2) MPCs may be provided by spray drying the ultrafiltered or microfiltered retentate to make an MPC powder. However, high protein food products prepared from powdered MPCs may have undesirable flavours as a result of the drying step or as a result of storage of the MPC in that dried state. High protein food products prepared from powdered MPCs also require high shear mixing, typically in hot water, in order to redissolve the powder.

[0006] There is therefore a need for alternative milk protein concentrates having a high concentration of protein, a commercially useful shelf life, acceptable or improved flavour, and/or that are easier to incorporate into food products.

[0007] It is an object of the present invention to provide improved or alternative liquid milk protein concentrates, or to at least provide the public with a useful choice.

SUMMARY

[0008] The disclosure provides a method for preparing a protein-containing food product, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh, liquid milk, the milk protein concentrate comprising

i) at least about 6% total protein by weight, preferably up to about 25% total protein by weight, and

ii) at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation, and

b) mixing the milk protein concentrate with one or more additional ingredients to produce the protein-containing food product.

[0009] The disclosure also provides a method for preparing a protein-containing food product, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh, liquid milk, the milk protein concentrate comprising

i) at least about 9% total protein by weight, and

ii) at least about 60% total protein by weight relative to total solids non-fat, wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation, and

b) mixing the milk protein concentrate with one or more additional ingredients to produce the protein-containing food product.

[0010] The disclosure also provides a method for preparing a protein-containing food product, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh, liquid milk, the milk protein concentrate comprising at least about 9% total protein by weight, and

wherein the milk protein concentrate after storage for at least about one, two or three months at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, i) to iv), and

b) mixing the milk protein concentrate with one or more additional ingredients to produce the protein-containing food product.

[0010a] In one aspect, the present disclosure provides a method for preparing a protein-containing food product, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh, liquid milk, the milk protein concentrate comprising at least about 9% total protein by weight, and

A) at least about 60% total protein by weight relative to total solids non-fat, wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation; or

B) wherein the milk protein concentrate after storage for at least about one month at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, (i) to (iv), and

vi) mixing the milk protein concentrate with one or more additional ingredients to produce the protein-containing food product.

[0011] In various examples, the method may comprise holding the milk protein concentrate at a temperature of at least about 10°C for at least about 3 days.

[0012] In various examples, the milk protein concentrate may be subjected to a heat treatment having an F_0 value of at least 3.0.

[0013] In various examples, the milk protein concentrate may be subjected to a heat treatment having an F_0 value of at least 6.0. In various examples, the milk protein concentrate has been subjected to a heat treatment having an F_0 value of at least 9.0.

[0014] In various examples, the milk protein concentrate may be prepared by a method comprising subjecting fresh liquid milk to ultrafiltration or microfiltration to produce a retentate.

[0015] In various examples the fresh liquid milk is not subjected to a heat treatment equal to or greater than 80 °C or 81 °C prior to ultrafiltration or microfiltration.

[0016] In various examples, the method may comprise subjecting the retentate to a heat treatment having an F_0 value of at least 3.0 to prepare the milk protein concentrate.

[0017] In various examples, the milk protein concentrate is not reconstituted.

[0018] In various examples, the milk protein concentrate after storage for at least about one, two or three months at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70, or

iv) any combination of any two or more, or all of (i) to (iii).

[0019] In various examples, the protein-containing food product may comprise at least about 1%, 1.5%, 2% or 2.5% total protein by weight.

[0020] In various examples, the one or more additional ingredients may comprise a lipid, a carbohydrate, flavour, vitamin, mineral, fibre, thickening agent, emulsifier, stabiliser, food additive, colour, protein, or any combination of two or more of these ingredients.

[0021] In various examples, the protein-containing food product may be a liquid nutritional composition, a beverage, ice cream, acidified/fermented milk, cheese, a pudding, a frozen dessert, coffee whitener, foam layer in a biscuit or in chocolate, a cream, or a gel.

[0022] In various examples, the cheese may be a fresh cheese or a processed cheese.

[0023] In various examples, the cheese may be a fresh cheese.

[0024] In various examples, the cheese may be cream cheese, quark, petit suisse, fromage frais, queso panela, queso fresco, paneer, or cottage cheese.

[0025] In one example, the processed cheese may be a processed cream cheese.

[0026] In one example the fermented milk may be a yoghurt.

[0027] In various examples the beverage may be a dairy beverage or sports beverage. In various examples the dairy beverage may be a liquid nutritional composition, a low lactose milk, a flavoured milk or a fortified milk.

[0028] The disclosure provides use of a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk in the preparation of a protein-containing food product, the milk protein concentrate comprising

a) at least about 6% total protein by weight, and

b) at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation.

[0029] The disclosure also provides use of a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk in the preparation of a protein-containing food product, the milk protein concentrate comprising

a) at least about 9% total protein by weight, and

b) at least about 60% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation.

[0030] The disclosure also provides use of a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk in the preparation of a protein-containing food product, the milk protein concentrate comprising at least about 9% total protein by weight,

wherein the milk protein concentrate after storage for at least about one, two or three months at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, i) to iv).

[0030a] In a further aspect, the present disclosure also provides use of a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk in the preparation of a protein-containing food product, the milk protein concentrate comprising at least about 9% total protein by weight, and

the milk protein concentrate comprises at least about 60% total protein by weight relative to total solids non-fat,

a) wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation; or

b) wherein the milk protein concentrate after storage for at least about one month at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s-1, or

v) a combination of any two or more of, or all of, (i) to (iv).

[0031] The disclosure also provides a method of preparing a liquid milk protein concentrate, the method comprising

a) providing a composition comprising casein and whey protein,

b) subjecting the composition to microfiltration or ultrafiltration to produce a retentate, and

c) subjecting the retentate to a heat treatment having an F_0 value of at least 3.0 to prepare a milk protein concentrate comprising at least about 13.8% total protein by weight, or comprising less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation.

[0032] The disclosure also provides a method of preparing a liquid milk protein concentrate, the method comprising

a) providing a composition comprising casein and whey protein,

b) subjecting the composition to microfiltration or ultrafiltration to produce a retentate, and

c) subjecting the retentate to a heat treatment having an F_0 value of at least 3.0 to prepare a milk protein concentrate

the milk protein concentrate comprising at least about 13.8% total protein by weight, or comprising less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation.

[0033] The disclosure also provides a method of preparing a liquid milk protein concentrate, the method comprising

a) providing a composition comprising casein and whey protein,

b) subjecting the composition to microfiltration or ultrafiltration to produce a retentate, and

c) subjecting the retentate to a heat treatment having an F_0 value of at least 3.0 to prepare a milk protein concentrate

the milk protein concentrate comprising at least about 13.8% total protein by weight, or comprising less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about one, two or three months at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s-1, or

v) a combination of any two or more of, or all of, i) to iv).

[0033a] In a further aspect, the present disclosure provides a method of preparing a liquid milk protein concentrate, the method comprising

a) providing a composition comprising casein and whey protein,

b) subjecting the composition to microfiltration or ultrafiltration to produce a retentate, and

c) subjecting the retentate to a heat treatment having an F_0 value of at least 3.0 to prepare a milk protein concentrate,

the milk protein concentrate comprising

A) at least about 13.8% total protein by weight, or comprising less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation; or

B) at least about 13.8% total protein by weight, or comprising less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about one month at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, (i) to (iv).

[0034] In various examples, the milk protein concentrate after storage for at least about one, two or three months at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70, or

iv) any combination of any two or more, or all of (i) to (iii).

[0035] In various examples, the composition comprising casein and whey protein is fresh milk.

[0036] In various examples, the composition comprising casein and whey protein is whole milk or skim milk.

[0037] In various examples the method may comprise subjecting the composition to microfiltration or ultrafiltration or a combination thereof.

[0038] In one example, the method comprises subjecting the composition to ultrafiltration to produce an ultrafiltration retentate and subjecting the ultrafiltration retentate to microfiltration to produce the retentate. In another example, the method

comprises subjecting the composition to microfiltration to produce a microfiltration retentate and subjecting the microfiltration retentate to ultrafiltration to produce the retentate.

[0039] In various examples the method comprises

i) subjecting a first composition comprising casein and whey protein to ultrafiltration to produce an ultrafiltration retentate,

ii) subjecting a second composition comprising casein and whey protein to microfiltration to produce a microfiltration retentate, and

iii) combining the ultrafiltration retentate and microfiltration retentate to produce a retentate.

[0040] In various examples, the retentate may be subjected to diafiltration to produce a diafiltered retentate before heat treatment.

[0041] In various examples, the diafiltered retentate may be subjected to evaporation to produce a concentrated retentate before heat treatment.

[0042] In various examples, the method may comprise directly subjecting the retentate, diafiltered retentate, or concentrated retentate to the heat treatment.

[0043] In various examples the milk protein concentrate does not comprise added non-dairy ingredients.

[0044] In various examples, the milk protein concentrate may not comprise added stabilisers, mouthfeel enhancers, emulsifiers, thickeners or sweeteners.

[0045] In various examples, the milk protein concentrate may comprise at least about 6%, 9%, 10%, 11%, 12%, 13%, 14%, 14.5%, 15%, 15.5%, or 16% total protein by weight.

[0046] In various examples, the milk protein concentrate may comprise from about 6% to about 25% total protein by weight.

[0047] In various examples, the milk protein concentrate may comprise from about 6% to about 24%, 6% to about 23%, about 9% to about 25%, about 9% to about 24%, about 9% to about 23% or about 9% to about 22% total protein by weight.

[0048] In various examples, the retentate may comprise at least about 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65% or 75% by weight total solids non-fat.

[0049] In various examples, the retentate may comprise at least about 55%, 60%, 65% or 75% total protein by weight relative to total solids non-fat.

[0050] In various examples, the milk protein concentrate may be packed to produce a packed milk protein concentrate comprising at least about 13.8% total protein by weight, or comprising less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat.

[0051] In various examples, the milk protein concentrate after storage for at least about one, two or three months at a temperature of about 4°C

i) exhibits essentially no observable gelation or aggregation,

v) comprises less than about 5% by weight sediment,

vi) has a whiteness index value of at least about 70, or

vii) any combination of any two or more, or all of (i) to (iii).

[0052] In various examples, the milk protein concentrate after storage for at least one, two or three months at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70, or

iv) any combination of any two or more, or all of (i) to (iii).

[0053] In various examples, the milk protein concentrate after storage for at least about one, two or three months at a temperature of about 30°C

i) exhibits essentially no observable gelation or aggregation,

v) comprises less than about 5% by weight sediment,

vi) has a whiteness index value of at least about 70, or

vii) any combination of any two or more, or all of (i) to (iii).

[0054] In various examples, the milk protein concentrate after storage for at least about one, two or three months storage at a temperature of about 4°C, 20°C or 30°C has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}.

[0055] The disclosure provides heat-treated, shelf stable liquid milk protein concentrate produced by a method described herein.

[0056] The disclosure also provides a heat-treated, shelf stable liquid milk protein concentrate, the concentrate comprising a microfiltration or ultrafiltration retentate, or a combination thereof, wherein the milk protein concentrate

a) comprises at least about 13.8% total protein by weight, or less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat, and

b) after storage for at least three months at a temperature of about 20°C has no apparent gelation.

[0057] The disclosure also provides a heat-treated, shelf stable liquid milk protein concentrate, the concentrate comprising a microfiltration or ultrafiltration retentate, or a combination thereof, wherein the milk protein concentrate

b) comprises at least about 13.8% total protein by weight, or less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat, and

c) after storage for at least one, two or three months at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, i) to iv).

[0057a] In a further aspect, the present disclosure provides a heat-treated, shelf stable liquid milk protein concentrate, the concentrate comprising a microfiltration or ultrafiltration retentate, or a combination thereof, wherein the milk protein concentrate

A)

a) comprises at least about 13.8% total protein by weight, or less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat, and

b) after storage for at least three months at a temperature of about 20°C has no apparent gelation; or

B)

a) comprises at least about 13.8% total protein by weight, or less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat, and

b) after storage for at least about one month at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, (i) to (iv).

[0057b] In a further aspect, the present disclosure provides a method of any one of claims 1 to 8 or 10 to 15 or a heat-treated, shelf stable liquid milk protein concentrate of claim 16, wherein the milk protein concentrate after storage for at least three months at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70, or

iv) any combination of any two or more, or all of (i) to (iii).

[0058] In various examples, the milk protein concentrate may comprise at least about 55%, 60%, 65% or 75% by weight total protein relative to total solids non-fat.

[0059] In a further aspect, the present disclosure provides a method for preparing a liquid nutritional composition, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk, the milk protein concentrate comprising

i) at least about 13.8% total protein by weight, or

ii) comprising less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation,

b) mixing the milk protein concentrate with at least one source of lipid and at least one source of carbohydrate to prepare the liquid nutritional composition.

[0060] In a further aspect, the present disclosure provides a liquid nutritional composition comprising

a) a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk, the milk protein concentrate comprising

i) at least about 13.8% total protein by weight, or

ii) comprising less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation,

b) at least one source of lipid, and

c) at least one source of carbohydrate,

wherein the liquid nutritional composition comprises

a) at least about 5% total protein by weight,

b) from about 0.1% to about 30% by weight fat,

c) from about 0.1% to about 45% carbohydrate, and

d) from about 50 to about 300 kcal per 100 mL of the composition.

[0061] In various examples, the liquid nutritional composition may comprise at least about 5%, 6%, 8%, 10%, 12%, 15%, or at least about 16% total protein by weight.

[0062] In a further aspect, the present disclosure provides a method for preparing a yoghurt, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk, the milk protein concentrate comprising

i) at least about 13.8% total protein by weight, or

ii) comprising less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about one, two or three months at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, i) to iv), and

b) mixing the milk protein concentrate with

i) at least one additional ingredient selected from the group comprising one or more milk powders, liquid milk and lactose powder, and

ii) a yoghurt starter culture,

to produce a yoghurt mix, and

c) allowing the yoghurt mix to ferment to prepare the yoghurt.

[0063] In a further aspect the present disclosure provides a yoghurt comprising a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk, the milk protein concentrate comprising

i) at least about 13.8% total protein by weight, or

ii) comprising less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about one, two or three months at a temperature of about 20°C

iii) exhibits essentially no observable gelation or aggregation,

iv) comprises less than about 5% by weight sediment,

v) has a whiteness index value of at least about 70,

vi) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

vii) a combination of any two or more of, or all of, i) to iv), and

wherein the yoghurt comprises at least about 3% by weight total protein.

[0064] In various examples the yoghurt may comprise at least about 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5 or at least about 8% by weight total protein.

[0065] In a further aspect the present disclosure provides a method for preparing a dairy beverage, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk, the milk protein concentrate comprising

i) at least about 13.8% total protein by weight, or

ii) comprising less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about one, two or three months a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s-1, or

v) a combination of any two or more of, or all of, i) to iv), and

b) mixing the milk protein concentrate with liquid milk or a milk powder, or a combination thereof to produce the dairy beverage.

[0066] In a further aspect, the present disclosure provides a method for preparing a sports beverage, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk, the milk protein concentrate comprising

i) at least about 13.8% total protein by weight, or

ii) comprising less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about one, two or three months at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, i) to iv), and

b) mixing the milk protein concentrate with one or more additional ingredients selected from the group comprising one or more flavour agents, a sweetener, one or more colouring agents, one or more stabilisers, an acidity regulator, one or more vitamins, one or more minerals, and one or more enzymes to produce the sports beverage.

[0067] In various examples, the milk protein concentrate comprises at least about 55, 60, 65, 70, or 75% total protein by weight relative to total solids non-fat.

[0068] In one example, the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation.

[0069] In various examples, the milk protein concentrate may be, or may comprise, a milk protein concentrate produced by a method described herein or a milk protein concentrate described herein.

[0070] In various examples, the method for preparing a stable, heat-treated liquid milk protein concentrate may comprise:

a) pasteurising fresh whole milk,

b) optionally separating the pasteurized whole milk to produce skim milk and cream,

c) optionally standardising either the pasteurised whole milk or skim milk with cream,

d) fractionating either the whole milk or skim milk by either ultrafiltration and/or microfiltration to produce a concentrated milk protein fraction or retentate,

e) optionally adding water to the whole milk or skim milk during either ultrafiltration and/or microfiltration to achieve diafiltration and produce a concentrated, diafiltered milk protein retentate,

f) optionally treating the milk protein retentate by cation exchange,

g) optionally subjecting the concentrated milk protein retentate to evaporation to produce a more concentrated milk protein retentate,

h) optionally standardising the prepared, concentrated milk protein retentate by the addition of cream,

i) heating the concentrated milk protein retentate to temperatures achieving a F0 value of at least 3.0, and

j) aseptically packing the stable, heat-treated liquid milk protein concentrate.

[0071] Any of the embodiments or preferences described herein may relate to any of the examples herein alone or in combination with any one or more embodiments, examples or preferences described herein, unless stated or indicated otherwise.

[0072] This disclosure may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more of said parts, elements or features, and where specific integers are mentioned herein which have known equivalents in the art to which this disclosure relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

[0073] It is intended that reference to a range of numbers disclosed herein (for example, 1 to 10) also incorporates reference to all rational numbers within that range (for example, 1, 1.1, 2, 3, 3.9, 4, 5, 6, 6.5, 7, 8, 9, and 10) and also any range of rational numbers within that range (for example, 2 to 8, 1.5 to 5.5, and 3.1 to 4.7) and, therefore, all sub-ranges of all ranges expressly disclosed herein are hereby expressly disclosed. These are only examples of what is specifically intended and all possible combinations of numerical values between the lowest value and the highest value enumerated are to be considered to be expressly stated in this application in a similar manner.

[0074] In this specification, where reference has been made to external sources of information, including patent specifications and other documents, this is generally for the purpose of providing a context for discussing the features of the present disclosure. Unless stated otherwise, reference to such sources of information is not to be construed, in any jurisdiction, as an admission that such sources of information are prior art or form part of the common general knowledge in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0075] The invention will now be described by way of example only and with reference to the drawings in which:

Figures 1 and 2 are flow charts showing exemplary methods of manufacturing the liquid milk protein concentrates described herein.

DETAILED DESCRIPTION OF THE INVENTION

[0076] The present invention relates to a method of preparing a protein-containing food product using a heat-treated liquid milk protein concentrate produced directly from fresh milk, and use of a heat-treated liquid milk protein concentrate produced directly from fresh milk in the preparation of a protein-containing food product. The present invention also relates to the liquid MPC produced from heat-treated milk.

[0077] Food products prepared from the liquid MPCs described herein generally have improved flavour and require less time for hydrating liquid MPC versus powdered MPC. There may be less undissolved powder particles. Additionally, when hydrating liquid MPC versus powdered MPC, minimal foaming occurs therefore the use of antifoam may not be required for liquid MPC.

1. Definitions

[0078] The term "comprising" as used in this specification means "consisting at least in part of". When interpreting statements in this specification which include that term, the features, prefaced by that term in each statement, all need to be present but other features

CLAIMS

1. A method for preparing a protein-containing food product, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh, liquid milk, the milk protein concentrate comprising at least about 9% total protein by weight, and

A) at least about 60% total protein by weight relative to total solids non-fat, wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation; or

B) wherein the milk protein concentrate after storage for at least about one month at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, (i) to (iv), and

b) mixing the milk protein concentrate with one or more additional ingredients to produce the protein-containing food product.

2. A method of claim 1, wherein the method comprises holding the milk protein concentrate at a temperature of at least about 10°C for at least about 3 days.

3. A method of claim 1 or 2, wherein the milk protein concentrate has been subjected to a heat treatment having an F_0 value of at least 3.0.

4. A method of any one of claims 1 to 3, wherein the milk protein concentrate is prepared by a method comprising subjecting fresh liquid milk to ultrafiltration or microfiltration to produce a retentate and, optionally, subjecting the retentate to a heat treatment having an F_0 value of at least 3.0 to prepare the milk protein concentrate.

5. A method of any one of claims 1 to 4, wherein the milk protein concentrate is not reconstituted.

6. A method of any one of claims 1 to 5 wherein the protein-containing food product comprises at least about 1%, 1.5%, 2% or 2.5% total protein by weight.

7. A method of any one of claims 1 to 6, wherein the one or more additional ingredients is a lipid, a carbohydrate, flavour, vitamin, mineral, fibre, thickening agent, emulsifier, stabiliser, food additive, colour, protein, or any combination of two or more of these ingredients.

8. A method of any one of claims 1 to 7, wherein the protein-containing food product is a liquid nutritional composition, a beverage, ice cream, acidified/fermented milk, cheese, a pudding, a frozen dessert, coffee whitener, foam layer in a biscuit or in chocolate, a cream, or a gel.

9. Use of a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk in the preparation of a protein-containing food product, the milk protein concentrate comprising at least about 9% total protein by weight, and

the milk protein concentrate comprises at least about 60% total protein by weight relative to total solids non-fat,

a) wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation; or

b) wherein the milk protein concentrate after storage for at least about one month at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s-1, or

v) a combination of any two or more of, or all of, (i) to (iv).

10. A method of preparing a liquid milk protein concentrate, the method comprising

a) providing a composition comprising casein and whey protein,

b) subjecting the composition to microfiltration or ultrafiltration to produce a retentate, and

c) subjecting the retentate to a heat treatment having an F_0 value of at least 3.0 to prepare a milk protein concentrate,

the milk protein concentrate comprising

A) at least about 13.8% total protein by weight, or comprising less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation; or

B) at least about 13.8% total protein by weight, or comprising less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about one month at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, (i) to (iv).

11. A method of claim 10, wherein the composition comprising casein and whey protein is fresh milk, and/or is whole milk or skim milk.

12. A method of claim 10 or 11, wherein

a) the retentate is subjected to diafiltration to produce a diafiltered retentate before heat treatment;

b) the method comprises directly subjecting the retentate, or diafiltered retentate, to the heat treatment;

c) the milk protein concentrate is packed to produce a packed milk protein concentrate comprising at least about 13.8% total protein by weight, or comprising less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat; or

d) any combination of any two or more of a) to c).

13. A method of any one of claims 10 to 12, wherein the milk protein concentrate does not comprise

a) added stabilisers or mouthfeel enhancers; and/or

b) added non-dairy ingredients.

14. A method of any one of claims 10 to 13, wherein the milk protein concentrate comprises

a) at least about 14%, 14.5%, 15%, 15.5% or 16% total protein by weight; and/or

b) at least about 15% by weight total solids non-fat.

15. A method of any one of claims 10 to 14, wherein the milk protein concentrate

a) after storage for at least about one month at a temperature of about 20°C has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1};

b) after storage for at least about three months at a temperature of about 30°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70 or

iv) any combination of any two or more, or all of (i) to (iii);

c) after storage for at least about three months at a temperature of about 4°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70, or

iv) any combination of any two or more, or all of (i) to (iii); or

d) any combination of any two or more of a) to c).

16. A heat-treated, shelf stable liquid milk protein concentrate, the concentrate comprising a microfiltration or ultrafiltration retentate, or a combination thereof, wherein the milk protein concentrate

A)

a) comprises at least about 13.8% total protein by weight, or less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat, and

b) after storage for at least three months at a temperature of about 20°C has no apparent gelation; or

B)

a) comprises at least about 13.8% total protein by weight, or less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat, and

b) after storage for at least about one month at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, (i) to (iv).

17. A method of any one of claims 1 to 8 or 10 to 15 or a heat-treated, shelf stable liquid milk protein concentrate of claim 16, wherein the milk protein concentrate after storage for at least three months at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70, or

iv) any combination of any two or more, or all of (i) to (iii).

18. A method for preparing a liquid nutritional composition, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk, the milk protein concentrate comprising

i) at least about 13.8% total protein by weight, or

ii) comprising less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation, and

b) mixing the milk protein concentrate with at least one source of lipid and at least one source of carbohydrate to prepare the liquid nutritional composition.

19. A liquid nutritional composition comprising

a) a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk, the milk protein concentrate comprising

i) at least about 13.8% total protein by weight, or

ii) comprising less than about 13.8% total protein by weight and at least about 75% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about three months at a temperature of about 20°C has no apparent gelation,

b) at least one source of lipid, and

c) at least one source of carbohydrate,

wherein the liquid nutritional composition comprises

a) at least about 5% total protein by weight,

b) from about 0.1% to about 30% by weight fat,

c) from about 0.1% to about 45% carbohydrate, and

d) from about 50 to about 300 kcal per 100 mL of the composition.

20. A method for preparing a yoghurt, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk, the milk protein concentrate comprising

i) at least about 13.8% total protein by weight, or

ii) comprising less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about one month at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, (i) to (iv), and

b) mixing the milk protein concentrate with

i) at least one additional ingredient selected from the group comprising one or more milk powders, liquid milk and lactose powder, and

ii) a yoghurt starter culture,

to produce a yoghurt mix, and

c) allowing the yoghurt mix to ferment to prepare the yoghurt.

21. A yoghurt comprising a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk, the milk protein concentrate comprising

i) at least about 13.8% total protein by weight, or

ii) comprising less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about one month at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, (i) to (iv), and

wherein the yoghurt comprises at least about 3% by weight total protein.

22. A method for preparing a dairy beverage, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk, the milk protein concentrate comprising

i) at least about 13.8% total protein by weight, or

ii) comprising less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about one month at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, (i) to (iv), and

b) mixing the milk protein concentrate with liquid milk or a milk powder, or a combination thereof to produce the dairy beverage.

23. A method for preparing a sports beverage, the method comprising

a) providing a heat-treated, liquid milk protein concentrate that has been produced directly from fresh liquid milk, the milk protein concentrate comprising

i) at least about 13.8% total protein by weight, or

ii) comprising less than about 13.8% total protein by weight and at least about 50% total protein by weight relative to total solids non-fat,

wherein the milk protein concentrate after storage for at least about one month at a temperature of about 20°C

i) exhibits essentially no observable gelation or aggregation,

ii) comprises less than about 5% by weight sediment,

iii) has a whiteness index value of at least about 70,

iv) has a viscosity of less than about 950 mPa.s when measured at a temperature of 20°C and a shear rate of 100 s^{-1}, or

v) a combination of any two or more of, or all of, (i) to (iv), and

b) mixing the milk protein concentrate with one or more additional ingredients selected from the group comprising one or more flavour agents, a sweetener, one or more colouring agents, one or more stabilisers, an acidity regulator, one or more vitamins, one or more minerals, and one or more enzymes to produce the sports beverage.