ACIDIC PROTEIN BEVERAGE

Technical Field

[0001]

The present invention relates to an acidic and liquid form beverage containing a protein.

Background Art

[0002]

Protein is macromolecule and amphiphilic, and thus some proteins have gelation property, thickening property, and water retentivity. A powdery protein material containing high concentration of protein, such as isolated protein, is easy of distribution and storage management compared to the liquid form material because it does not contain water. In addition, it is widely used as an agent, which is added to various processed food, for improving physical property of the food because it is able to be included in high concentration.

Furthermore, for example, a soybean protein has a well-balanced amino acid composition and has a physiological function represented by hypocholesterolemic activity, and thus is used for a food appealing nutrition and health benefits, which is expected to supply nutrients and to have a physiological function.

[0003]

According to "Annual Report on the Aging Society: 2011" issued by Cabinet Office of Japan, an elderly population, that is, persons aged 65 years and over in Japan was a record high with 29.58 million, that is, one in five Japanese were elderly persons. Accordingly, Japan are in face of a super-aged society, in which elderly persons aged 65 years and over account for a proportion of over 21% of the entire population. Under the circumstances, "Healthy Japan 21" promoted by Ministry of Health, Labour and Welfare of Japan states its aim of extending healthy life expectancy. The term "healthy life expectancy" refers to a period without any disease or disorder during one's lifespan, and is represented by the following equation: healthy life expectancy (an average period of self-sufficient living) = average life expectancy - a period of self-insufficient living (a period when one cannot live self-sufficiently because of ill health).

[0004]

For an extension of healthy life expectancy, intake of a required amount of nutritional components is indispensable. Among others, proteins are essential materials to preserve life, and the proteins construct human tissues as well as perform various functions. According to "Dietary Reference Intakes for Japanese"

(2010) issued by Ministry of Health, Labour and Welfare of Japan, a recommended intake amount of proteins for an elderly person aged 70 years or over is 60 g daily, which is the same as that for a general adult. Generally, an elderly person is, however, inactive with respect to daily activities, and also has a decreased appetite, which results in decreased dietary intake. Accordingly, an efficient intake of proteins with a small amount of ingestion is required.

[0005]

In the circumstances, excellent nutritional physiological functions of various proteins have been utilized to develop food products for the purpose of supplying an elderly person with proteins. As one of the forms of the food products, various beverages have been developed. However, most of previously marketed products of high protein beverages for supplying proteins were neutral beverages. However, in accordance with growing numbers of elderly population, palatability requirements of the elderly population have been changed, which results in requirement of food products which are rich in variety, and thus it is required to develop food products with an acidic flavor, such as food products containing a fruit juice, as well as food products with a neutral flavor. Further, products with an acidic flavor are also required in the

field of enteral nutrients (also called as "thick liquid food").

[0006]

However, most proteins such as soybean protein and milk protein have isoelectric points within an acidic range. Thus such proteins are precipitated under an acidic condition, which results in deterioration of the commercial value in terms of appearance and feel in the mouth. Further, most health-oriented beverages and enteral nutrients are fortified with minerals such as calcium and magnesium, and the minerals are highly reactive with proteins, which results in promotion of protein aggregation, and thus stabilization of protein dispersion becomes much more difficult. Furthermore, since fat is also included in an enteral nutrient, long-term emulsion stability is also required.

Accordingly, in an acidic and liquid form beverage, a technique by which a large amount of protein may be included and dispersion of the protein is stabilized for long periods of time is required.

Prior Art Documents

Patent Documents

[0007]

Patent Document 1: JP H05-7458 A

Patent Document 2: JP H07-99947 A

Patent Document 3: JP 2001-190220 A

Patent Document 4: JP 2005-323530 A

Patent Document 5: JP S60-256372 A

Patent Document 6: JP 2007-536924 A

Summary of Invention

Problems to be Solved by Invention

[0008]

A dispersion stability of a protein is most deteriorated in an acidic and liquid form beverage. It is technically difficult that a relatively large amount of protein is included in such a beverage. Specifically, it is more difficult to stabilize a dispersion obtained by rehydrating powdery protein material in powder state and adding the rehydrated protein in large amount. Further, even if a liquid form beverage containing a relatively large amount of protein was supplemented with, for example, water-soluble polysaccharides already known as a dispersion stabilizer for protein from Patent Documents 1 to 6, still it has been difficult to prevent formation of precipitate and to ensure dispersion stability of the protein for a long period of time.

Thus, an object of the present invention is to provide an acidic and liquid form beverage in which precipitate is

hardly formed and dispersion of protein in the liquid is stably maintained for a long period of time even when a relatively large amount of protein is included.

Means for Solving the Problems

[0009]

The inventors initially tried to use combinations of powdery protein materials having high solubility and various water-soluble polysaccharides to solve the above-mentioned problems. However, it was difficult to stabilize a protein dispersion by any of the combinations. The inventors have further extensively studied for the above problems. As a result, they have found that, in a system of protein beverage in a liquid form and acidic having a pH of 3 to 5 in which a relatively large amount of protein is contained and water-soluble polysaccharides are used in combination as a dispersion stabilizer for the protein, it is important for stabilization of a protein dispersion in the acidic beverage that soybean polysaccharide or pea polysaccharide is selected as water-soluble polysaccharide, further a specific powdery protein material is selected, and the selected polysaccharide and powdery protein material are included in combination. The present invention has been completed based on the findings.

[0010]

Accordingly, the present invention includes constitutions as described below:

(1) An acidic protein beverage including a protein-containing raw material, and soybean polysaccharide and/or pea polysaccharide, where the acidic protein beverage contains 1% by weight or more of protein, where the acidic protein beverage is liquid form, where pH of the acidic protein beverage is pH of 3 to 5, and where at least one of the protein-containing raw material is a powdery protein material which meets the following a) to c):

a) the powdery protein material is a protein hydrolysate, and a degree of hydrolysis of the protein hydrolysate is 10 to 35% as a 0.22 M trichloroacetic acid (TCA) solubility,

b) Nitrogen Solubility Index (NSI) of the powdery protein material is 10 to 80, and

c) dilute acid NSI of the powdery protein material is 10 to 70;

(2) The acidic protein beverage of (1), where the protein content of the acidic protein beverage is 1 to 20% by weight;

(3) The acidic protein beverage of (1) or (2), where the protein content of the powdery protein material is 40% by weight or more in a dry basis;

(4) The acidic protein beverage of any one of (1) to

(3), where a content of insoluble dietary fiber of the powdery protein material is 2% by weight or less in a dry basis;

(5) The acidic protein beverage of any one of (1) to (4), where a transmittance, which is obtained by measuring a 5% by weight dispersion liquid of the powdery protein material with a spectrophotometer at 600 nm, is 1%T or less;

(6) The acidic protein beverage of any one of (1) to (5), where the powdery protein material is derived from one or more selected from the group consisting of soybean, pea, mung bean, and milk;

(7) The acidic protein beverage of any one of (1) to (6), where a proportion of centrifuge precipitate is 5% by weight or less after a centrifugation of the beverage under the condition at 700 × G for 20 minutes;

(8) The acidic protein beverage of any one of (1) to (7), where an average particle size of particles dispersed in the beverage is 5 μm or less;

(9) The acidic protein beverage of any one of (1) to (8), wherein viscosity of the beverage is 50 mPa·s or less;

(10) The acidic protein beverage of any one of (1) to (9), where the beverage is an enteral nutrient;

(11) The acidic protein beverage of any one of (1) to (10), wherein the beverage is filled in a hermetic

container and the container is sealed;

(12) The acidic protein beverage of any one of (1) to (5), where the powdery protein material is derived from one or more selected from the group consisting of soybean, pea, and mung bean, and where a proportion of centrifuge precipitate is 5% by weight or less after a centrifugation of the beverage under the condition at 700 × G for 20 minutes;

(13) The acidic protein beverage of (12), where an average particle size of particles dispersed in the beverage is 5 μm or less;

(14) The acidic protein beverage of (13), where viscosity of the beverage is 50 mPa·s or less; and

(15) The acidic protein beverage of (14), where the beverage is an enteral nutrient, and where the beverage is filled in a hermetic container and the container is sealed.

Effects of Invention

[0011]

The present invention enables to provide an acidic protein beverage in which dispersion of protein in a liquid is stably maintained for a long period of time, and emulsification property with fat is favorable, whereas a relatively large amount of protein is included in the acidic protein beverage which is liquid form and has pH of

3 to 5. Furthermore, the present invention enables to maintain dispersion stability of protein even in the case of low viscosity, and thus the acidic protein beverage may be made as a beverage having clean taste with low coarse texture and no viscosity, and also may be made as a beverage having a favorable flavor which is derived from a powdery protein material as a raw material.

Mode for Carrying Out Invention

[0012]

An acidic protein beverage of the present invention is characterized in that at least one of raw materials containing a protein is a powdery protein material which meets following three requirements:

a) the powdery protein material is a protein hydrolysate, and the degree of hydrolysis is 10 to 35% as a 0.22 M trichloroacetic acid (TCA) solubility,

b) Nitrogen Solubility Index (NSI) of the powdery protein material is 10 to 80, and

c) dilute acid NSI of the powdery protein material is 10 to 70;

where a protein content is 1% by weight or more, soybean polysaccharides and/or pea polysaccharides are contained as a dispersion stabilizer for a protein, and the acidic protein beverage is liquid form and has a pH of 3 to 5.

A detailed description of embodiments of the present invention is provided below.

[0013]

(Liquid form and acidic protein beverage)

A liquid form and acidic protein beverage, which is the subject matter of the present invention (hereinafter called as "the present beverage"), is developed as a liquid form commercial product, and drunk by consumers. A beverage recently called as a RTD (Ready-To-Drink) beverage and an enteral nutrient are also conceptually included in the liquid form and acidic protein beverage.

[0014]

The enteral nutrient (eternal nutrient), which is also called as a thick liquid food in Japan, refers to a liquid form nutritional composition, such as, in the form of soup and potage with no solid ingredients, milk beverage, and fruit beverage. The enteral nutrient has a caloric value of 1 kcal/mL or more and contains at least protein, lipid, carbohydrate, mineral, and vitamin as nutrient components. Preferably, the enteral nutrient has an energy formulation of 10 to 25% of protein, 15 to 45% of lipid, and 35% or more of carbohydrate, and formulation of 20 to 110 mg/100 kcal of calcium and 10 to 70 mg/100 kcal of magnesium. More preferably, the enteral nutrient has an energy formulation of 16 to 20% of protein, 20 to 30% of lipid,

and 50 to 65% of carbohydrate, and formulation of 35 to 65 mg/100 kcal of calcium and 15 to 40 mg/100 kcal of magnesium.

[0015]

As a typical example of the distribution form, the beverage is filled in a hermetic container with sealing and sold to a consumer as a packed beverage. As another example, the beverage is poured into a drink server in a restaurant, and poured into a cup to be served to a consumer at request. Accordingly, it is stringently required that precipitates of an insolubilized protein are hardly formed when stored in a liquid form for a long period of time. An effect of the present invention is specifically produced in an embodiment of a liquid form beverage, and is most remarkably produced in a form of a hermetic container-filled beverage stored for a longer period of time.

[0016]

Further, liquid properties of the present beverage have acidity of pH of 3 to 5, more preferably pH of 3.4 to 4.6. A skilled person in the art selects pH values within the above-mentioned range with considering qualities such as flavor of a product. When pasteurization conditions are desired to be as mild as possible, selection of pH ranging from 3 or more to less than 4 is preferable. Alternatively,

pH ranging from 4 to 5 may be selected for the purpose of reducing sour taste.

[0017]

(Protein)

The present beverage is an acidic protein beverage containing at least a protein as a nutrient component, and a protein content is 1% by weight or more with respect to the total weight of the beverage. Furthermore, a higher content of the protein, e.g. 1.5% by weight or more, more preferably, 2% by weight or more, further preferably, 2.5% by weight, is preferable because an effect of the present invention is effectively exerted. Further, an upper limit of the content may be 20% by weight or less, 15% by weight or less, or 10% by weight or less. Since most proteins such as soybean protein and milk protein have isoelectric points at around pH 4.5, solubility of proteins is drastically decreased under a liquid and acidic circumstance like in the present beverage, and thus proteins are easily precipitated during storage. That is, dispersion stability of proteins is deteriorated. When storage periods become longer, more precipitation occurs. However, such problems are solved by the present invention.

[0018]

Types of protein include plant-derived protein such as pulse, e.g. soybean, pea, and mung bean, and canola seed;

and milk-derived protein. Specifically, an effect of the present invention may be produced for protein from soybean, dispersion stabilization of which is generally relatively difficult under acidic condition. Protein in the present beverage is included by adding a protein material including the above-mentioned protein as a raw material to the present beverage, and then one essential and important raw material is a specific powdery protein material described in detail below. Further, in the present beverage, two or more of powdery protein materials may be used in combination, for example, soybean protein material and milk protein material may be used in combination.

[0019]

(Powdery protein material)

A specific powdery protein material used in the present beverage is a food material, which is used for various processed foods and beverages, containing a protein as a main ingredient. For example, a protein from soybean is prepared from soybean raw material, such as defatted soybean and whole soybean, by further processing the raw material to concentrate soybean protein. Generally, the protein from soybean conceptually includes isolated soybean protein, soymilk powder, or processed material thereof. In addition, milk-derived protein such as casein and milk protein concentrate (MPC) may be used.

A protein content of the powdery protein material is appropriately at least 40% by weight or more, preferably 50% by weight or more, more preferably 60% by weight or more in a dry basis.

A content of insoluble dietary fiber is preferably as low as possible to prevent precipitation of insoluble material during storage because the powdery protein material is used for a liquid form beverage. The content of insoluble dietary fiber is preferably 2% by weight or less, more preferably 1% by weight or less in a dry basis.

[0020]

Further, the specific powdery protein material used in the present beverage must meet further following essential requirements of a) to c).

a) the powdery protein material is a protein hydrolysate, and the degree of hydrolysis is 10 to 35% as a 0.22 M trichloroacetic acid (TCA) solubility,

b) Nitrogen Solubility Index (NSI) of the powdery protein material is 10 to 80,

c) dilute acid NSI of the powdery protein material is 10 to 70.

It is important that the included protein and specific polysaccharide, which is described below, coexist in the present beverage by adding the specific protein material, which meets the above a) to c). Then, as a result of a

synergistic effect of the above-mentioned combination, a liquid form and acidic protein beverage, which generates an extremely small amount of precipitates, and has little coarse texture, a homogeneous and favorable appearance, low viscosity, and a favorable flavor even when stored for a long period of time under a liquid and acidic circumstance of pH of 3 to 5 which is extremely unfavorable for dispersion stability of protein, may be obtained.

These requirements are described more specifically below.

[0021]

a) 0.22 M Trichloroacetic acid solubility

It is important that a powdery protein material used in the present beverage is a protein hydrolysate enzymatically degraded to a certain degree of degradation. The degree of degradation of a protein is shown by an index of 0.22 M trichloroacetic acid solubility (TCA solubility). The value is measured by Kjeldahl method as a proportion of a protein dissolved in 0.22 M trichloroacetic acid (TCA) with respect to the total protein in a dispersion liquid, which is obtained by dispersing a powdery protein material to water in an amount of 1.0% by weight as a protein content and sufficient stirring. The TCA solubility increases as degradation of a protein proceeds.

It is important that a powdery protein material used

in the present beverage has a 0.22 M TCA solubility in a range of 10 to 35%. Specifically, a lower limit is preferably 11% or more, more preferably 12% or more, further more preferably 13% or more. An upper limit is preferably 30% or less, more preferably 28% or less.

[0022]

When the TCA solubility of the material is too low, that is, the material is not enzymatically degraded or a degree of degradation is excessively low even though the material is degraded, precipitation tends to occur during storage, and thus coarse texture is readily perceptible because protein particles are not finely dispersed in the present beverage even when a specific polysaccharide described below coexists. In addition, when the TCA solubility is too high, that is, as the enzymatic degradation exceeds, a particle size of the proteins also tends to be large from unknown cause, and thus, precipitation occurs easily during storage, and thus coarse texture becomes readily perceptible. Further, as the degree of degradation increases, a bitter taste of the peptides degraded into low molecule becomes readily perceptible. A product so called "soybean peptides", such as commercially available "HINUTE (Registered Trademark) DC 6" (manufactured by FUJI OIL CO., LTD.), is a low molecular degradation product (having 10 bonds or less between amino

acids in the molecule), which is a considerably highly degraded product of proteins and has a 0.22 M TCA solubility of 90% or more, and thus is distinguished from a powdery soybean protein material used in the present beverage.

[0023]

When a degree of hydrolysis of the powdery protein material used in the present beverage is shown by a molecular weight of the protein as another index, the average molecular weight is preferably about 10,000 to about 100,000, more preferably about 20,000 to about 90,000. The average molecular weight may be measured by a method described below.

[0024]

b) Nitrogen Solubility Index (NSI)

It is important that a powdery protein material used in the present beverage has 10 to 80, preferably 15 to 75, more preferably 20 to 70 of NSI (Nitrogen Solubility Index) as an index of solubility in water.

When the NSI is too low, that is, solubility of proteins is too low, a large amount of precipitation occurs, and thus strong coarse texture becomes perceptible. In this respect, a powdery protein material whose NSI is lowered by, for example, addition of divalent metals such as calcium and magnesium, and reaction of proteins with the

divalent metals at the time of manufacture, tends to have strong coarse texture, and thus it is more preferable to use a powdery protein material which is not subjected to such a mineral reaction, and it is preferable to use a powdery protein material whose NSI is lowered by the enzymatic degradation represented by the above a).

The NSI is shown by a proportion (% by weight) of water-soluble nitrogen (a crude protein) with respect to the total nitrogen content measured by a predetermined method, and the NSI is shown by a value measured according to a method described below.

[0025]

c) Dilute acid NSI

A powdery protein material used in the present beverage is not an "acidic-soluble protein" such as an acidic-soluble soybean protein described in WO 2002/67690 A or a whey protein, in which proteins are highly soluble at an acidic range, but is characterized by having moderate or lower solubility at the acidic range. The solubility at an acidic range may be represented by "dilute acid NSI" (NSI is an abbreviation for Nitrogen Solubility Index) as an index, and a higher value of the dilute acid NSI indicates higher solubility at an acidic range. The dilute acid NSI is measured according to a method described below.

[0026]

It is important for a powdery protein material used in the present beverage to have dilute acid NSI of 10 to 70, preferably 11 to 60.

When dilute acid NSI of the material is too high as in the case of an acidic-soluble protein, proteins are highly soluble at an acidic range, but aggregation can occur as a result of reaction with minerals, and coagulant can be formed by heating. In addition, when dilute acid NSI of the material is too low, solubility of proteins is too low, and a large amount of precipitation occurs, and thus strong coarse texture becomes perceptible.

[0027]

The powdery protein material used in the present beverage has NSI and dilute acid NSI both in moderate ranges, and proteins are only partially dissolved in water. Thus, its dispersion liquid is not transparent as in the case of an acidic-soluble protein but is cloudy. Transmittance of the dispersion liquid (concentration: 5% by weight) is 1%T or less when measured with a spectrophotometer at 600 nm.

The transmittance (%T) is an index of transparency of a dispersion liquid containing a protein, and is defined as follows. That is, a dispersion liquid is obtained by dispersing protein powder into water to give a protein content of 5% by weight, and then stirring the resultant

liquid sufficiently, and the obtained dispersion liquid is measured with a spectrophotometer (U-3210 recording spectrophotometer manufactured by Hitachi High-Technologies Corporation) using a 1 cm cell at 600 nm to give the transmittance (%T).

[0028]

Varieties of powdery protein materials which meet all of the above-mentioned requirements of a) to c) are on the market, and thus such materials are commercially available. Examples of products which may be used include "PROLEENA (Registered Trademark) 800", "PROLEENA (Registered Trademark) HD 101", and "FUJIPRO (Registered Trademark) CL", in powdery soybean protein materials manufactured by FUJI OIL CO., LTD., and any product other than the above-mentioned products may also be used so long as it meets all of the above-mentioned requirements.

However, popular powdery soybean protein materials, which are not hydrolyzed, such as "FUJIPRO (Registered Trademark) F", have TCA solubility of less than 10% and NSI of 90 or more. Further, "PROLEENA (Registered Trademark) SU" has TCA solubility of more than 35%. Furthermore, "SOYASOUR (Registered Trademark)", which is known as an acid-soluble powdery soybean protein, has extremely high solubility of proteins at an acidic range, that is, 90 or more of NSI and 90% or more of dilute acid NSI, and high

transparency with 80%T or more of transmittance. Thus, these products do not correspond to the powdery protein materials, which meet the above-mentioned requirements, used in the present beverage.

[0029]

(Polysaccharide)

The present beverage contains specific polysaccharide (hereinafter, sometimes also called as "the present polysaccharide") along with the above-mentioned protein, and it is important to use soybean polysaccharide and/or pea polysaccharide, as the specific polysaccharide, as a dispersion stabilizer of the protein. It is a known effect of these polysaccharides to stabilize dispersion of proteins in the present liquid form and acidic beverage. However, a remarkable synergistic effect of a combination of the polysaccharide and the above-mentioned specific powdery protein material has been found in the present invention.

Soybean polysaccharide and pea polysaccharide are water-soluble polysaccharides which include saccharides such as rhamnose, fucose, arabinose, xylose, galactose, glucose, and uronic acid, and are generally have an average molecular weight of 1,000,000 or less analyzed by gel filtration HPLC method under the following conditions. The soybean polysaccharide and the pea polysaccharide may be

extracted from raw materials containing insoluble dietary fibers (pulp) of soybean and pea with water by a known method, and the resultant extract may be purified if required, and thus obtained preparation may be used. As the soybean polysaccharide, commercially available products may be used, for example, "SOYAFIBE (Registered Trademark)" series (manufactured by FUJI OIL CO., LTD.), and "SM" series (manufactured by San-Ei Gen F. F. I., Inc.) may be used. Further, the pea polysaccharide obtained by methods described in WO 2012/176852 A and WO 2014/103833 A may be used.

Gel filtration HPLC is performed by using a standard pullulan (Showa Denko K.K.) as a reference material, and using an analytical column "TSKgel G5000PWXL" (manufactured by Tosoh Corporation, column size: 7.8 mm I.D. × 30 cm, packing material substrate: methacrylate polymer, packing material particle diameter: 10 μm, exclusion limit molecular weight: 2,500,000). An average absolute molecular weight (MM) is calculated by multi-angle laser light scattering (MALLS), which was calibrated with toluene after passing through the column. An eluent used is, for example, 50 mM sodium acetate aqueous solution (pH 5.0). Column flow rate is, for example, 1.0 mL/min. And a detector used is, for example an RI detector and a MALLS detector. Nevertheless, each of conditions for analysis

may be changed as required as long as the change does not develop a large error in the analytical value.

[0030]

In the present beverage, other water-soluble polysaccharides used as a dispersion stabilizer for proteins also may be used in combination so long as an effect of the present beverage is not prevented. For example, propylene glycol alginate, high methoxyl pectin, carboxymethyl cellulose (CMC), xanthan gum, locust bean gum, guar gum, gum arabic, and the like may be used. With respect to timing for adding the present polysaccharide in the present beverage, the present polysaccharide is more preferably added before a step for homogenizing raw material liquid with a homogenizer, or by stirring or heat sterilization during a manufacturing process of the present beverage. The present polysaccharides may be added at timing either before or after adding protein in the present beverage. The present polysaccharide may be mixed with protein sufficiently under aqueous conditions for homogenization in advance, and the homogenized material may be used. The present polysaccharide also may be added in a powdery protein material under aqueous conditions or under dry conditions in advance, and the resultant material may be used. A content of the present polysaccharide added in the present beverage is preferably 5 to 40% by weight, more

preferably 7 to 35% by weight with respect to the protein content. Within the above-mentioned range, the present polysaccharide may react with proteins sufficiently, and may exert the effect to stabilize dispersion of proteins in an acidic liquid more efficiently. The content of the present polysaccharide may be analyzed based on a content of dietary fiber as an indication, and may be analyzed by an official measurement method for dietary fiber using an enzymatic-gravimetric method (modified Prosky method) as water-soluble dietary fiber independent of insoluble dietary fiber.

[0031]

(Average particle size in beverage)

In the present beverage, protein particles included from specific powdery protein material may be homogenized and micronized by synergistic effect with the present polysaccharide. Thus, even when stored for long periods of time under acidic and liquid conditions, precipitate of protein is hardly formed and coarse texture is hardly perceptible. An average particle size of particles dispersed in the present beverage may be at least 5 μm or less, preferably may be 3 μm or less, more preferably 2 μm or less, further more preferably 1.5 μm or less, and most preferably 1 μm or less.

[0032]

(Proportion of centrifuge precipitate of a beverage)

In the present beverage, a precipitation amount during long-term storage is small, and dispersion stability of proteins is extremely excellent. As an index of the dispersion stability, a "proportion of centrifuge precipitate", which represents a proportion of a protein content in precipitates produced by centrifugation of a beverage to a protein content in the whole liquid, may be used.

Specifically, a certain fixed amount of measurement sample liquid is transferred into a centrifuge tube, and the centrifuge tube is centrifuged at conditions of at 700 G for 20 minutes with a centrifugal separator, and then supernatant is discarded to measure an amount of residual precipitate (g). A proportion of the amount of precipitate (% by weight) to the amount of the sample liquid (g) is referred to as a "proportion of centrifuge precipitate". Determination of long-term dispersion stability of proteins in a liquid is easily made by the "proportion of centrifuge precipitate". The proportion of centrifuge precipitate in the present beverage may be 5% by weight or less, preferably may be 3% by weight or less.

[0033]

(Viscosity of beverage)

The present beverage enables to maintain a quality

with high dispersion stability because the protein included is hardly precipitated even under an acidic pH and low viscosity. Viscosity of a beverage may be suitably controlled, for example, by addition of a thickener in accordance with preferences and thus is not specifically limited. However, lower viscosity is preferable when clean taste is preferred, and may be produce a higher effect of the present invention. The viscosity may be 50 mPa·s or less, preferably 20 mPa·s or less, more preferably 10 mPa·s or less. Furthermore, the viscosity may be 5 mPa·s or less. The viscosity is measured with a type B viscometer at room temperature of 20°C.

[0034]

(Other raw materials added in beverage)

A variety of raw materials may be added in the present beverage according to a product design in addition to the above-mentioned raw materials, and types and amounts of such materials are not specifically limited.

For example, variety of fruit juice (such as citrus fruit and grape), saccharide (such as sucrose, high-fructose corn syrup and dextrin), sweetener (such as sucralose and aspartame), fat (such as rapeseed oil, soybean oil, EPA and DHA), emulsifier (such as lecithin and fatty acid ester), pH adjuster (such as citric acid, fumaric acid, tartaric acid and phosphoric acid), mineral

(such as potassium salt, sodium salt, magnesium salt, calcium salt and iron salt), vitamin (such as A, B, C, D, E, P and K), chelating agent (such as sodium citrate and polymer phosphate), flavoring agent, physiologically functional material (such as isoflavone, saponin, lactic acid bacterium powder, peptide and glucosamine) may be added appropriately.

In a manufacturing process of the present beverage, timing for addition of a pH adjuster to adjust pH to 3 to 5 is preferably after the addition of a powdery protein material and the present polysaccharide.

[0035]

The present beverage may be manufactured by a known method, and may be manufactured through steps such as mixing of raw materials, addition of water, stirring, dissolution, pH adjustment, homogenization (with a homogenizer and the like), and heat sterilization.

[0036]

(Method for measurement)

Analytical values in the present invention are measured by methods for measurement provided below.

<Method for measurement of NSI>

To 3 g of sample is added 60 ml of water, stirred with propeller at 37°C for 1 hour, and then the mixture is centrifuged at 1400 × g for 10 minutes, and the resultant

supernatant liquid (I) is recovered. Then, to the residual precipitate is added again 100 ml of water, stirred with propeller again at 37°C for 1 hour, and then centrifuged, and the resultant supernatant liquid (II) is recovered. The liquid (I) and the liquid (II) are mixed, and to the liquid mixture is added water to make the volume to 250 ml. The resultant liquid mixture is filtered with filter paper (No. 5), and then nitrogen content in the filtrate is measured by Kjeldahl method. An amount of nitrogen in the sample is measured by Kjeldahl method simultaneously, and then a proportion of the amount of nitrogen recovered as the filtrate (water-soluble nitrogen) with respect to the total nitrogen content in the sample is represented in % by weight, which is referred to as NSI.

[0037]

<Method for measurement of dilute acid NSI>

To 2.0 g of sample is added 100 ml of 0.1% by weight of citric acid aqueous solution, and stirring and extraction are performed at 40°C for 60 minutes, and then the mixture is centrifuged at 1400 × g for 10 minutes to obtain supernatant 1. Then, to the residual precipitate is added again 100 ml of 0.1% by weight of a citric acid aqueous solution, stirring and extraction are performed at 40°C for 60 minutes, and then the mixture is centrifuged at 1400 × g for 10 minutes to obtain supernatant 2. The

supernatant 1 and the supernatant 2 are mixed, and 0.1% by weight of a citric acid aqueous solution is added to make the volume to 250 ml. The resultant liquid is filtered with a No. 5A filter, and then a nitrogen content in the filtrate is measured by Kjeldahl method. A nitrogen content in the sample is measured by Kjeldahl method simultaneously, and then a proportion of the nitrogen recovered as the filtrate (water-soluble nitrogen) with respect to the total nitrogen in the sample is represented in % by weight, which is referred to as dilute acid NSI.

[0038]

<Average molecular weight>

A dispersion liquid of a protein degradation product prepared by dilution with a 50 mM phosphate buffer (1% (weight/volume) SDS, 1.2% (weight/volume) NaCl, pH 7.0) is treated by ultrasonication for 10 minutes, and then filtered with a 0.2 μm filter. The obtained filtrate is passed through columns of a "TSK gel G3000 SWXL column" and a "TSK gel G2000 SWXL column" (both manufactured by Tosoh Corporation, column size: internal diameter of 7.8 mm × length of 30 cm) connected in series sequentially at flow rate of 0.4 ml/min at room temperature of 20°C, and then the protein degradation product is eluted with the above-described phosphate buffer. The protein degradation product is detected with a UV detector by measurement of

absorbance at 220 nm. A weight-average molecular weight of the protein degradation products in each fraction separated and purified as described above is calculated from a chart obtained with GPC software (manufactured by Tosoh Corporation)

[0039]

As molecular weight markers, compounds with following molecular weights are used.

335,000 (Thyroglobulin, manufactured by Wako Pure Chemical Industries, Ltd.)

150,000 (γ-globlin, manufactured by Wako Pure Chemical Industries, Ltd.)

67,000 (Albumin (BSA), manufactured by SIGMA)

43,000 (Peroxidase, manufactured by Wako Pure Chemical Industries, Ltd.)

18,000 (Myoglobin, manufactured by SIGMA)

12,384 (Cytochrome-C, manufactured by SIGMA)

5,734 (Insulin, manufactured by SIGMA)

307 (Glutathione, manufactured by Wako Pure Chemical Industries, Ltd.)

137 (p-amino benzoic acid, manufactured by Wako Pure Chemical Industries, Ltd.)

Examples

[0040]

Hereinafter, embodiments of the present invention are described in more detail with reference to examples. The expressions "%" and "parts" in the examples mean "% by weight" and "parts by weight" respectively unless otherwise described. All of the different powdery protein materials used in the Examples are commercially available products manufactured by FUJI OIL CO., LTD., and soybean polysaccharides used are "SOYAFIBE (Registered Trademark)-S" manufactured by FUJI OIL CO., LTD.

[0041]

Test Example 1 (Tests T1 to T9)

An undegraded powdery soybean protein material, "FUJIPRO (Registered Trademark) F" (protein content: 90.8% in a desiccated product), was provided, and commercially available products A to H were provided as hydrolyzed type powdery soybean protein materials. The commercially available products A to H are available by requesting to FUJI OIL CO., LTD.

Analytical values of 0.22 M TCA solubility (degree of degradation), NSI, and dilute acid NSI of these materials are shown in Table 1 below.

[0042]

Table 1

Test No.	T1	T2	T3	T4	T5	T6
Powdery protein material	FUJIPRO F	A	B	C	D	E
Protein content (% of solid content)	90.8	91.5	92.1	89.4	91.0	92.7
Degree of degradation (%)	**≤3**	**8**	14	19	21	23
NSI	**90**	**90**	**90**	80	65	65
Dilute acid NSI	**4**	**7**	15	20	21	25

Test No.	T7	T8	T9
Powdery protein material	F	G	H
Protein content (% of solid content)	91.1	91.0	93.0
Degree of degradation (%)	33	**50**	12
NSI	65	50	**93**
Dilute acid NSI	36	55	**95**

[0043]

To each of the powdery soybean protein materials was added water to make a protein concentration of 5%, and the resultant liquid was sufficiently mixed to obtain dispersion liquid. The pH of these dispersion liquids was adjusted to 4.0 with a 50% citric acid solution.

However, except for in the case of T9 using the commercially available product H which has a high dilute acid NSI and a favorable solubility under acidic conditions, each of the products alone produces aggregations in any of

the T1 to T8, and thus an acidic protein dispersion liquid were not prepared, and thus each of the products was unsuitable for an acidic protein beverage.

The protein dispersion liquid of T9 using the commercially available product H was in transparent liquid form even under acidic conditions and aggregations were not produced when the dispersion was heated. However, astringency was perceived, and thus there was a room for improvement of flavor for use in an acidic protein beverage.

[0044]

Test Example 2 (Tests T10 to T18)

Each of the powdery protein materials of Test Example 1 and soybean polysaccharide were mixed to make a protein concentration of 5% and a soybean polysaccharide concentration of 1%, and water was added to the mixture to disperse sufficiently to obtain dispersion liquid. The pH of the liquid mixture was adjusted to 4.0 with a 50% citric acid solution, and then the mixture was homogenized with a homogenizer at 20 MPa, heated to 93°C to sterilize, and cooled to obtain an acidic protein dispersion liquid.

Each of the obtained dispersion liquids was kept stationary at 20°C for 24 hours, and then physical properties of each dispersion liquids were measured. A viscosity was measured with a type B rotary viscometer (manufactured by Toki Sangyo Co., Ltd), and a median

diameter was measured with "SALD-2000" (manufactured by SHIMADZU CORPORATION). Further, a "proportion of centrifuge precipitate", which is an index of dispersion stability of protein, was calculated from a denominator and a numerator, which were obtained as follows: a certain amount of each dispersion liquid was taken in a centrifuge tube as a sample, and an amount of the obtained sample (g) was used as the denominator, and the obtained sample was centrifuged at conditions of at 700 × G for 20 minutes with a centrifugal separator, and then supernatant was discarded, and an amount of the residual precipitate (g) was used as the numerator.

For each of the dispersion liquids, 10 panelists were enrolled to make sensory evaluations of coarse texture, bitter taste, and astringency (astringent taste) using criteria as provided in Table 2 below, and average values of the evaluations made by each of the panelists were calculated. Then, the average values were classified as Grade "A" when the average value was less than 1.5 points, Grade "B" when the value was 1.5 points or more and less than 2.5 points, Grade "C" when the value was 2.5 points or more and less than 3.5 points, and Grade "D" when the value was 3.5 points or more and 4 points or less.

[0045]

Table 2

Coarse texture	1: No coarse texture 2: Slight coarse texture, but favorable 3: Some coarse texture, but permissible 4: Heavy coarse texture, and inadequate for drinking
Viscosity	1: No viscosity, and clean taste 2: Slight viscosity, but favorable 3: Some viscosity, but permissible 4: Heavy viscosity, and hard to drink
Bitter taste	1: No bitter taste 2: Slight bitter taste, but favorable 3: Some bitter taste, but permissible 4: Heavy bitter taste, and inadequate for drinking
Astringency	1: No astringency 2: Slight astringency, but favorable 3: Some astringency, but permissible 4: Heavy astringency, and inadequate for drinking

[0046]

Results of physical property measurement and results of sensory evaluation as described above are shown in Table 3, and overall judgments are made from these results, and then "overall evaluations" of whether each of the powdery protein materials is suitable for an acidic protein beverage are shown.

[0047]

Table 3

Test No.	T10	T11	T12	T13	T14	T15
Powdery protein material	FUJIPRO F	A	B	C	D	E
Degree of degradation (%)	≤3	8	14	19	21	23
NSI	90	90	90	80	65	65
Dilute acid NSI	4	7	15	20	21	25
Soybean polysaccharide	Yes	Yes	Yes	Yes	Yes	Yes
[Results of physical property measurements]						
Viscosity after heating (mPa·s)	2.4	2.5	2.3	2.5	2.5	2.2
Median diameter after heating (μm)	5.5	5.2	2.6	1.5	1.2	0.77
Proportion of centrifuge precipitate (%)	6.0	5.9	5.5	4.4	2.2	2.0
[Results of sensory evaluation]						
Coarse texture	D	D	C	B	A	A
Viscosity	A	A	A	A	A	A
Bitter taste	A	A	A	B	B	B
Astringency	A	A	A	A	A	B
[Overall evaluation]	×	×	×	○	○	○

Test No.	T16	T17	T18
Powdery protein material	F	G	H
Degree of degradation (%)	33	50	12
NSI	65	50	93
Dilute acid NSI	36	55	95
Soybean polysaccharide	Yes	Yes	Yes
[Results of physical property measurements]			
Viscosity after heating (mPa·s)	2.0	2.1	32
Median diameter after heating (μm)	0.80	3.8	2.6
Proportion of centrifuge precipitate (%)	1.7	8.7	1.2
[Results of sensory evaluation]			
Coarse texture	A	B	A
Viscosity	A	A	D
Bitter taste	C	D	B
Astringency	C	D	D
[Overall evaluation]	○	×	×

[0048]

Discussion

As shown in T13 to T16, the beverages using the selected powdery soybean protein materials C to F and soybean polysaccharide in combination had low viscosity even after heating, low proportions of centrifuge precipitate of 5% or less, and tendency to have low coarse texture, viscous, a bitter taste, and astringency, and thus the beverages were suitable for acidic protein beverages. Specifically, the beverages of T13 to T15, whose bitter taste and astringency were weak, using powdery soybean protein materials C to E were preferable.

As shown in T10, the beverage using "FUJIPRO (Registered Trademark) F" (undegraded/NSI 90) as a powdery soybean protein material was unsuitable in a proportion of centrifuge precipitate and coarse texture.

The beverages of T11 and T12, using powdery soybean protein materials A and B respectively, showed unfavorable dispersion stability of the protein in terms of proportion of centrifuge precipitate and unfavorable feel in the mouth in terms of coarse texture, and thus, ware unsuitable. This may be because their NSI were too high while they were degraded products.

On the contrary, the beverage of T17, using the

powdery soybean protein material G was, showed unfavorable median diameter after heating, proportion of centrifuge precipitate, bitter taste, and astringency. This may be because the degree of degradation, which was 50%, was too high. Further, the beverage using the powdery soybean protein material H showed unfavorable considerably high viscosity after heating, and astringency. This may be because the NSI and dilute acid NSI were too high.

Accordingly, the beverages were not suitable for acidic protein beverages in examples using the powdery protein materials except for the powdery soybean protein materials C to F of T13 to T16 even when combined with soybean polysaccharide which is dispersion stabilizer of proteins.

From the above, selected powdery protein material, which has a degree of degradation, NSI, and dilute acid NSI within certain ranges, used in combination with soybean polysaccharide, was suitable for an acidic protein beverage.

[0049]

Test Example 3 (Tests T19 to T20)

An acidic protein dispersion liquid was prepared by using the powdery soybean protein material D in the same manner as Test Example 2 except that HM pectin and Sodium Carboxymethyl Cellulose (CMC-Na) were used instead of soybean polysaccharide, and then physical property

measurement and sensory evaluation were performed. The obtained results are shown in Table 4.

[0050]

Table 4

Test No.	T19	T20
Powdery protein material	D	D
Degree of degradation (%)	21	21
Types of polysaccharide	HM pectin	CMC-Na
[Results of physical property measurements]		
Viscosity after heating (mPa·s)	**31**	4.6
Median diameter after heating (μm)	3.5	4.7
Proportion of centrifuge precipitate (%)	4.7	**15**
[Results of sensory evaluation]		
Coarse texture	B	C
Viscosity	**D**	B
Bitter taste	B	B
Astringency	A	A
[Overall evaluation]	×	×

[0051]

(Discussion)

As shown in T19 and T20, unsuitable properties as an acidic protein beverage were observed even when the powdery soybean protein material D was combined with HM pectin or CMC-Na. In T19, viscosity of the obtained acidic protein beverage was considerably increased, and thus the beverage had extremely highly viscous feel in the mouth, and did not have clean taste. In T20, median diameter after heating was large, and coarse texture was produced, and further a

large amount of centrifuge precipitate was found, and thus dispersion stability of proteins was low, and the beverage was unsuitable in deteriorated appearance of the product.

[0052]

Example 1 (Example of formulation for acidic protein beverage)

To 950 g of water was added 50 g of soybean polysaccharide, stirred and dissolved at 80°C for 20 minutes, and then cooled to 20°C to obtain 5% soybean polysaccharide solution. Then, into 560 g of water at room temperature was mixed 200 g of 5% soybean polysaccharide solution by stirring, and then 28 g of the powdery soybean protein material E having degree of degradation of 23% shown in Table 1 was mixed and dispersed homogeneously. Then, 90 g of granulated sugar and 70 g of high-fructose corn syrup were mixed, and stirred until the raw materials were dispersed homogeneously. Then, pH was adjusted to 4.0 with a 50% citric acid solution, and then water was added to make a total amount of 1000 g, and homogenization was carried out at 150 kg/cm^2. The homogenized dispersion liquid was pasteurized at conditions of at 90°C for 20 minutes, poured into a container, and then cooled to obtain an acidic protein beverage containing 2.5% of protein. The beverage formulation of Example 1 is listed in Table 5.

[0053]

Table 5

[Acidic protein beverage formulation]	(g)
Powdery protein material E	28
Granulated sugar	90
High-fructose corn syrup (Bx 70)	70
5% Soybean polysaccharide solution	200
Water	560
50% Citric acid solution	*
Additional water	q.s.
Total	1000

*add to make pH of 4.0

[0054]

Example 2 (Example of formulation for acidic enteral nutrient)

To 900 g of water was added 100 g of soybean polysaccharide, stirred and dissolved at 80°C for 20 minutes, and then cooled to 20°C to obtain 10% soybean polysaccharide solution. Then, into 500 g of water at room temperature during stirring was mixed 100 g of 10% soybean polysaccharide solution by stirring. Then, 55 g of powdery soybean protein material E having degree of degradation of 23% shown in Table 1, 76 g of granulated sugar, and 80 g of dextrin were mixed by powder blending, and the resultant mixture was mixed into the water at room temperature containing the soybean polysaccharide, and stirred until the raw materials were dispersed homogeneously. Then, pH was adjusted to 4.0 with 50% citric acid solution, and 100

g of mineral solution separately prepared according to the formulation of Table 5 was added, and the resultant mixture was stirred sufficiently. Then, 25 g of rapeseed oil was added, and pre-emulsification was carried out with a homomixer at 7000 rpm for 10 minutes, and water was added to make a total amount of 1000 g, and homogenizations were carried out at 450 kg/cm^2 for the first homogenization and 50 kg/cm^2 for the second homogenization. The homogenized dispersion liquid was sterilized at conditions of at 90°C for 20 minutes, and a container was filled with the resultant dispersion liquid and sealed, and then cooled to obtain an acidic enteral nutrient containing 5% of protein. The beverage formulation of Example 2 is listed in Table 6.

[0055]

Table 6

[Liquid food formulation]	(g)
Emulsifier	0.6
Powdery protein material E	55
Granulated sugar	76
Dextrin	80
Water	500
10% Soybean polysaccharide solution	100
50% Citric acid solution	*
Mineral solution	100
Rapeseed oil	25
Additional water	q.s.
Sum of raw materials	1000

*add to make pH of 4.0

[Mineral solution formulation]	(g)
Potassium dihydrogenphosphate	0.1
Potassium chloride	2.2
Sodium chloride	1.7
Magnesium chloride hexahydrate	1.5
Calcium lactate pentahydrate	5.3
Distilled water	q.s.
Total	100.0

[0056]

After stationary storing the acidic protein beverage and the enteral nutrient obtained in Examples 1 and 2 at 20°C for 24 hours, physical property measurement and sensory evaluation of each of the samples were carried out. The method for the measurement and the method for sensory evaluation were as described in Test Example 2. The obtained results are shown in Table 7.

[0057]

Table 7

	EXAMPLE 1 Acidic protein beverage	EXAMPLE 2 Acidic thick liquid food
[Results of physical property measurements]		
Viscosity (mPa·s)	1.98	5.82
Median diameter (μm)	0.96	1.70
Proportion of centrifuge precipitate (%)	1.80	0.59
[Results of sensory evaluation]		
Coarse texture	B	A
Viscosity	A	B
Bitter taste	A	A
Astringency	A	A
[Overall evaluation]	○	○

[0058]

In either case, the beverages had extremely low viscosity of less than 6 mPa·s, and median diameter of less than 2 μm, that is, physical property conditions were preferable, and the particles were minute, and thus the beverages had a smooth feel in the mouth, and had a less coarse texture. Further, a proportion of centrifuge precipitate was less than 2%, and thus beverages having remarkably preferable dispersion stability of protein could be obtained. Furthermore, in the enteral nutrient in Example 2, separation of fat during storage was not observed, and thus an emulsion stability was also high. In

addition, with respect to flavor, bitter taste and astringency were exceedingly weak, and thus the beverages tasted good.

[0059]

Examples 3 and 4

Acidic protein beverages were obtained in the same manner as Example 1 except that the 50% citric acid solution of the formulation in Example 1 was added to adjust the pH to 3.4 (Example 3) and to adjust the pH to 4.5 (Example 4) respectively. These beverages had a favorable mouthfeel and favorable dispersion stability of proteins similar to that of Example 1.

[0060]

As described above, when powdery protein material having a certain degree of degradation and soybean polysaccharide are selected and used in combination, acidic and liquid form beverage having remarkably favorable flavor, mouthfeel, and dispersion stability of protein was obtained.

CLAIMS

1. An acidic protein beverage comprising a protein-containing raw material, and soybean polysaccharide and/or pea polysaccharide as a protein stabilizer, wherein the acidic protein beverage comprises 2.5 to 20% by weight of plant-derived protein with respect to the total weight of the beverage, wherein a content of the soybean polysaccharide and/or pea polysaccharide in the acidic protein beverage is 5 to 40% by weight with respect to the plant-derived protein content, wherein the acidic protein beverage is liquid form, wherein a viscosity of the acidic protein beverage after heat sterilization is 10 mPa·s or less, wherein pH of the acidic protein beverage is pH of 3 to 5, wherein a proportion of centrifuge precipitate is 3% by weight or less after a centrifugation of the beverage under the condition at 700 × G for 20 minutes, wherein an average particle size of particles dispersed in the beverage is 5 μm or less, wherein the beverage is filled in a hermetic container after heat sterilization and the container is sealed, and wherein at least one of the protein-containing raw material is a powdery protein material which meets the following a) to c):

a) the powdery protein material is a protein hydrolysate, and a degree of hydrolysis of the protein

hydrolysate is 10 to 28% as a 0.22 M trichloroacetic acid (TCA) solubility,

b) Nitrogen Solubility Index (NSI) of the powdery protein material is 20 to 70, and

c) dilute acid NSI of the powdery protein material is 10 to 70.

2. The acidic protein beverage according to claim 1, wherein the plant-derived protein is soybean protein.

3. The acidic protein beverage according to claim 2, wherein the protein content of the powdery protein material is 40% by weight or more in a dry basis.

4. The acidic protein beverage according to claim 3, wherein a content of insoluble dietary fiber of the powdery protein material is 2% by weight or less in a dry basis.

5. The acidic protein beverage according to claim 4, wherein a transmittance, which is obtained by measuring a 5% by weight dispersion liquid of the powdery protein material with a spectrophotometer at 600 nm, is 1%T or less.

6. The acidic protein beverage according to claim 1, wherein the beverage is an enteral nutrient.