However, it was observed by the present inventors that the protein-dense, low viscosity compositions according to EP2249666 suffer from the drawback that it forms protein coagulates at stomach pH values and thus shows a reduced digestibility. As a consequence, they have a limited use for enhancing the concentration of essential amino acids in the blood, e.g. in the treatment and/or prevention of a condition linked to a loss of muscle mass and/or strength.

It is therefore an object of the present invention to develop an improved low volume liquid nutritional composition of low viscosity, having a high protein content (>10g/100 ml), which is shelf-stable (UHT treated) and which does not suffer from coagulation in the upper gastro-intestinal tract. In particular, the inventors sought to provide a protein-dense liquid composition which is useful in the therapeutic or preventive treatment of loss of muscle mass and/or strength, for example a condition related to malnutrition and loss of muscle mass. Advantageously, the composition can be used to prevent or reduce coagulation in the upper gastro-intestinal tract; to increase the rate of gastric emptying; to enhance protein digestion, and/or to increasing the blood serum concentration of free essential amino acids, preferably leucine. Preferably, the composition shows a rate of gastric emptying, gastric digestion at substantially the same level as whey protein.

Summary

It was surprisingly found that at least some of these goals were met by the provision of a heat-treated liquid high-protein composition comprising at least 10 g of protein per 100 ml of the composition, wherein at least 40 wt.% of the protein is micellar casein and at least 10 wt.% of the protein is hydrolysed whey protein having a degree of hydrolysation (DH) of at least 5%, and wherein the weight ratio of micellar casein to hydrolysed whey protein is in the range of 40:60 to 90:10. More in particular, it is demonstrated herein using a gastric simulation model that such a combination of micellar casein and hydrolysed whey protein allows gastric emptying and digestion comparable to whey protein, but considerably faster than the reference micellar casein and caseinate source as taught in EP2249666. Overall, the blend of micellar casein and hydrolysed whey

allows for a high concentration (> 10g/100ml) of high-quality protein (in contrast to e.g. hydrolysed collagen) in a small serving volume, and showing a fast and high-quality amino acid profile that is known to be beneficial in the treatment and/or prevention of a condition linked to a loss of muscle mass and/or strength.

In one aspect, the present disclosure refers to a use of a heat-treated liquid high-protein composition comprising at least 10 g of protein per 100 ml of the composition, wherein at least 40 wt.% of the protein is micellar casein and at least 10 wt.% of the protein is hydrolysed whey protein having a degree of hydrolysation of at least 5%, and wherein the weight ratio of micellar casein to hydrolysed whey protein is in the range of 40:60 to 90:10, in the manufacture of a medicament for the treatment and/or prevention of a condition linked to a loss of muscle mass and/or strength, wherein the subject is suffering from a decline of lean muscle mass, muscle wasting, muscle decline, bone decline, sarcopenia, osteoporosis and/or osteosarcopenia.

In another aspect, the present disclosure refers to a non-therapeutic method for improving the muscle mass and/or strength in a malnourished subject while a) preventing or reducing coagulation in the upper gastro-intestinal tract; b) increasing the rate of gastric emptying; c) enhancing protein digestion; and/or d) increasing the blood serum concentration of free essential amino acids, preferably leucine, wherein the subject is to be administered a heat-treated liquid high-protein composition comprising at least 10 g of protein per 100 ml of the composition, wherein at least 40 wt.% of the protein is micellar casein and at least 10 wt.% of the protein is hydrolysed whey protein having a degree of hydrolysation of at least 5%, and wherein the weight ratio of micellar casein to hydrolysed whey protein is in the range of 40:60 to 90:10.

Accordingly, in one example the disclosure provides a heat-treated liquid nutritional composition comprising at least 10 g of protein per 100 ml of the composition, wherein at least 40 wt.% of the protein is micellar casein and at least 10 wt.% of the protein is hydrolysed whey protein having a DH of at least 5%, and wherein the weight ratio of micellar casein to hydrolysed whey protein is in the range of 40:60 to 90:10, for use in the treatment and/or prevention of a condition linked to a loss of muscle mass and/or strength.

More in particular, the disclosure provides a heat-treated liquid nutritional composition comprising at least 10 g of protein per 100 ml of the composition, wherein at least 40 wt.% of the protein is micellar casein and at least 10 wt.% of the protein is hydrolysed whey protein having a DH of at least 5%, and wherein the weight ratio of micellar casein to hydrolysed whey protein is in the range of 40:60 to 90:10, for use in the treatment and/or prevention of a condition linked to a loss of muscle mass and/or strength in a subject, wherein the subject is in a disease state, recovering from a disease state, and/or malnourished. In particular, the subject suffers from a decline of lean muscle mass, muscle wasting, muscle decline, bone decline, sarcopenia, osteoporosis and/or osteosarcopenia, more in particular from a decline of lean muscle mass, muscle wasting, muscle decline and/or sarcopenia.

In another example, the disclosure relates to a heat-treated liquid nutritional composition comprising at least 10 g of protein per 100 ml of the composition, wherein at least 40 wt.% of the protein is micellar casein and at least 10 wt.% of the protein is hydrolysed whey protein having a DH of at least 5%, and wherein the weight ratio of micellar casein to hydrolysed whey protein is in the range of 40:60 to 90:10, for use in any one or more of the following: a) preventing or reducing coagulation in the upper gastro-intestinal tract; b) increasing the rate of gastric emptying; c) enhancing protein digestion; d)

increasing the blood serum concentration of free essential amino acids, preferably leucine, in a subject. In particular, the subject is in a disease state, recovering from a disease state, and/or malnourished. More in particular, the subject suffers from a decline of lean muscle mass, muscle wasting, muscle decline, bone decline, sarcopenia, osteoporosis and/or osteosarcopenia, preferably from a decline of lean muscle mass, muscle wasting, muscle decline and/or sarcopenia.

The disclosure also relates to the use of a composition as herein disclosed, for any one or more of the following: a) preventing or reducing coagulation in the upper gastro-intestinal tract; b) increasing the rate of gastric emptying; c) enhancing protein digestion; d) increasing the blood serum concentration of free essential amino acids, preferably leucine; in a subject. Typically, these latter uses are not for the purpose of carrying out therapy on the human or animal body. Thus, the disclosure relates to a non-therapeutic method for any one or more of the following: a) preventing or reducing coagulation in the upper gastro-intestinal tract; b) increasing the rate of gastric emptying; c) enhancing protein digestion; d) increasing the blood serum concentration of free essential amino acids, preferably leucine; in a subject, comprising the step of administering to the subject a heat-treated liquid high-protein composition comprising at least 10 g of protein per 100 ml of the composition, wherein at least 40 wt.% of the protein is micellar casein and at least 10 wt.% of the protein is hydrolysed whey protein having a degree of hydrolysation of at least 5%, and wherein the weight ratio of micellar casein to hydrolysed whey protein is in the range of 40:60 to 90:10.

In still another example, the disclosure relates to a composition as herein disclosed for use in a method for increasing the blood serum concentration of essential amino acids to overcome anabolic resistance in a subject, preferably an older subject, a subject in a diseased state, a subject that is recovering from a disease state, or a subject that is malnourished.

A composition for use or a method according to the present disclosure is not disclosed or suggested in the art.

WO2013/133727 relates to casein compositions for increasing the rate of gastric emptying following ingestion of the composition. It is disclosed that

casein being about 10 to about 100% calcium depleted, having a degree of hydrolysis less than about 1% and having an unmodified phosphorylation pattern, is able to increase the blood serum concentration of free leucine in a subject to substantially the same level as whey protein within about 15 to about 60 minutes of administration. WO2013/133727 teaches against the use of micellar casein, let alone micellar casein in combination with hydrolysed whey. Furthermore, at very high protein concentrations, the compositions of WO2013/133727 will be too viscous after heat treatment.

WO2016/174651 relates to liquid high-protein compositions comprising a combination of micellar casein and hydrolysed whey protein and methods for preparing the same. It generally teaches various nutritional uses thereof. Importantly however, it does not address the digestibility / coagulation properties and it fails to teach or suggest the uses of the present disclosure relating to the treatment and/or prevention of a condition linked to a loss of muscle mass and/or strength.

The disclosure also relates to a heat-treated liquid high-protein composition, wherein at least 40 wt.% of the protein is micellar casein and at least 10 wt.% of the protein is hydrolysed whey protein, wherein the ratio of micellar casein to hydrolysed whey protein is in the range of 40:60 to 90:10, and wherein the composition is in the form of a unit serving size of up to 100 ml, preferably up to 80 ml, and wherein said unit serving size comprises at least 15 g of protein, preferably at least 18 g of protein.

Detailed description of the invention

The verb “to comprise” as is used in this description and in the claims and its conjugations is used in its non-limiting sense to mean that items following the word are included, but items not specifically mentioned are not excluded.

In addition, reference to an element by the indefinite article "a" or "an" does not exclude the possibility that more than one of the element is present,

Claims

1. Use of a heat-treated liquid high-protein composition comprising at least 10 g of protein per 100 ml of the composition, wherein at least 40 wt.% of the protein is micellar casein and at least 10 wt.% of the protein is hydrolysed whey protein having a degree of hydrolysation of at least 5%, and wherein the weight ratio of micellar casein to hydrolysed whey protein is in the range of 40:60 to 90:10, in the manufacture of a medicament for the treatment and/or prevention of a condition linked to a loss of muscle mass and/or strength, wherein the subject is suffering from a decline of lean muscle mass, muscle wasting, muscle decline, bone decline, sarcopenia, osteoporosis and/or osteosarcopenia.

2. The use according to claim 1, wherein the subject suffers from a decline of lean muscle mass, muscle wasting, muscle decline and/or sarcopenia.

3. A non-therapeutic method for improving the muscle mass and/or strength in a malnourished subject while
   a) preventing or reducing coagulation in the upper gastro-intestinal tract;
   b) increasing the rate of gastric emptying;
   c) enhancing protein digestion; and/or
   d) increasing the blood serum concentration of free essential amino acids, preferably leucine,

   wherein the subject is to be administered a heat-treated liquid high-protein composition comprising at least 10 g of protein per 100 ml of the composition, wherein at least 40 wt.% of the protein is micellar casein and at least 10 wt.% of the protein is hydrolysed whey protein having a degree of hydrolysation of at least 5%, and wherein the weight ratio of micellar casein to hydrolysed whey protein is in the range of 40:60 to 90:10.

4. The use according to claim 1 or 2 or the method according to claim 3, wherein the combined amount of micellar casein and hydrolysed whey protein in the composition is at least 70 wt%, preferably at least 85 wt%, of the total protein.

5. The use according to claim 1, 2, or 4, or the method according to claim 3, in which the protein provides 20-95%, preferably 50-80%, of the total energy content of the composition.

6. The use according to claim 1, 2, 4, or 5, or the method according to claim 3, wherein the composition comprises at least 12, preferably at least 15, more preferably at least 18 g protein per 100 ml of the composition.

7. The use according to any of claims 1, 2, or 4-6, or the method according to claim 3, wherein the liquid nutritional composition has a unit serving size comprising at least 12 g of protein, preferably at least 15 g of protein, more preferably at least 18 g of protein and/or a unit serving size of up to 125 ml, preferably up to 100 ml, more preferably up to 80 ml.

8. The use according to any of claims 1, 2, or 4-7, or the method according to claim 3, wherein at least 50 wt.% of the protein is micellar casein and/or at least 15 wt.% of the protein is hydrolysed whey protein.

9. The use according to any of claims 1, 2, or 4-8, or the method according to claim 3, wherein the weight ratio of micellar casein to hydrolysed whey protein is in the range of 60:40 to 90:10, preferably 60:40 to 84:16.

10. The use according to any of claims 1, 2, or 4-9, or the method according to claim 3, wherein the hydrolysed whey protein has a degree of hydrolysation in the range of 5 to 25%, preferably 7 to 15%.

11. The use according to any of claims 1, 2, or 4-10, or the method according to claim 3, wherein the viscosity of the composition is 150 mPa.s or lower, at 20°C and at a shear rate of 100 s^{-1}.

12. The use according to any of claims 1, 2, or 4-11, or the method according to claim 3, wherein the composition has an energy density of 1.5 kcal/ml or higher.

13. The use according to any of claims 1, 2, or 4-12, or the method according to claim 3, wherein the composition further comprises one or more micronutrients, preferably selected from the group consisting of vitamins, preferably vitamin D, vitamin B1, vitamin B2, vitamin B12 and/or vitamin K, minerals, preferably calcium, magnesium, phosphorus and/or selenium, and/or a leucine metabolite, preferably beta-hydroxy-beta-methylbutyrate (HMB).

14. The use according to any of claims 1, 2, or 4-13, or the method according to claim 3, wherein the composition increases the blood serum concentration of leucine in a subject to higher than 250 micromol/L, preferably higher than 300 micromol/L within about 60 minutes after administration.

15. A heat-treated liquid nutritional composition, wherein at least 40 wt.% of the protein is micellar casein and at least 10 wt.% of the protein is hydrolysed whey protein having a degree of hydrolysation of at least 5%, wherein the ratio of micellar casein to hydrolysed whey protein is in the range of 40:60 to 90:10, and wherein the composition is in the form of a unit serving size of up to 100 ml, preferably up to 80 ml, and

wherein said unit serving size comprises at least 15 g of protein, preferably at least 18 g of protein.