), gelatin, tragacanth gum, bacterial cellulose, hydroxyethylcellulose, polyethylene glycol, locust bean gum, agar, fine crystalline cellulose, and the like are known. These materials can also be contained partly in the composition of the present invention.

[0084]

By using an adjuvant that imparts a viscous property but not a shear thinning characteristic in the composition of the present invention, the concentrations of a thickening agent necessary for imparting the intended viscosity, an emulsifier, or a substance that imparts a shear thinning characteristic can be kept low, whereby the shear thinning characteristic attributable to these substances can be suppressed. As a result, the composition of the present invention can attain a low shear thinning characteristic and a viscous property close to the Newtonian viscous property, while maintaining high viscosity.

[0085]

The composition of the present invention is advantageous in that the dripping rate in drip feeding can readily be adjusted due to said composition having a viscous property close to the Newtonian viscous property.

[0086]

The shear thinning characteristic as used in the present specification has the meaning as commonly used in the field of the present invention, and a shear thinning fluid refers to a fluid in which an apparent viscous rate or consistency decreases with an increase in the shear deformation rate.

[0087]

After mixing some or all of the aforementioned raw materials, homogenization is performed as needed. Homogenization refers to homogenizing the mixed components by thorough mixing and mechanically miniaturizing fat globules and coarse particles of other components to prevent floatation and aggregation of fat and the like, while making the nutritional composition into a uniform emulsion. An emulsified nutritional composition can have a flow characteristic close to a Newtonian fluid even when it is rich with a certain degree of viscosity. By increasing homogenization treatment pressure in homogenization process, viscosity after heat treatment can be reduced and generation of sediment (settling particles) can be reduced. That is, the viscosity of the nutritional composition and the generation of sediment can be controlled by adjusting the homogenization treatment pressure. Homogenization treatment is normally performed by shearing an adjusted solution using a conventional homogenizer under certain pressure. In the present invention, homogenization treatment can be preferably performed at a homogenization pressure of 10, 25, 40, 60, 100 MPa, and the like; however, treatment pressure is not limited to those exemplified above. That is, the viscosity (spindle type rotational viscometer, 20°C, 12 rpm) of the composition after heat treatment and storage at a temperature equal to or below normal temperature for a certain period of time, for example 7 days, can also be adjusted to 300 to 3000 mPa·s, for example 400 to 3000 mPa·s by applying homogenization treatment at a homogenization treatment pressure of 10 to 100 MPa in addition to using, for example, an adjuvant that imparts a viscous property but not a shear thinning characteristic, a thickening agent, an emulsifier, or a substance that imparts a shear thinning characteristic as described above.

[0088]

Homogenization treatment after mixing the raw materials can be performed at any appropriate temperature. Homogenization treatment can be performed, for example, at room temperature of around 20°C. Homogenization treatment can also be performed at a temperature higher than this, for example at 20 to 85°C, for example at 45 to 80°C, preferably

at 45 to 70°C, more preferably at around 50°C to 60°C. Homogenization treatment is preferably performed at around 50°C to 60°C.

[0089]

In the production of the nutritional composition of the present invention, heat treatment or heat sterilization is performed. For heat sterilization conditions, sterilization conditions generally applied to food product can be used, and heat sterilization can be performed using a conventional device. For example, sterilization at 62 to 65°C for 30 minutes, 72°C or higher for 15 seconds or more, 72°C or higher for 15 minutes or more, or 120 to 150°C for 1 to 5 seconds, or disinfection at 121 to 124°C for 5 to 20 minutes, at 105 to 140°C, retort (autoclave) sterilization, high pressure steam disinfection, and the like can be used; however, heat sterilization is not limited to those exemplified above. Heat sterilization can be performed preferably under pressure. Further, by using an adjuvant that imparts a viscous property but not a shear thinning characteristic having a property such that its water absorbency is increased by heating, for example a water-absorbing dietary fiber or a starch not having been subjected to pregelatinization treatment in advance, the nutritional composition can be sterilized by heat treatment, and also the viscosity of the composition can be increased. In the present specification, disinfection and sterilization can be used synonymously. Also, retort sterilization can be used as one aspect of heat sterilization.

[0090]

The viscosity (spindle type rotational viscometer, 20°C, 12 rpm) of the nutritional composition of the present invention gradually increases by storing the composition at a temperature equal to or below room temperature following heat treatment, and after the elapse of a certain period of time, the viscosity is almost stabilized. The storage period of the composition can be appropriately selected according to the desired viscosity, for example, several hours to half a day, 1 day, 2 days, 3 days, 4 days, 5 days, 6 days, 7 days, 10 days, 14 days, 20 days, 30 days, 40 days, 50 days, 60 days, 70 days, 80 days, and 90 days. That is, the storage period of the composition of the present invention after heat treatment can be, for example, 1 to 90 days, preferably 5 to 60 days, more preferably 7 to 30 days, and even more preferably 7 days. The viscosity (spindle type rotational viscometer, 20°C, 12 rpm) of

a nutritional composition according to a preferable embodiment of the present invention is almost stabilized approximately 7 days after (approximately one week after) storage at a temperature equal to or below normal temperature following heat treatment. Those skilled in the art can appropriately determine the time required for stabilization of a heat-treated composition by a conventional technique.

[0091]

Also, preferably, the viscosity (spindle type rotational viscometer, 20°C, 12 rpm) of the nutritional composition of the present invention that has been subjected to heat treatment and then stored at normal temperature (15 to 25°C) or below for a certain period of time, for example 7 days, is 300 to 6500 mPa·s, preferably 300 to 3000 mPa·s, preferably 400 to 3000 mPa·s, preferably 400 to 2000 mPa·s, and more preferably 500 to 1500 mPa·s. The heat-treated nutritional composition of the present invention is preferably stored at 0°C to normal temperature or below. By adjusting the viscosity to the aforementioned values, conventional free-fall tube feeding can be employed for feeding a liquid nutritional composition to those who consume it. As a result, gastroesophageal reflux, which is a problem associated with tube feeding of a low-viscosity nutritional composition, and cumbersome operation such as injection by syringe, which is a problem associated with feeding of a semi-solid nutritional composition with high viscosity (spindle type rotational viscometer, 20°C, 12 rpm, for example 4000 to 20000 mPa·s), are solved, whereby simple feeding is made possible. Alternatively, a composition having the same degree of viscosity (spindle type rotational viscometer, 20°C, 12 rpm) as a semi-solid liquid food of 4000 mPa·s or more can be obtained by appropriately adjusting the types and contents of a water-absorbing dietary fiber, a thickening agent, and a non-pregelatinized starch, the contents and types of other ingredients such as an emulsifier, homogenization treatment pressure, and the like.

[0092]

In the present specification, when the viscosity (spindle type rotational viscometer, 20°C, 12 rpm) of the nutritional composition of the present invention that has been subjected to heat treatment and then stored for a certain period of time at a temperature equal

to or below normal temperature is expressed as 300 to 3000 mPa·s, it is intended to indicate a range from not lower than the lower limit to less than the upper limit. That is, "300 to 3000 mPa·s" means 300 mPa·s or more to less than 3000 mPa·s.

[0093]

The viscosity of the nutritional composition of the present invention can be measured by a conventional method. As an example, when the measurement is made at a constant shear rate, the viscosity can be measured with a spindle type rotational viscometer (for example, measurement is made with a spindle type rotational viscometer at 20 to 85°C and 12 rpm). Also, when the measurement is made at varied shear rates, as an example, the measurement can also be made under the conditions of a gap of 1 mm, 25°C, a shear rate of 1 to 100/s using the rheometer Physica MCR301 (Anton Paar) with a cone plate having a diameter of 25 mm. Those skilled in the art can select an appropriate viscosity measurement device and determine measurement conditions according to the desired requirements.

[0094]

When the viscosity is measured under the conditions of a shear rate of 10/s, the viscosity of the nutritional composition of the present invention can be adjusted to 150 to 1000 m·Pas, 200 to 800 m·Pas, or 300 to 500 m·Pas. Examples of the measurement method of the aforementioned viscosity include a measurement method performed under the conditions of a gap of 1 mm and 25°C using the rheometer Physica MCR301 (Anton Paar) with a cone plate having a diameter of 25 mm.

[0095]

The measurement of the viscosity (spindle type rotational viscometer, 20°C, 12 rpm) of the nutritional composition of the present invention can be performed in accordance with, for example, "Standard for labeling approval of foods for special dietary uses: Test method for foods for the elderly 3, Viscosity ("How to handle the labeling approval for foods for the elderly", (February 23, 1994, Notice No. 15 by the chief of the Office of Health Policy on Newly Developed Foods, Food Sanitation Division, Environmental Health Bureau, the Ministry of Health, Labour and Welfare of Japan)) ". Specifically, using a spindle type rotational rotating viscometer, the reading is taken two minutes after rotating a rotor.

Subsequently, the value thus obtained is multiplied by a coefficient corresponding to this value, and the resulting value is expressed as mPa·s. The measurement is performed at $20 \pm 2^{\circ}\text{C}$.

[0096]

Also, as other examples, the viscosity can be measured properly or continuously during the production step using an inline viscometer such as a torsional vibration viscometer, an ultrasonic viscometer, and a rotating viscometer.

[0097]

By virtue of the effect of an adjuvant that imparts a viscous property but not a shear thinning characteristic, the amounts of a thickening agent necessary for imparting a certain degree of viscosity to a composition, an emulsifier, a substance that imparts a shear thinning characteristic, and the like in the nutritional composition of the present invention can be reduced. Since the use of a substance that imparts a shear thinning characteristic such as a thickening agent can be reduced, the nutritional composition of the present invention achieves an increasing effect on the viscosity of the composition after heat treatment and storage at a temperature equal to or below normal temperature for a certain period of time, for example 1 to 90 days, for example 7 days. In light of the above, the viscosity of the nutritional composition of the present invention before heat treatment can be kept lower than that of a composition in which the viscosity is increased primarily by a thickening agent. That is, the present invention provides a nutritional composition that can be easily produced and fed by tube. Meanwhile, as will be demonstrated in, for example, Comparative Example 1 in Example 1 to be described later, the viscosity of a nutritional composition produced by adding an emulsifier, not an adjuvant that imparts a viscous property but not a shear thinning characteristic, did not increase even after heat treatment and further storage at a temperature equal to or below normal temperature for 7 days, in comparison with the viscosity (spindle type rotational viscometer, 20°C , 12 rpm) before heat treatment.

[0098]

Here, the effect of an adjuvant that imparts a viscous property but not a shear thinning characteristic means that, in the production of a nutritional composition having a viscosity (spindle type rotational viscometer, 20°C , 12 rpm) of 300 to 3000 mPa·s after heat

treatment and then storage at a temperature equal to or below normal temperature for a certain period of time, for example 1 to 90 days, for example 7 days, regardless of the fact that the viscosity of the composition before heat treatment is markedly lower than the viscosity of a composition in which the

viscosity is increased primarily by a thickening agent, the viscosity of the composition can be brought to equal to or more than the viscosity of the nutritional formulation in which the viscosity is increased primarily by a thickening agent by heat treatment and further storage at a temperature equal to or below normal temperature for a certain period of time, for example 1 to 90 days, for example 7 days.

[0099]

By appropriately adjusting the formulation ratio of an adjuvant that imparts a viscous property but not a shear thinning characteristic, a thickening agent, and an emulsifier to be contained in the nutritional composition of the present invention and subjecting the composition to heat treatment and then to storage at a temperature equal to or below normal temperature for a certain period of time, for example 1 to 90 days, for example 7 days, a nutritional composition having a certain viscosity can be obtained. Since the viscosity of the composition is affected by factors such as the contents and types of protein and fat contained in the nutritional composition and particle diameter of fat globules before sterilization, the formulation ratio of a water-absorbing dietary fiber, a thickening agent that does not have a network structure in an aqueous solution, a non-pregelatinized starch, and an emulsifier can be appropriately adjusted.

[0100]

Further, the present invention can also provide a nutritional composition having a low shear thinning characteristic. The present invention enables a reduction in free water by virtue of the water-absorbing action of the adjuvant that imparts a viscous property but not a shear thinning characteristic used in the present invention, whereby it was made possible to reduce the amount of substances such as a thickening agent necessary for imparting a certain degree of viscosity. As a result, a shear thinning characteristic attributable to a thickening agent and the like can be reduced. In light of the above, the nutritional composition of the present invention is characterized by having a low shear thinning characteristic and fluidity closer to the Newtonian viscous property.

[0101]

The nutritional composition having a low shear thinning characteristic as used in the present specification refers to a nutritional composition having a reduced shear thinning characteristic. In other words, the nutritional composition having a low shear thinning characteristic as used in the present specification refers to a composition in which n , which is the non-Newtonian fluid index as defined in the description of the viscous property formula as above, is 0.3 or more, preferably 0.35 or more, preferably 0.4 or more, preferably 0.45 or more, preferably 0.5 or more, preferably 0.55 or more, preferably 0.6 or more, and less than 1.0, less than 0.9, for example less than 0.85, less than 0.8, less than 0.75, and less than 0.7. In the present invention, when the aforementioned lower and upper limit values are set at any of the values specified above, n can be described as "(lower limit value) to (upper limit value)". That is, according to a further embodiment, the nutritional composition having a low shear thinning characteristic of the present invention refers to a composition having a non-Newtonian fluid index n of, for example, 0.3 to 1.0, 0.3 to 0.9, 0.4 to 0.8, 0.4 to 0.7, 0.5 to 0.8, 0.5 to 0.7, 0.6 to 0.8, and 0.6 to 0.7.

[0102]

It should be noted that although Examples in the present specification describe the compositions having large n values as non-limiting examples of preferable formulation, those skilled in the art understand that in order to reduce the n value, the proportion of a substance that increases the shear thinning characteristic such as a thickening agent to be added to the composition may be increased.

[0103]

By virtue of the present invention, a nutritional composition suitable for managing the dosing rate in tube feeding through gastric fistula, duodenal fistula, and the like can be provided.

[0104]

With conventional compositions having shear thinning characteristics, a phenomenon in which the viscosity of the composition decreases with an increase in the shear rate occurs, controlling the dripping rate is difficult. In this regard, it was necessary to appropriately adjust the composition and viscosity of a composition, the type of gastrostomy tube, and the

container or package for storage of the nutritional composition in accordance with the desired dripping rate.

[0105]

In contrast, the dripping rate of the nutritional composition of the present invention can readily be controlled since the viscosity of said composition of the present invention is less affected by the dripping rate. Accordingly, the nutritional composition of the present invention can be used with any gastrostomy tube and container or package for storage of the nutritional composition, irrespective of the type of gastrostomy tube (tube type, button type, balloon type, bumper type, and the like) as well as the size, form, and type of the container or package for storage of the nutritional composition. Further, diarrhea and the like can be prevented by adjusting the dosing rate even when the nutritional composition has high osmotic pressure; therefore, it is also possible to maintain the quality of life (QOL) of patients receiving nutritional compositions.

[0106]

(Examples)

Example 1 Soybean dietary fiber

The effect of a water-absorbing dietary fiber on the viscosity of a nutritional composition was tested by adding a certain amount of a water-absorbing dietary fiber to the composition. Raw materials were stirred and mixed in accordance with the recipe in the upper table in Table 1 to formulate various nutritional compositions (Production Examples 1 and 2, and the like). The resulting nutritional compositions were subjected to homogenization treatment under the conditions of 50 to 60°C and a homogenization treatment pressure of 20 MPa, followed by homogenization treatment at 50 to 60°C and 30 MPa. The specific gravities of Production Examples 1 to 2 and Comparative Example 1 were all measured to be 1.14 by a density and specific gravity meter at 20°C. After the viscosity of these nutritional compositions was measured [before retort sterilization], they were filled and sealed in containers and then subjected to retort sterilization under the conditions of 121 to 123.5°C for 5 to 20 minutes. The nutritional compositions after retort sterilization were stored at 15°C for one week, and the viscosity was measured again [after

retort sterilization]. It should be noted that the viscosity was measured using a spindle type rotational viscometer under the conditions of 12 rpm, 20°C or 50°C. Also, the milk-derived protein used in the present Example was a combination of 1.9% by weight of MPC, 3.8% by weight of casein sodium, and 1.5% of degradation products of milk protein, the water-absorbing dietary fiber used in the present Example was an insoluble fiber of soybean dietary fiber, and the emulsifier used in the present Example was diacetyl tartaric (acid) ester of monoglyceride (DATEM). A thickening agent was not used. Also, the composition of Production Examples 1 and 2 and Comparative Example 1 is shown in Table 1-2.

[Table 1-1]

	Production Example 1	Production Example 2	Comparative Example 1
Raw material	Formulation ratio (w/w%)	Formulation ratio (w/w%)	Formulation ratio (w/w%)
Milk-derived protein	7.2	7.2	7.2
Dextrin	22.5	22.5	22.5
Dietary fiber			
Indigestible dextrin	0.73	1.1	0
Insoluble soybean dietary fiber	1.47	1.1	0
Sucrose	1.6	1.6	1.6
Mineral mixture	1.3	1.3	1.3
pH Adjuster	0.16	0.16	0.16
Prepared fat	4.23	4.23	4.23
Vitamin mixture	0.18	0.18	0.18
Fragrance	0.18	0.18	0.18
Emulsifier	Diacetyl tartaric (acid) ester of monoglyceride (DATEM)	Diacetyl tartaric (acid) ester of monoglyceride (DATEM)	Diacetyl tartaric (acid) ester of monoglyceride (DATEM)
	0.64	0.64	0.64
Thickening agent	None	None	None
Water	59.81	59.81	62.01

Viscosity prior to retort sterilization mPa·s	270(20°C)	120(20°C)	65(20°C)
Viscosity post retort sterilization mPa·s 20°C	1600	940	52

[Table 1-2]

Composition		Production Example 1, Production Example 2	Comparative Example 1
Protein		6.3g/100g	6.3g/100g
Lipid		4.4g/100g	4.4g/100g
Carbohydrate		24.6g/100g	22.7g/100g
Detail	Sugar	22.7g/100g	22.7g/100g
	Dietary fiber	1.9g/100g	0g/100g

[0107]

The results of measurement of viscosity before and after heat treatment are shown in the lower table in Table 1. The viscosity of the nutritional composition of Production Example 1 was 270 mPa·s (20°C) before retort sterilization, whereas it was markedly increased to 1600 mPa·s (20°C) after retort sterilization. The viscosity of Comparative Example 1 without insoluble soybean dietary fiber was 65 mPa·s (20°C) before retort sterilization, and after retort sterilization, it was only slightly changed to 52 mPa·s (20°C). That is, even in the absence of a thickening agent (Production Examples 1 and 2), the viscosity of a composition containing a certain amount of a water-absorbing dietary fiber after retort sterilization was approximately 5.9 to 7.8 times as high as that before retort sterilization.

[0108]

From the above results, it was found that by using a water-absorbing dietary fiber in the nutritional composition of the present invention, the viscosity of the composition after retort sterilization could be dramatically increased even in the absence of a thickening agent or in the presence of only a small amount of a thickening agent.

[0109]

Example 2 Starch not having been pregelatinized in advance

The effect of a starch not having been pregelatinized in advance on the viscosity of a nutritional composition was tested by adding a certain amount of a starch not having been pregelatinized in advance to the composition. Raw materials were stirred and mixed in accordance with the recipe in Table 2-1 to formulate various nutritional compositions

(Formulations 3 and 4), and the resulting nutritional compositions were subjected to homogenization treatment under the conditions of 50 to 60°C and a homogenization treatment pressure of 20 MPa, followed by homogenization treatment at 50 to 60°C and 30 MPa. Also, the specific gravities of Formulations 3 and 4 were both measured to be 1.14 by a density and specific gravity meter at 20°C. After the viscosity of these nutritional compositions was measured [before retort sterilization], they were filled and sealed in containers and then subjected to retort sterilization under the conditions of 121 to 123.5°C for 5 to 20 minutes. The nutritional compositions after retort sterilization were stored at 15°C for three days, and the viscosity was measured again [after retort sterilization]. It should be noted that the viscosity was measured using a spindle type rotational viscometer under the conditions of 12 rpm, 20°C or 50°C. Also, the starch not having been pregelatinized in advance used in the present Example was waxy corn starch (trade name "Suehiro 200", the product of OJI CORNSTARCH Co., Ltd.), the milk-derived protein used in the present Example was a combination of 1.9% by weight of MPC, 3.7% by weight of casein sodium, and 1.5% of degradation products of milk protein, and the emulsifier used in the present Example was diacetyl tartaric (acid) ester of monoglyceride (DATEM). A thickening agent was not used. Also, the composition of Formulations 3 and 4 is shown in Table 2-2.

[Table 2-1]

	Formulation 3	Formulation 4
Raw material	Formulation ratio (w/w%)	Formulation ratio (w/w%)
Milk-derived protein	7.1	7.1
Dextrin	22.2	22.1
Waxy corn starch	1.5	2.0
Sucrose	1.6	1.6
Mineral mixture	1.3	1.3
pH Adjuster	0.16	0.16
Prepared fat	4.17	4.15
Vitamin mixture	0.18	0.18
Fragrance	0.18	0.18
Emulsifier	Diacetyl tartaric (acid) ester of monoglyceride (DATEM)	Diacetyl tartaric (acid) ester of monoglyceride (DATEM)
	0.63	0.63
Thickening agent	None	None
Water	61.08	60.77

Viscosity prior to retort sterilization mPa·s	60(20°C)	66(20°C)
Viscosity post retort sterilization mPa·s	560(20°C)	1600(20°C)

[Table 2-2]

Composition	Formulation 3	Formulation 4
Protein	6.3g/100g	6.3g/100g
Lipid	4.4g/100g	4.4g/100g
Carbohydrate	24.2g/100g	24.5g/100g
Detail Sugar	24.2g/100g	24.5g/100g
Dietary fiber	0g/100g	0g/100g

[0110]

The results of measurement of viscosity before and after heat sterilization are shown in Table 2-1. After heat sterilization, the viscosity of Formulations 3 and 4 was dramatically increased compared to before heat sterilization. Particularly, the viscosity of Formulation 4

after heat sterilization was increased to approximately 24 times as high as the viscosity before heat sterilization.

[0111]

From the above results, it was found that the viscosity of the composition after retort sterilization could be dramatically increased even in the absence of a thickening agent or in the presence of only a small amount of a thickening agent by using a starch not having been pregelatinized in advance in the nutritional composition of the present invention.

[0112]

Further, based on the observation that these nutritional compositions had a certain degree of viscosity even in the absence of a thickening agent or in the presence of only a small amount of a thickening agent, it was speculated that the Newtonian fluidity was improved. In light of this, the following test was conducted to reveal the fluidization characteristics of these nutritional compositions.

[0113]

Example 3

The shear rate-dependent viscosity of the nutritional composition of the present invention was measured. Also, a dripping test was performed using a percutaneous endoscopic gastrostomy catheter.

[0114]

Nutritional composition

Formulations 1 to 4 were prepared in accordance with Table 2-1 (Example 2) and Table 3-1. The composition of Formulations 1 and 2 is shown in Table 3-2. The specific gravities of Formulations 1 to 4 were all measured to be 1.14 by a density and specific gravity meter at 20°C. Also, as a Comparative Example, a commercially available liquid food (trade name "F2 Light", the product of TERUMO CORPORATION) was used. It should be noted that the milk-derived protein used in the present Example was a combination of 1.9% by weight of MPC, 3.7% by weight of casein sodium, and 1.5% of degradation products of milk protein in Formulations 3 and 4, while that was a combination of 1.9% by weight of MPC, 3.8% by weight of casein sodium, and 1.5% of degradation products of milk protein in

Formulations 1 and 2, and the emulsifier used in the present Example was diacetyl tartaric (acid) ester of monoglyceride (DATEM), and as to carrageenan, λ -carrageenan was used. For specific gravity, an actual measurement value obtained by a hydrometer was recorded.

[0115]

The commercially available liquid food is assumed to have the nutritional components and specific gravity as shown in Table 3-3 based on the information of the nutritional components and physical property values of the trade name "F2 light" as listed in the pamphlet of this commercially available liquid food.

[0116]

For Formulations 1 to 4, the raw materials were stirred and mixed and homogenization treatment was performed under the conditions of 50 to 60°C and a homogenization treatment pressure of 20 MPa, followed by homogenization treatment at 50 to 60°C and 30 MPa. Formulations 1 to 4 after homogenization treatment were each filled and sealed in containers and subjected to retort sterilization under the conditions of 121 to 123.5°C for 10 to 20 minutes. Thereafter, the resulting products were stored at 15°C for one week and then subjected to viscosity measurement and a dripping test.

[0117]

Measurement method for shear rate-dependent viscosity

The nutritional compositions of the present invention (Formulations 1 to 4 and Production Examples 1 and 2, and a commercially available liquid food) were tested. When the viscosity was measured at varied shear rates, the measurement was made under the conditions of a gap of 1 mm, 25°C, a shear rate of 1 to 100/s using the rheometer Physica MCR301 (Anton Paar) with a cone plate having a diameter of 25 mm.

[0118]

Dripping test method

The nutritional compositions of the present invention (Formulations 1 and 2, and a commercially available liquid food) were tested.

The following apparatus or samples were used in this experiment:

- Tube: Percutaneous endoscopic gastrostomy catheter (CORFLO-DUAL GT, catalog No. 8144, shaft diameter (outside diameter) 8 mm, shaft length 22.5 cm, BOSTON SCIENTIFIC CORPORATION)

- Button : PEG feeding tube (bolus feeding tube, shaft diameter (outside diameter) 4 mm, shaft length 30.5 cm, BOSTON SCIENTIFIC CORPORATION) with a button-type percutaneous endoscopic gastrostomy catheter with a bumper (Button (TM), catalog No. 6828, shaft diameter (outside diameter) 6 mm, shaft length 2.4 cm, BOSTON SCIENTIFIC CORPORATION) attached to its tip

- 1 L Plastic graduated cylinder (cylinder diameter $\phi 70$ mm $\times$ total height 420 mm)

- Sample to be packed in a pouch: A soft pack container for liquid food (pouch with one outlet) having 300 ml of liquid foods filled and sealed therein is used as a sample (the size of the soft pack container used is 25.5 cm in length $\times$ 17 cm in width, the outside diameter of the tip of an attachment port (spout part) is 0.6 cm, and normally, the container is filled with a volume of 333 ml. Also, as shown in Figure 3, the attachment port is disposed at one of the bottom corners.)

A dripping test was performed using a device shown in Figure 3. A vat 6 is placed on a scale 7 shown in Figure 3, and a 1 L graduated cylinder 4 filled with water 5 ($25 \pm 2^\circ\text{C}$ drinkable water, tap water) is placed on top of the vat 6. A sample pouch 1, in which a feeding tube 3 or a tube with a button attached to its tip 3 is connected to a spout part 2, is mounted on a stand so that the sample pouch 1 is hung from the stand. Subsequently, the height of the stand is adjusted so that the tip of the aforementioned tube or button deposits in a depth of water d of 13 to 15 cm in the graduated cylinder 4. After confirming that the tube or button was filled with the sample content, the tube or button was fixed with a clamp so that dripping of the liquid food was stopped. This state was defined as the initial state of measurement. After confirming the initial weight of the scale, dripping is started by removing the clamp. Time elapsed until the amount of dripping reached 100 g was measured. [0119]

It is assumed that human stomach is under an abdominal pressure of approximately 10 mmHg. Taking this into consideration, the experimental apparatus was designed so that the

tip of the tube deposits at a depth of water of 14 cm. That is, the water pressure is approximately 10 mmHg at a depth of water of 14 cm, and this was assumed to serve as abdominal pressure.

[Table 3-1]

	Formulation 1	Formulation 2
Raw material	Formulation ratio (w/w%)	Formulation ratio (w/w%)
Milk-derived protein	7.2	7.2
Dextrin	22.5	22.5
Indigestible dextrin	2.2	1.76
Insoluble soybean dietary fiber	0	0.44
Sucrose	1.6	1.6
Mineral mixture	1.3	1.3
pH Adjuster	0.16	0.16
Prepared fat	4.23	4.15
Fragrance	0.18	0.18
Emulsifier	Diacetyl tartaric (acid) ester of monoglyceride (DATEM)	Diacetyl tartaric (acid) ester of monoglyceride (DATEM)
	0.64	0.63
Thickening agent	λ -Carrageenan	λ -Carrageenan
	0.12	0.053
Water	59.69	60.77

[Table 3-2]

Composition	Formulation 1	Formulation 2
Protein	6.3g/100g	6.3g/100g
Lipid	4.4g/100g	4.4g/100g
Carbohydrate	24.7g/100g	24.65g/100g
Detail Sugar	22.7g/100g	22.7g/100g
Dietary fiber	2.0g/100g	1.95g/100g

[Table 3-3]

	Commercially available liquid food (per pack)
Content (g)	400
Calories (kcal)	300
Protein (g)	12
Lipid (g)	6.6
Carbohydrate (g)	50.8
Sugar (g)	45.9
Dietary fiber (g)	4.9
Water (g)	330
Viscosity (mPa·s)	4,000
Specific weight	1.06

[0120]

Shear rate-dependent viscosity

In Figure 1, the shear rate (1/s) and viscosity are expressed in logarithmic scale on the horizontal axis and vertical axis, respectively. The viscosity of the commercially available liquid food is extremely high at a low shear rate, while the viscosity is low at a high shear rate. An ideal Newtonian fluid exhibits a horizontal linear line for having a constant viscosity, irrespective of the shear rate. Regarding formulations 1, 2, 3 and 4, which are the nutritional compositions of the present invention, the non-Newtonian fluidity characteristic is alleviated and a low viscosity is maintained even at a low shear rate (Formulation 2 exhibits a viscosity of approximately 1000 at a shear rate of 1.0), and even at a high shear rate the decrease of viscosity is relatively low (Formulation 2 exhibits a viscosity of approximately 200 at a shear rate of 100).

[Table 4]

	Results of measurement of shear rate-dependent viscosity				Results of dripping test	
	Non-Newtonian viscosity index (n value)	Viscosity (mPa·s)			Time (minutes) for dripping of 100 g	
		1/s	10/s	100/s	Tube	Button
Commercially available liquid food	0.288	2500	450	96	3.2	170
Formulation 1 of the present invention	0.679	730	390	170	4.0	14
Formulation 2 of the present invention	0.677	1020	480	230	4.5	23
Formulation 3 of the present invention	0.761	648	474	240	-	-
Formulation 4 of the present invention	0.612	2110	931	391	-	-
Production Example 1 of the present invention	0.701	2000	1050	500		
Production Example 2 of the present invention	0.691	1100	570	280		

[0121]

The results are shown in Figure 4 and Table 4. Regarding the results of measurement of the shear rate-dependent viscosity, the viscosity of the commercially available liquid food varied greatly according to the shear rate. Meanwhile, in Formulations 1 and 2 of the present invention, the phenomenon of shear thinning is alleviated. Regarding the dripping test, when a feeding tube was used, time (minutes) required until the amount of dripping of the commercially available liquid food reached 100 g was 3.2 minutes, whereas that was 4.0 minutes and 4.5 minutes for Formulations 1 and 2 of the present invention, respectively. Also, when a button was used, the time required for the commercially available liquid food was 170 minutes, whereas that was 14 minutes and 23 minutes for Formulations 1 and 2 of the present invention, respectively. In fact, when the commercially available liquid food was dripped using a button, dripping almost completely stopped after reaching a cumulative drip amount of 47.4 g, which occurred 20 minutes after initiation of dripping. Therefore, the aforementioned 170 minutes were obtained by approximation from the plot for the dripped weight (g) - dripping time (minutes) from 0 to 20 minutes. As shown above, particularly when a button is used, the viscosity of a commercially available product increases due to a decrease in the shear rate, resulting in a drastically reduced flow rate. Meanwhile, the aforementioned problem of shear thinning is improved and solved with the nutritional composition of the present invention as shown in Figure 2. The ratio of dripping rate

between the use of a tube and the use of a button was 0.019 for the conventional product, 0.286 for Formula 1 of the present invention, and 0.196 for Formulation 2 of the present invention, revealing that the problem of shear thinning is markedly improved.

[0122]

Assessment of fluidity index

In the following viscous property formula:

$$P = \mu D^n$$

[wherein, P represents a shear stress(Pa), which is a value obtained by multiplying the viscosity value by the shear rate value, D represents a shear rate, μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index. The viscosity (25°C, Pa·s) is measured under the conditions of a gap of 1 mm, 25°C, a shear rate of 1 to 1000/s, for example 1 to 100/s, using the rheometer Physica MCR301 (Anton Paar) with a cone plate having a diameter of 25 mm]

an ideal Newtonian fluid has $n = 1$ and when the shear rate (1/s) and shear stress (Pa) are expressed in logarithmic scale on the horizontal axis and vertical axis, respectively, an ideal Newtonian fluid exhibits a linear line passing through the origin. In contrast, the slope of a non-Newtonian fluid is n, wherein n is a fluidity index of the non-Newtonian fluid. The relationship between the shear rate and shear stress of Formulations 1 to 4 of the present invention in comparison with that of a conventional product is shown in Figure 2. The viscosity (Pa·s) is a value obtained by dividing shear stress (Pa) by shear rate (1/s). As shown in Figure 2, the n of the commercially available liquid food is 0.288, whereas that of Formulation 1 of the present invention is 0.679 and that of Formulation 2 of the present invention is 0.677, and as shown in Table 4, the n of Formulation 3 is 0.761 and that of Formulation 4 is 0.612, revealing that the fluidity index of the Formulations of the present invention is relatively closer to 1 compared to the commercially available liquid food. Further, similarly to Formulations 3 and 4, there was a tendency that the viscosity of the nutritional compositions of Production Examples 1 and 2, to which insoluble soybean dietary fiber was added but not a thickening agent, increased after retort heat sterilization. There was

a tendency that in these nutritional compositions, the value of n approached closer to 1 compared to the commercially available liquid food (Table 4).

Reference Signs List

[0123]

- 1 Sample pouch
- 2 Spout part
- 3 Tube
- 4 Graduated cylinder
- 5 Water
- 6 Vat
- 7 Scale

All the publications, patents, and patent applications cited in the present specification are incorporated herein by reference in their entirety.

CLAIMS

[Claim 1]

A nutritional composition having a fluidization characteristic comprising a water-absorbing dietary fiber in an amount of 0.10 to 1.50% by weight of the nutritional composition, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate 0.1/s to 1000/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index,

the value of n is 0.3 to 1.0 and the viscosity at a shear rate of 10/s (25°C) is 150 mPa·s or more, wherein the water-absorbing dietary fiber is an insoluble dietary fiber.

[Claim 2]

A nutritional composition having a fluidization characteristic comprising a water-absorbing dietary fiber in an amount of 0.10 to 1.50% by weight of the nutritional composition, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 100/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index,

the value of n is 0.4 to 0.8 and the viscosity at a shear rate of 10/s (25°C) is 150 to 1000 mPa·s or more, wherein the water-absorbing dietary fiber is an insoluble dietary fiber.

[Claim 3]

The nutritional composition having a fluidization characteristic according to claim 1 or 2, wherein the insoluble dietary fiber is an insoluble fiber of a *fusuma* bran dietary fiber of a cereal.

[Claim 4]

The nutritional composition having a fluidization characteristic according to claim 1 or 2, wherein the insoluble dietary fiber is an insoluble fiber of soybean dietary

fiber and/or soybean *fusuma* bran.

[Claim 5]

The nutritional composition having a fluidization characteristic according to claim 1 or 2, comprising one or more from the group consisting of protein, lipid, and sugar, wherein the specific gravity of the composition is 1.06 to 1.5.

[Claim 6]

The nutritional composition having a fluidization characteristic according to claim 1 or 2, comprising one or more from the group consisting of a thickening agent and an emulsifier.

[Claim 7]

The nutritional composition having a fluidization characteristic according to claim 1 or 2, wherein the viscosity of the composition is 5 to 300 mPa·s, wherein the viscosity of the composition is measured at 45 to 85°C and 12 rpm using a spindle type rotational viscometer.

[Claim 8]

A nutritional composition having a fluidization characteristic comprising an adjuvant selected from the group consisting of a water-absorbing dietary fiber in an amount of 0.10 to 1.50% by weight of the nutritional composition, a thickening agent that does not have a network structure in an aqueous solution in an amount of 0.10 to 1.50% by weight of the nutritional composition, and a starch not having been subjected to pregelatinization treatment in advance in an amount of 0.10 to 1.50% by weight of the nutritional composition, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate 0.1/s to 1000/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index,

the value of n is 0.3 to 1.0 and the viscosity at a shear rate of 10/s (25°C) is 150 mPa·s or more,

wherein a homogenization treatment is performed prior to a heat treatment by adjusting the homogenization treatment pressure to 10 to 100 MPa, and wherein said heat treatment is used to produce the nutritional composition.

[Claim 9]

A nutritional composition having a fluidization characteristic comprising an adjuvant selected from the group consisting of a water-absorbing dietary fiber in an amount of 0.10 to 1.50% by weight of the nutritional composition, a thickening agent that does not have a network structure in an aqueous solution in an amount of 0.10 to 1.50% by weight of the nutritional composition, and a starch not having been subjected to pregelatinization treatment in advance in an amount of 0.10 to 1.50% by weight of the nutritional composition, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 100/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index,

the value of n is 0.4 to 0.8 and the viscosity at a shear rate of 10/s (25°C) is 150 to 1000 mPa·s or more,

wherein a homogenization treatment is performed prior to a heat treatment by adjusting the homogenization treatment pressure to 10 to 100 MPa, and wherein said heat treatment is used to produce the nutritional composition.

[Claim 10]

The nutritional composition having a fluidization characteristic according to claim 1 or 2, wherein the viscosity of the composition reaches 300 to 3000 mPa·s by subjecting the composition to a heat treatment and then to storage at a temperature equal to or below normal temperature of 15 to 25°C for 1 to 90 days, wherein the viscosity of the composition is measured at 20°C and 12 rpm using a spindle type rotational viscometer, wherein said heat treatment is used to produce the nutritional composition.

[Claim 11]

A method for producing a nutritional composition having a fluidization characteristic comprising an adjuvant, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 1000/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index,

the value of n is 0.3 to 1.0 and the viscosity at a shear rate of 10/s (25°C) is 150 mPa·s or more, comprising the steps of:

i) preparing an adjuvant selected from the group consisting of a water-absorbing dietary fiber, a thickening agent that does not have a network structure in an aqueous solution, and a starch not having been subjected to pregelatinization treatment in advance, wherein said adjuvant is 0.10 to 5.00% by weight relative to the nutritional composition,

ii) applying pressure treatment for homogenization, and

iii) applying heat treatment,

wherein the viscosity of the composition prior to the heat treatment is 5 to 300 mPa·s, wherein the viscosity of the composition prior to the heat treatment is measured at 45 to 85°C and 12 rpm using a spindle type rotational viscometer, and the homogenization treatment pressure in the step of applying pressure treatment for homogenization is 10 to 100 MPa, and the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature of 15 to 25°C for 1 to 90 days is 300 to 3000 mPa·s, wherein the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature of 15 to 25°C for 1 to 90 days is measured at 20°C and 12 rpm using a spindle type rotational viscometer.

[Claim 12]

A method for producing a nutritional composition having a fluidization characteristic, wherein the composition is prepared so that when results of measurement of shear stress and shear rate at any two or more measurement points in a shear rate range of shear rate of 0.1/s to 100/s are expressed by the following viscous property formula:

$$P = \mu D^n$$

wherein, P represents a shear stress (Pa), D represents a shear rate (1/s), μ represents a non-Newtonian viscosity coefficient, and n represents a non-Newtonian viscosity index,

the value of n is 0.4 to 0.8 and the viscosity at a shear rate of 10/s (25°C) is 150 to 1000 mPa·s, comprising the steps of:

i) preparing an adjuvant selected from the group consisting of a water-absorbing dietary fiber, a thickening agent that does not have a network structure in an aqueous solution, and a starch not having been subjected to pregelatinization treatment in

advance, wherein said adjuvant is 0.10 to 5.00% by weight relative to the nutritional composition,

ii) applying pressure treatment for homogenization, and

iii) applying heat treatment,

wherein the viscosity of the composition prior to the heat treatment is 5 to 300 mPa·s, wherein the viscosity of the composition prior to the heat treatment is measured at 45 to 85°C and 12 rpm using a spindle type rotational viscometer, and the homogenization treatment pressure in the step of applying pressure treatment for homogenization is 10 to 100 MPa, and the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature of 15 to 25°C for 1 to 90 days is 300 to 3000 mPa·s, wherein the viscosity of the composition after the heat treatment and storage at a temperature equal to or below normal temperature of 15 to 25°C for 1 to 90 days is measured at 20°C and 12 rpm using a spindle type rotational viscometer.

ABSTRACT

Provided is a liquid food that can be fed by free fall and has a more physiologically favorable viscous property than a liquid food having a very low viscosity. The use of an adjuvant that imparts a viscous property but not a shear thinning characteristic enables the provision of a nutritional composition which maintains a viscosity at which the production thereof is facilitated from the step of mixing raw materials to the step of filling a container with the resulting mixture, and which, after heat treatment, has a viscosity suitable for tube feeding by free fall.