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(54) Title: WHEY PROTEIN CONCENTRATE, ACIDIFIED MILK PRODUCTS COMPRISING THE CONCENTRATE AND METHODS THEREFOR

(57) Abstract: The present invention relates to a method of producing an ideal whey protein concentrate. The whey protein concentrate has a pH in the range of 6.8-7.5 and 70-90% of the total proteins of the concentrate are whey proteins and 10-30% of the total proteins of the concentrate are caseins. The present invention relates also to an ideal whey protein concentrate and its uses in reducing the total milk protein content and/or in increasing the whey protein content of a spoonable acidified milk product. In addition, the present invention relates to a method of producing a spoonable acidified milk product having high whey protein content but a reduced total milk protein content. The present invention relates also to a spoonable acidified milk product having high whey protein content but a reduced total milk protein content.



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WHEY PROTEIN CONCENTRATE, ACIDIFIED MILK PRODUCTS COMPRISING THE CONCENTRATE AND METHODS THEREFOR

FIELD OF THE INVENTION

The present invention relates to a method of producing an ideal whey protein concentrate. The present invention relates also to an ideal whey protein concentrate and its uses in reducing the total milk protein content and/or in increasing the whey protein content of a spoonable acidified milk product. In addition, the present invention relates to a method of producing a spoonable acidified milk product having high whey protein content but a reduced total milk protein content. The present invention relates also to a spoonable acidified milk product having high whey protein content but a reduced total milk protein content.

BACKGROUND OF THE INVENTION

Currently commercially available spoonable acidified milk products, such as yogurts and quarks, contain milk protein about 4% and about 7-11%, respectively. In addition, the amount of whey protein in the currently commercially available spoonable acidified milk products is about 20% of the total milk protein content, which corresponds to the typical ratio of casein proteins to whey proteins in cow's milk.

Yogurt is an acidified milk product produced typically by lactic acid bacterial fermentation of milk. The bacteria used to make yogurt are known as "yogurt cultures". Fermentation of lactose by these bacteria produces lactic acid, which acts on milk protein to give yogurt its texture and its characteristic tang.

Quark is unripened fresh cheese which is made from pasteurized skim milk by adding an acidifier to the milk. Typically, a small amount of rennet is also added. The ratio of casein proteins to whey proteins in quark is about 80:20. Quark has a smooth texture and mild, acid flavour. Quark products presently in the market are typically spoonable and firm in texture.

It has been very challenging to manufacture spoonable acidified milk protein products having reduced protein content, such as yogurts containing proteins about 3% or less, without addition of hydrocolloids, in an industrial scale using the methods known in the art.

Patent publication WO 2005/041677 discloses a method for producing low fat spread, wherein a heat treated aqueous whey protein solution is used as a stabilizer.

Methods for producing spoonable acidified milk protein products having reduced total milk protein content and at the same time high whey protein content are required for fulfilling the increasing commercial need of such acidified milk products.

BRIEF DESCRIPTION OF THE INVENTION

An object of the present invention relates to a method for producing an ideal whey protein concentrate. Another object of the present invention relates to an ideal whey protein concentrate.

An object of the present invention relates to a method for producing a spoonable acidified milk product having high whey protein content but a reduced total milk protein content. Another object of the present invention relates to a spoonable acidified milk product having high whey protein content but a reduced total milk protein content.

In addition, an object of the present invention relates to a use of an ideal whey protein solution or an ideal whey protein concentrate in the reduction of the total protein content of a spoonable acidified milk product. The present invention also relates to the use of an ideal whey protein solution or an ideal whey protein concentrate in increasing the whey protein content of a spoonable acidified milk product.

The objects of the invention are achieved by methods, products and uses characterized by what is stated in the independent claims. The preferred embodiments of the invention are disclosed in the dependent claims.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 show the amount of the total protein and the amount of whey protein in typical commercially available quark and yoghurt products as well as the corresponding ones produced according to the present invention in Example 3.

DETAILED DESCRIPTION OF THE INVENTION

It has been very challenging to manufacture spoonable acidified milk products having a reduced protein content, such as yogurts containing

proteins about 3% or less, or quark type products containing proteins less than about 7% in an industrial scale using the methods known in the art.

The present invention is based on a finding that when an ideal whey protein solution containing whey proteins about 70-90% and casein about 10-30% of the total milk proteins and having a pH value in the range of 6.8-7.5, was heated to a temperature of about 88-95°C for about 1-10 minutes, and then mixed with the conventional/typical starting ingredients of a spoonable acidified milk product, such as yogurt or quark, the total protein content of the acidified milk product was reduced whereas the whey protein content of the acidified milk product was increased compared to a corresponding conventional acidified milk product. Accordingly, using the method of the present invention spoonable acidified milk products containing less protein than the currently commercially available products can be produced. In addition, using the method of the present invention, spoonable acidified milk products containing more whey proteins than the currently commercially available products can be produced. In particular, using the method of the present invention, it is possible to produce spoonable acidified milk products containing whey proteins at least about 30% by weight of the total milk proteins of the product. Specifically, using the method of the present invention, it is possible to produce spoonable yogurts containing milk proteins about 3 w-%, at the maximum, whereas the currently commercially available yogurts typically contain milk proteins at least about 4 w-%. Using the method of the present invention, it is possible to produce quark or quark-type products containing milk proteins about 7 w-%, at the maximum, wherein the currently commercially available quark products typically contain protein about 11-12 w-%. In addition, using the method of the present invention, it is possible to produce yogurts and quark or quark-type products containing whey proteins at least about 30% by weight of the total milk proteins of the product, whereas the currently commercially available products contain whey proteins typically only about 20% by weight. Accordingly, using the method of the present invention spoonable acidified milk products containing at least 25% less milk proteins than the currently commercially available acidified milk products can be produced. Further, using the method of the present invention spoonable acidified milk products containing at least 50% more whey proteins than the currently commercially available acidified milk products can be produced. The nutritional quality of the products of the present invention is advantageous especially for children because the ratio

of whey and casein proteins of the product of the present invention correspond to that of the breast milk. Further, the amino acid composition of the ideal whey protein solution as well as the ideal whey protein concentrate is close to that of the breast milk. Additionally, from the nutritional point of view low protein products are recommended to infants below 3 years. In addition, the nutritional quality of the products of the present invention is advantageous for athletes because of the high proportion of the whey proteins in the product.

Whey is a by-product of the cheese-making process, and it can be further processed to whey protein concentrate (WPC) and to whey protein isolate (WPI). They are described in terms of their protein concentration, protein content as percentage of dry matter, which ranges from 25 to 85% and >90%, respectively. WPC and WPI have been exposed to heat treatment process twice, chemical modification and pH regulation during the production of cheese and whey. Each of these heat treatment, chemical modification and pH regulation steps damages/denatures the whey proteins. The damaged proteins are then filtered out and what remains is a narrow range of "undenatured" proteins that have survived the cheese and whey manufacturing process. WPC and WPI contain caseinomacropeptides (14-17% of total protein) and thermally formed κ -casein β -lactoglobulin complexes as by-products.

The ideal whey protein concentrate of the present invention is based on an ideal whey protein solution which is prepared by microfiltering skim milk and concentrating the obtained microfiltration permeate by ultrafiltration. Accordingly, the ideal whey protein solution is an ultrafiltration retentate of the microfiltration permeate of skim milk. Microfiltration of the skim milk is typically carried out at a temperature of about 2°C to about 55°C. In one embodiment, the microfiltration is performed in a temperature below 20°C. In another embodiment the microfiltration is performed in a temperature range of 2°C to 20°C. In a further embodiment the temperature during microfiltration is in the range of 10°C to 14°C. In an embodiment, the microfiltration is carried out at about 10°C. Ultrafiltration is typically performed at about 5°C to about 55°C. In one embodiment, the ultrafiltration is performed in a temperature below 20°C. In another embodiment the ultrafiltration is performed in a temperature range of 2°C to 20°C. In a further embodiment the temperature during ultrafiltration is in the range of 10°C to 14°C. In an embodiment, the ultrafiltration is carried at about 10°C. The ideal whey protein solution contains whey proteins about 70-90% and casein about 10-30% of the total milk proteins. Preferably, the ideal

whey protein solution contains whey proteins about 80-90%. The ideal whey protein solution contains β -casein, but it contains other casein monomers to a lesser extent than milk. Further, it is free of caseinomacropeptides and thermally formed k-casein β -lactoglobulin complexes. It may contain traces of fat.

5 The protein content of the ideal whey protein solution can range from about 4% to about 25%. The ideal whey protein solution has only been exposed to mild heat treatment and thus the proteins are essentially native. The casein content of the total milk proteins in the ideal whey protein solution is about 10-30%, of which about 50-80% is β -casein. In an embodiment, the content of β -casein is about 5-30% of the total milk proteins. In an embodiment, the protein content of the ideal whey protein solution is about 9%. In one embodiment, the content of β -casein in the ideal whey protein solution is about 20% based on total protein. The lactose content of the ideal whey protein solution can be reduced, if desired. The lactose removal can be accomplished with methods known in the art, for example. The ideal whey protein solution contains more α -lactalbumin (α -LA) and β -lactoglobulin (β -LG) in total whey protein than WPC or WPI manufactured from cheese whey because the caseinomacropeptide fraction does not exist in ideal whey protein solution. In addition, the amino acid composition of the ideal whey protein solution resembles that of the breast milk.

20 The ideal whey protein concentrate contains whey proteins about 70-90% and casein about 10-30% of the total milk proteins. Preferably, the ideal whey protein concentrate contains whey proteins about 80-90%. The ideal whey protein concentrate contains β -casein, but it contains other casein monomers to a lesser extent than milk. Further, it is free of caseinomacropeptides and thermally formed k-casein β -lactoglobulin complexes. The ideal whey protein concentrate contains more α -lactalbumin (α -LA) and β -lactoglobulin (β -LG) in total whey protein than concentrates based on WPC or WPI. The casein content of the total milk proteins in the ideal whey protein concentrate is about 10-30%, of which about 50-80% is β -casein. In an embodiment, the content of β -casein is about 5-30% of the total milk proteins. The protein content of the ideal whey protein concentrate can range from about 4% to about 25%. In one embodiment, the ideal whey protein concentrate contains proteins 8.5-9.2% of which 6.4-7.6% are whey proteins and 1.1-2.7% casein (of which about 50-80% is β -casein), lactose 2.4-3.0%, ash 0.48-1.14%, dry matter 11.8-12.7%, sodium 260-310 mg/kg, potassium 1100-300 mg/kg, calcium 500-580 mg/kg, magnesium 90-110 mg/kg, chloride 320-460 mg/kg, phosphorus 370-460 mg/kg. In

one embodiment, the ideal whey protein concentrate contains proteins 8.8% of which 6.9% are whey proteins and 1.7% casein, lactose 2.7%, ash 0.54%, dry matter 12.1%, sodium 300 mg/kg, potassium 1250 mg/kg, calcium 560 mg/kg, magnesium 100 mg/kg, chloride 410 mg/kg, phosphorus 430 mg/kg. In one
5 embodiment, the ideal whey protein concentrate is not subjected to an additional calcium depletion treatment, such as ion exchange, for example.

The ideal whey protein concentrate can be used in the method of the present invention in a powder form or as a liquid. In one embodiment, the ideal whey protein concentrate is used in a liquid form. The functional proper-
10 ties of the whey proteins are better maintained when the drying step does not exist in the manufacturing process of the ideal whey protein concentrate.

Accordingly, the present invention relates to a method of producing an ideal whey protein concentrate comprising the steps of:

- providing an ideal whey protein solution containing whey pro-
15 teins about 70-90% and casein about 10-30% of the total protein;
- adjusting the pH of the solution to pH 6.8-7.5;
- heat-treating the solution at a temperature of 88-95°C for 1-10 minutes to provide an ideal whey protein concentrate;
20 - optionally cooling the concentrate to a temperature of about 4-45°C;
- optionally storing the concentrate at a temperature of about 4-8°C.

In the method of producing the ideal whey protein concentrate, the pH is adjusted to the range of 6.8-7.5. In one embodiment, the pH of the ideal
25 whey protein concentrate is adjusted to the range of 6.8-7.3. In one embodiment, the pH of the ideal whey protein concentrate is adjusted to the range of 7-7.5. In the present invention, it is important that the pH is adjusted to a value above the isoelectric point of the whey proteins in order to keep them soluble.

In the method of producing the ideal whey protein concentrate of the
30 present invention, the step of heat-treating the ideal whey protein solution is performed at the temperature of 88-95°C for 1-10 minutes. In one embodiment, the heat-treatment is performed at the temperature of 90-95°C. In one embodiment, the heat-treatment is performed at the temperature of about 92°C for 5 minutes. In the step of heat-treating the ideal whey protein solution, the
35 whey proteins are denatured. If the thermal/heat load during the step of heat-treating is too high, the whey proteins will also form aggregates. Accordingly, in

the present invention it is important that the whey proteins denature but do not form aggregates as a result of the heat-treatment.

In one embodiment of the method of producing the ideal whey protein concentrate, in the step of cooling the ideal whey protein concentrate, the concentrate is cooled to a temperature from 4°C to 45°C. In one embodiment, the ideal whey concentrate is cooled to a temperature of 4-8°C.

The method of producing an ideal whey protein concentrate may further comprise additional process steps such as diluting the ideal whey solution before the heat treatment step. In one embodiment, the dilution is done by mixing the ideal whey solution with water, UF-permeate, protein free ingredient, lactose concentrate, RO-retentate and/or RO-permeate. The method of producing an ideal whey protein concentrate may also comprise an additional step of adjusting the pH of the solution back to pH about 6.7-6.8 before the storage of the concentrate.

The pH of the ideal whey protein concentrate of the present invention is in the range of 6.8-7.5 and about 70-90% of the total proteins are whey proteins and about 10-30% are casein proteins. In one embodiment, about 50-80% of casein is β -casein. In one embodiment, the pH of the ideal whey protein concentrate of the present invention is in the range of 6.8-7.5. In one embodiment, the pH of the ideal whey protein concentrate of the present invention is in the range of 6.8-7.3. In one embodiment, the pH of the ideal whey protein concentrate of the present invention is in the range of 7-7.5. In one embodiment, about 80-90% of the total proteins are whey proteins. In one embodiment, about 20-30% are casein proteins. In one embodiment, the milk protein content of the concentrate is about 8-11 w-%. In another embodiment, the milk protein content of the concentrate is about 9 w-%.

The present invention relates also to a method of producing a spoonable acidified milk protein product comprising the steps of:

- providing typical starting ingredients for a spoonable acidified milk product ;
- heat-treating the ingredients;
- providing an ideal whey protein concentrate having pH 6.8-7.5;
- combining/mixing the heat-treated ingredients and the ideal whey protein concentrate and;
- acidifying the mixture to provide a spoonable acidified milk product having a pH in the range of about 4.0 to about 4.8.

The method may also comprise the additional optional steps of cooling the acidified product and/or packing the product, or alternatively packing the mixture before the acidification step and/or cooling the product.

In addition, the present invention relates to a method of producing a spoonable acidified milk protein product comprising the steps of:

- providing an ideal whey protein solution having whey proteins about 70-90% of the total protein;
- adjusting the pH of the solution to pH 6.8-7.5;
- heat-treating the solution at the temperature of 88-95°C for 1-10 minutes to provide an ideal whey protein concentrate;
- optionally cooling the concentrate;
- providing the typical starting ingredients for a spoonable acidified milk product;
- heat-treating the starting ingredients;
- combining/mixing the ideal whey protein concentrate and the heat-treated ingredients;
- acidifying the mixture to provide a spoonable acidified milk product having pH in the range of about 4.0 to about 4.8;
- optionally cooling the acidified product
- optionally packing the product.

In one embodiment of the method of producing the spoonable acidified milk protein product, in the step of cooling the ideal whey protein concentrate, the concentrate is cooled to a temperature from 4°C to 45°C. In one embodiment of the method of producing the spoonable acidified milk protein product, in the step of cooling the acidified milk product, the product is cooled to a temperature from 4°C to 45°C.

The spoonable acidified milk protein product of the present invention has a pH value in the range of about 4.0 to about 4.8. In one embodiment, the spoonable acidified milk protein product of the present invention has a pH value in the range of about 4.5 to about 4.8. In one embodiment, the spoonable acidified milk protein product of the present invention has a pH value in the range of about 4.0 to about 4.5. The spoonable acidified milk protein product of the present invention has a viscosity in the range of about 300 to about 12 000 mPas. In one embodiment, the spoonable acidified milk protein product of the present invention has a viscosity in the range of about 300 to about 2 000 mPas. In one embodiment, the spoonable acidified milk protein product of the

present invention has a viscosity in the range of about 5000 to about 12 000 mPas. In one embodiment, the viscosities are determined with the shear rate 50, 1/s.

The spoonable acidified milk protein product can be selected from yogurts, quarks and quark-type products, for example.

In one embodiment of the invention, the spoonable acidified milk protein product is yogurt. In this embodiment, the present invention relates to a method for producing a spoonable yogurt comprising the steps of:

- providing the starting ingredients for yogurt;
- 10 - heat-treating the starting ingredients;
- providing an ideal whey protein concentrate having pH 6.8-7.5;
- combining/mixing the ideal whey protein concentrate and the heat-treated ingredients;
- acidifying the mixture to provide a yogurt;
- 15 - optionally cooling the yogurt;
- optionally packing the yogurt.

In this embodiment, the present invention also relates to a method for producing a spoonable yogurt comprising the steps of:

- providing an ideal whey protein solution having whey proteins about 70-90% of the total protein;
- 20 - adjusting the pH of the solution to pH 6.8-7.5;
- heat-treating the solution at the temperature of 88-95°C for 1-10 minutes to provide an ideal whey protein concentrate;
- optionally cooling the concentrate;
- 25 - providing the typical starting ingredients for yogurt;
- heat-treating the starting ingredients;
- combining/mixing the ideal whey protein concentrate and the heat-treated ingredients;
- acidifying the mixture to provide yogurt;
- 30 - optionally cooling the yogurt;
- optionally packing the yogurt.

The yogurt may a stirred yogurt or a set-type yogurt. Accordingly, in an alternative embodiment, the spoonable acidified milk protein product is a set-type yogurt. In this embodiment, the method comprises the steps of:

- 35 - providing the starting ingredients for yogurt;
- heat-treating the starting ingredients;

- providing an ideal whey protein concentrate having pH 6.8-7.5;
- combining/mixing the ideal whey protein concentrate and the heat-treated ingredients;
- packing the mixture with an acidifier
- 5 - acidifying the mixture to provide a yogurt in the package;
- optionally cooling the yogurt.

In this alternative embodiment, the method for producing a spoonable yogurt may comprise the steps of:

- 10 - providing an ideal whey protein solution having whey proteins about 70-90% of the total protein;
- adjusting the pH of the solution to pH 6.8-7.5;
- heat-treating the solution at the temperature of 88-95°C for 1-10 minutes to provide an ideal whey protein concentrate;
- optionally cooling the concentrate;
- 15 - providing the typical starting ingredients for yogurt;
- heat-treating the starting ingredients;
- combining/mixing the ideal whey protein concentrate and the heat-treated ingredients;
- packing the mixture with an acidifier;
- 20 - acidifying the mixture to provide a yogurt in the package;
- optionally cooling the yogurt.

In one embodiment of the invention, the spoonable acidified milk protein product is quark or a quark-type product. In the present invention the term "quark" refers also to tvorog and skyr. In the present invention, the term a
25 quark-type product refers to an acidified milk protein product which has a thickness similar to quark, but which is not classified as quark in the legislation. In one embodiment, the present invention relates to a method for producing a quark or a quark type product comprising the steps of:

- 30 - providing the typical starting ingredients for a quark or a quark type product;
- heat-treating the starting ingredients;
- providing an ideal whey protein concentrate having pH 6.8-7.5;
- combining/mixing the ideal whey protein concentrate and the heat-treated ingredients;
- 35 - optionally treating with rennet and/or chymosin;
- acidifying the mixture to provide a quark or quark type product;

- optionally cooling the quark or quark type product;
- optionally packing the quark or quark type product.

In the step of treating with rennet and/or chymosin, the addition of rennet and/or chymosin may be performed before, after or simultaneously with the acidification step.

In this embodiment, the present invention relates also to a method for producing a quark or a quark type product comprising the steps of:

- providing an ideal whey protein solution having whey proteins about 70-90% of the total protein;
- adjusting the pH of the solution to pH 6.8-7.5;
- heat-treating the solution at the temperature of 88-95°C for 1-10 minutes to provide an ideal whey protein concentrate;
- optionally cooling the concentrate;
- providing the typical starting ingredients for a quark or a quark type product;
- heat-treating the starting ingredients;
- combining/mixing the whey protein concentrate and the heat-treated ingredients;
- acidifying the mixture to provide a quark or quark type product;
- optionally cooling the quark or quark type product;
- optionally packing the quark or quark type product.

In one embodiment, the method of producing a spoonable acidified milk product does not comprise addition of a hydrocolloid, such as gelatine, starch, locust bean gum, carrageenan, guar gum, pectin, for example.

The conventional and/or typical starting ingredients for yogurt manufacturing include skim milk and optionally cream, vegetable oil, water and other milk-based ingredients. The conventional and/or typical starting ingredients for quark manufacturing include skim milk and optionally cream, vegetable oil, water and other milk-based ingredients. The conventional and/or typical starting ingredients for yogurt and quark manufacturing are known to a person skilled in the art.

In the method of producing a spoonable acidified milk protein product of the present invention, the step of heat-treating the ideal whey protein solution is performed at the temperature of 88-95°C for 1-10 minutes. In one embodiment, the heat-treatment is performed at the temperature of 90-95°C. In one embodiment, the heat-treatment is performed at the temperature of

about 92°C for 5 minutes. In the method of producing a spoonable acidified milk protein product of the present invention, the step of heat-treating the typical starting ingredients is performed in the manner known in the art. Examples of heat treatment processes useful for the process of the invention are pasteurization, high pasteurization, heating at a temperature lower than the pasteurization temperature for a sufficiently long time, thermisation, i.e., heating for at least 15 s at approximately 57 to 68°C, UHT, HT, and ESL treatments. In UHT, the raw material is heated at approximately 135 to 140°C for 2 to 4 s. HT ("short UHT treatment") is described in published patent application WO 2010085957. In ESL, the raw material is heated at approximately 127 to 135°C for less than 2 s. In pasteurization, the raw material is heated at approximately 70 to 72°C at least for 15 s, and in high pasteurization, the raw material is heated at approximately 95°C at least for 5 min. Heat treatment may also be a combination of different techniques.

In the method of producing a spoonable acidified milk protein product of the present invention, the step of acidifying may be performed by adding a biological starter specific to each product type (e.g. bulk starter or direct to vat starter DVI/DVS), a chemical starter, or organic or inorganic acids with or without rennet. For instance, the *Lactobacillus bulgaricus* and *Streptococcus thermophiles* strains are conventionally used in yogurt production. Examples of suitable organic acids include glucono-delta-lactone (GDL), calcium lactate, citric acid, and lactic acid. The used acid is preferably glucono-delta-lactone.

The acidified milk products prepared by the process of the invention can be acidified either in a tank before packaging the product or immediately after packaging in a consumer or food service package.

The method of producing a spoonable acidified milk protein product of present invention may further comprise additional process steps such as homogenization, separation, flavouring, cooling, packaging and/or product recovery specific to the product being prepared. The homogenization is conventionally done by using either one- or two-phase homogenizers, and the typical homogenization conditions are a temperature of 55 to 80°C, more typically of 65 to 70°C and a pressure of 100 to 500 bar, more typically of 150 to 200 bar.

The spoonable acidified milk protein product of the present invention contains less proteins than the currently commercially available spoonable acidified products. The spoonable acidified milk protein product of the present invention contains more whey proteins than the currently commercially availa-

ble products. In one embodiment, the spoonable acidified milk protein product of the present invention contains whey proteins at least about 30% by weight of the total milk proteins in the product. In one embodiment, the spoonable acidified milk protein product contains whey proteins at least about 50% by weight of the total milk proteins in the product. In one embodiment, the product contains whey proteins about 50-80% by weight of the total milk proteins in the product. In another embodiment, the product contains whey proteins about 65-70% by weight of the total milk proteins in the product. Further, the yogurts of the present invention contain milk proteins about 3 w-%, at the maximum, and the quark or quark-type products contain milk proteins about 7 w-%, at the maximum whereas the currently commercially available yogurts and quark products typically contain milk proteins at least about 4 w-%. and about 11-12 w-%, respectively. In one embodiment, the spoonable acidified products of the present invention contain at least 25% less milk proteins than the currently commercially available acidified milk products. Further, the products of the present invention contain at least 50% more whey proteins than the currently commercially available acidified milk products. The nutritional quality of the products of the present invention is advantageous especially for children because the ratio of whey and casein proteins of the product of the present invention correspond to that of the breast milk. Further, the amino acid composition of the product of the present invention is close to that of the breast milk.

The texture of the products of the present invention is solid and thick. This is mainly because of the behaviour of the separately heat-treated whey proteins which are forming a gel-like thick texture during the lowering of the pH in the subsequent acidification step.

In one embodiment, the spoonable acidified milk product is free from hydrocolloids, such as gelatine, starch, locust bean gum, carrageenan, guar gum, pectin, for example.

The present invention relates also to a use of an ideal whey protein solution or an ideal whey protein concentrate in the reduction of the total protein content of a spoonable acidified milk product. The present invention also relates to the use of an ideal whey protein solution or an ideal whey protein concentrate in increasing the whey protein content of a spoonable acidified milk product.

The following examples are given to further illustrate the invention without, however, restricting the invention thereto.

Example 1 – Preparation of ideal whey protein solution

Skimmed milk was microfiltered with polymeric microfiltration membranes of 800 kDa (Synder FR-3A-6338) at 10°C. The microfiltration was performed with a concentration factor of 16.5 to provide an ideal casein solution as a microfiltrate retentate. The microfiltration permeate obtained from the microfiltration was concentrated by ultrafiltration with an ultrafiltration membrane of 10 kDa (Koch HFK-131 6438-VYT) and with a concentration factor of 36 at 10°C to provide an ideal whey solution as an ultrafiltration retentate. The protein content of the ideal whey solution was 9%. β -casein content is about 20% based on total protein.

Example 2 – Preparation of an infant yogurt

Infant yogurt was made by separate pasteurization of yogurt milk and an ideal whey protein solution. The final compositions are given below:

Ingredients	Formulation 1	Formulation 2
Cream (35% fat)	5%	10%
Skimmed milk	45%	42.5%
Lactose concentrate (lactose 15.8-21.8%, ash 0.52-1.19%)	22%	22%
Whey protein concentrate	17.3%	17.3%
Vegetable oil	1.8%	0%
RO-retentate (ash 1.86-1.97%)	2.9%	0%
Water	6%	8.2%

The ideal whey protein solution was mixed with water, and its pH was adjusted with 20% KOH to pH 7.3 prior to pasteurization at 92°C for 5 minutes. All other ingredients were mixed, in Formulation 1 pre-homogenized with Ystral mixer, pre-heated to 60°C, homogenized at 400 bar and pasteurized at 92°C for 5 minutes. Pasteurized whey protein concentrate was mixed with yogurt milk and fermented at 42°C about 5 hours until pH was 4.55. The yogurts were hand mixed and subsequently cooled down. A reference sample was made, where all ingredients were mixed and pasteurized together.

The viscosities and wheying off behavior of the yoghurts was determined. Those produced by the method of the invention had a structure typical for stirred yoghurt, whereas the reference yoghurts were very fluid. The

total protein content of the yogurts produced by the method of the invention was 3.3%, of which 50% was whey protein.

Sample	Viscosity (mPas)	Whey separation
Formulation 1	815	+++
Reference 1	16	-
Formulation 2	870	-
Reference 2	97	-

Example 3 Preparation of a creamy yogurt

- 5 A creamy yogurt was made by separate pasteurizations of yogurt milk and an ideal whey protein solution. A reference without whey protein concentrate was made:

Ingredients	Formulation 1	Reference 1
UF retentate (11.5-11.9% protein, lactose 4.2-4.4%, 1.37-1.41% ash)	15%	20.8%
Cream (35% fat)	8.8%	8.6%
Milk	61.1%	64.5%
Lactose concentrate	6.1%	6.1%
Whey protein concentrate	9%	0%

- 10 The ideal whey protein solution was mixed with water, and its pH was adjusted with 20% KOH to pH 7.3 prior to pasteurization at 9°C for 5 minutes. All other ingredients were mixed, pre-heated to 60°C, homogenized at 400 bar and pasteurized at 92°C for 5 minutes. Pasteurized whey protein concentrate was mixed with yoghurt milk and fermented at 42°C about 5 hours
 15 until pH was 4.6. The yoghurts were hand mixed and subsequently cooled down. A reference sample was made, where all ingredients were mixed and pasteurized together.

- The viscosities and wheying off behavior of the yoghurts was determined. The yogurt produced by the method of the invention was very vis-
 20 cous and contained less titratable acids as compared with the reference. The total protein content of the yogurt produced by the method of the invention was 5% of which 30% was whey protein.

Sample	Viscosity (mPas)	Titrateable acidity SH
Formulation 1	1870	43.8
Reference 1	484	45.8

Example 4 – A quark-type product

A quark-type product, which has lower protein content than normal quark, but higher share of good whey proteins, which is suitable for active exercising people, was prepared as follows:

5 Ideal whey protein solution, which has the total protein concentration at least 8%, was heat-treated at 90°C for 5 min. After the heat-treatment the whey was mixed with pasteurized milk (f.ex. 0-3.5% fat) to get a mixture of about 30-35% casein and 65-70% whey protein. The total protein content was about 6.7%.

10 The mixture was heated up to 42°C and fermented 4.5-5 h to reach pH 4.55-4.6.

 The gelled product was mixed by hand or using a kitchen mixer (Pamix) and cooled down to ambient temperature. The mixed product was homogenized at 80 bar to get a smooth velvet-like texture which had a viscosity of 11700 mPas.

 The product was flavored by mixing a suitable jam or fruit/berry preparation in the product. The added amount was about 12-15%.

 The share of casein and whey proteins were compared with those of a commercial high protein yoghurt (total protein 7%) and high protein quark (total protein 11%) made of regular milk with the normal casein/whey protein ratio (80/20). The results are shown in Figure 1.

 This type of a product is ideal for exercising people, who need a lot of protein but less calories.

25 It will be obvious to a person skilled in the art that, as the technology advances, the inventive concept can be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

Claims

1. A method of producing an ideal whey protein concentrate comprising the steps of:

- 5 - providing an ideal whey protein solution containing whey proteins about 70-90% and caseins about 10-30% of the total protein;
- adjusting the pH of the solution to pH 6.8-7.5;
- heat-treating the solution at a temperature of 88-95°C for 1-10 minutes to provide an ideal whey protein concentrate;
- 10 - optionally cooling the concentrate;
- optionally storing the concentrate at a temperature of 4-8°C.

2. The method of claim 1, wherein the pH of the solution is adjusted to pH 6.8-7.3.

3. An ideal whey protein concentrate, wherein the pH of the concentrate is the range of 6.8-7.5 and about 70-90% of the total proteins of the concentrate are whey proteins and about 10-30% of the total proteins of the concentrate are caseins.

4. The ideal whey protein concentrate of claim 3, wherein the pH of the concentrate is the range of 6.8-7.3.

5. The method of claim 1 or claim 2 or the concentrate of claim 3 or claim 4, wherein about 50-80% of the caseins is β -casein.

6. A method of producing a spoonable acidified milk product comprising the steps of:

- 25 - providing typical starting ingredients for a spoonable acidified milk product ;
- heat-treating the ingredients;
- providing an ideal whey protein concentrate having whey proteins about 70-90% and caseins about 10-30% of the total proteins and pH in the range of 6.8-7.5;
- 30 - combining/mixing the heat-treated ingredients and the ideal whey protein concentrate and;
- acidifying the mixture to provide a spoonable acidified milk product having a pH value in the range of about 4.0 to about 4.8.

7. A method of producing a spoonable acidified milk product comprising the steps of:

- providing an ideal whey protein solution having whey proteins about 70-90% and caseins about 10-30% of the total protein;
- 5 - adjusting the pH of the solution to pH 6.8-7.5;
- heat-treating the solution at the temperature of 88-95°C for 1-10 minutes to provide an ideal whey protein concentrate;
- optionally cooling the concentrate;
- 10 - providing the typical starting ingredients for a spoonable acidified milk product;
- heat-treating the starting ingredients;
- combining/mixing the ideal whey protein concentrate and the heat-treated ingredients;
- 15 - acidifying the mixture to provide a spoonable acidified milk product having a pH value in the range of about 4.0 to about 4.8.

8. The method of claim 6 or claim 7, wherein the pH is adjusted to pH 6.8-7.3.

9. The method of any one of claims 6 to 8, wherein the spoonable acidified milk product is a yogurt or a quark or a quark-type product.

20 10. The method of any one of claims 6 to 9, wherein the method does not contain addition of a hydrocolloid.

11. A spoonable acidified milk product produced according to any one of claims 6 to 10.

25 12. A spoonable acidified milk product containing whey proteins at least 30% by weight of the total milk proteins in the product.

13. The spoonable acidified milk product of claim 12, wherein the product contains whey proteins at least 50% by weight of the total milk proteins in the product.

30 14. The spoonable acidified milk product of claim 12 or claim 13, wherein the product is a yogurt.

15. The yogurt of claim 14, wherein it contains milk proteins about 3 weight-%, at the maximum.

16. The spoonable acidified milk product of claim 12 or claim 13, wherein the product is a quark or a quark-type product.

35 17. The quark or quark-type product of claim 16, wherein it contains milk proteins about 7 weight-%, at the maximum.

18. The spoonable acidified milk product of any one of claims 11 to 17, wherein the product does not contain a hydrocolloid.

19. Use of an ideal whey protein solution or an ideal whey protein concentrate having whey proteins about 70-90% and caseins about 10-30% of the total proteins and pH in the range of 6.8-7.5 in reducing the total milk protein content of a spoonable acidified milk product.

20. Use of an ideal whey protein solution or an ideal whey protein concentrate having whey proteins about 70-90% and caseins about 10-30% of the total proteins and pH in the range of 6.8-7.5 in increasing the whey protein content of a spoonable acidified milk product.

21. The use of claim 19 or claim 20, wherein about 50-80% of the caseins in the ideal whey protein solution or concentrate is β -casein.

22. The use according to any one of claims 19 to 21, wherein the spoonable milk product is a yogurt or a quark or a quark-type product.

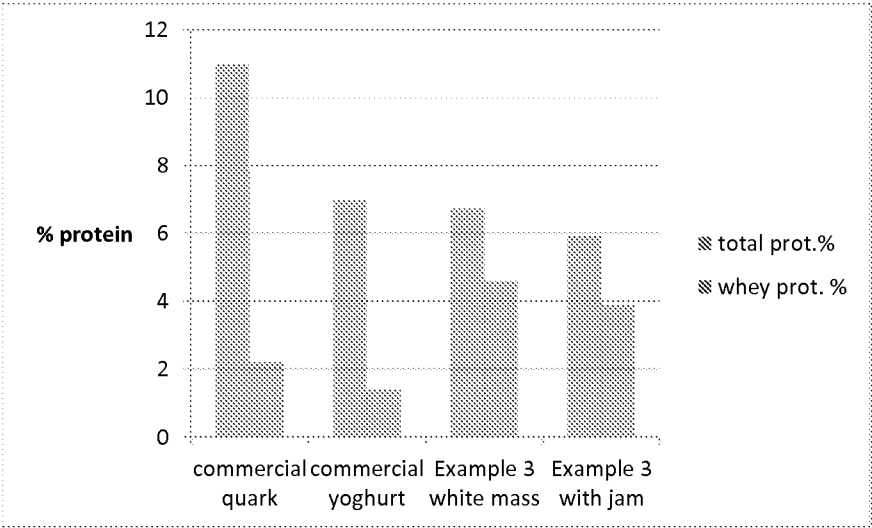


FIG.1

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER INV. A23C9/123 A23C9/13 A23C19/068 A23C19/076 A23C21/02 A23C21/06 A23J1/20 A23J3/08 ADD. According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) A23C A23J Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data, BIOSIS, FSTA		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	WO 2014/087054 A1 (VALIO OY) 12 June 2014 (2014-06-12) page 1, lines 16-24; claims 1-10,15-23; figure 1; examples 1-11 page 3, line 17 - page 5 -----	6,11,12, 14-22 5 1,2,7-10
X Y	US 2002/164401 A1 (SATO KAORU [JP] ET AL) 7 November 2002 (2002-11-07) paragraph [0002]; claims; examples 1-3 -----	1-4 5
X	US 5 714 182 A (BISSON JEAN-PIERRE [FR] ET AL) 3 February 1998 (1998-02-03) examples 12-15 ----- -/--	11,18
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 1 March 2016		Date of mailing of the international search report 11/03/2016
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Muller, Isabelle

INTERNATIONAL SEARCH REPORT

International application No

PCT/FI2015/050926

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/051557 A1 (VALIO LTD [FI]; HARJU MATTI [FI]; HEINO ANTTI [FI]; TIKANMAEKI REETTA) 5 May 2011 (2011-05-05) paragraphs [0017], [0019], [0020], [0024], [0036], [0037]; claims 2,6,13-15,22; examples 1-4,7,8 -----	3-5
X	PUVANENTHIRAN ET AL: "Structure and visco-elastic properties of set yoghurt with altered casein to whey protein ratios", INTERNATIONAL DAIRY JOURNAL,, vol. 12, no. 4, 2002, pages 383-391, XP002525404, DOI: 10.1016/S0958-6946(02)00033-X items 3.1, 3.2, 3.3 and 4.4; pages 384,389; tables 1,2 -----	11-14,18
X	KAILASAPATHY K ET AL: "EFFECT OF PARTIALLY REPLACING SKIM MILK POWDER WITH WHEY PROTEIN CONCENTRATE ON THE SENSORY QUALITIES OF LACTOSE HYDROLYSED ACIDOPHILUS YOGURT", MILCHWISSENSCHAFT, VV GMBH VOLKSWIRTSCHAFTLICHER VERLAG. MUNCHEN, DE, vol. 53, no. 7, 1998, pages 385-389, XP000785246, ISSN: 0026-3788 item 2.1 and 3.; pages 386-387; table 1 -----	11,12, 14,18
X	ISABELLE SODINI ET AL: "Physical properties of yogurt fortified with various commercial whey protein concentrates", JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE, vol. 85, no. 5, 2005, pages 853-859, XP055187577, ISSN: 0022-5142, DOI: 10.1002/jsfa.2037 pages 854-855 -----	11,18
A	-----	1-10
X	AUGUSTIN M A ET AL: "USE OF BLENDS OF SKIM MILK AND SWEET WHEY PROTEIN CONCENTRATES IN RECONSTITUTED YOGURT", AUSTRALIAN JOURNAL OF DAIRY TECHNOLOGY, DAIRY INDUSTRY ASSOCIATION OF AUSTRALIA, MELBOURNE, AU, vol. 58, no. 1, 2003, pages 30-35, XP001166338, ISSN: 0004-9433 abstract; pages 31-33; tables 2,3 ----- -/--	11,18

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2015/050926

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2005/016015 A1 (FONTERRA CO OPERATIVE GROUP [NZ]; LOWE EDWIN [NZ]; ANEMA SKELTE [NZ];) 24 February 2005 (2005-02-24) claims; examples -----	1-22
A	WO 2006/068505 A1 (FONTERRA COOP GROUP) 29 June 2006 (2006-06-29) claims 1,2,6,8-17,23,32,33,39-47,53; examples -----	1-22
A	WO 2008/092458 A1 (ARLA FOODS AMBA [DK]; ANDERSEN CLAUS [DK]; CHRISTENSEN GUNNER [AR]; BU) 7 August 2008 (2008-08-07) claims; examples -----	1-22
A	EP 0 184 267 A1 (HOLLAND MELKUNIE [NL]) 11 June 1986 (1986-06-11) claims; examples I,II -----	1-22
A	WO 2009/108074 A1 (COKER CHRISTINA JUNE [NZ]; RAM SATYENDRA PARSHU [NZ]; REID DAVID CAMPB) 3 September 2009 (2009-09-03) claims; examples -----	1-22

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/FI2015/050926

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2014087054 A1	12-06-2014	EP 2928312 A1 US 2015296822 A1 WO 2014087054 A1	14-10-2015 22-10-2015 12-06-2014
US 2002164401 A1	07-11-2002	AU 717320 B2 AU 4188396 A CA 2200972 A1 DE 69528991 D1 DE 69528991 T2 DK 0782825 T3 EP 0782825 A1 FI 971298 A JP 3073236 B2 NO 971582 A NZ 297099 A US 2002031600 A1 US 2002164401 A1 WO 9705784 A1	23-03-2000 05-03-1997 20-02-1997 09-01-2003 24-07-2003 24-03-2003 09-07-1997 19-05-1997 07-08-2000 04-06-1997 24-09-1998 14-03-2002 07-11-2002 20-02-1997
US 5714182 A	03-02-1998	AT 207303 T BR 9503631 A CZ 9501899 A3 DE 69523405 D1 DE 69523405 T2 DK 0709034 T3 EP 0696426 A1 EP 0709034 A2 ES 2164130 T3 PL 310000 A1 PT 709034 E SK 99895 A3 US 5714182 A ZA 9506185 A	15-11-2001 04-06-1996 14-02-1996 29-11-2001 16-05-2002 26-11-2001 14-02-1996 01-05-1996 16-02-2002 19-02-1996 29-04-2002 06-03-1996 03-02-1998 27-01-1997
WO 2011051557 A1	05-05-2011	AR 078779 A1 AU 2010311316 A1 BR 112012009744 A2 CA 2778360 A1 CN 102595915 A EP 2493325 A1 JP 2013509171 A JP 2015221041 A KR 20120098753 A RU 2012121886 A WO 2011051557 A1	30-11-2011 31-05-2012 01-09-2015 05-05-2011 18-07-2012 05-09-2012 14-03-2013 10-12-2015 05-09-2012 10-12-2013 05-05-2011
WO 2005016015 A1	24-02-2005	AU 2004264306 A1 CN 1838883 A EP 1659872 A1 MX PA06001852 A NZ 527678 A US 2007128324 A1 WO 2005016015 A1	24-02-2005 27-09-2006 31-05-2006 31-05-2006 27-01-2006 07-06-2007 24-02-2005
WO 2006068505 A1	29-06-2006	AU 2004325988 A1 BR PI0419183 A EP 1838163 A1 JP 2008525018 A	29-06-2006 18-12-2007 03-10-2007 17-07-2008

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/FI2015/050926

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 2008305208 A1	11-12-2008
		WO 2006068505 A1	29-06-2006
WO 2008092458	A1	07-08-2008	
		AR 065147 A1	20-05-2009
		DK 2120591 T3	14-01-2013
		EA 200970712 A1	30-12-2009
		EP 2120591 A1	25-11-2009
		ES 2396263 T3	20-02-2013
		HR P20121039 T1	31-01-2013
		IL 199927 A	31-07-2013
		JP 5421123 B2	19-02-2014
		JP 2010517515 A	27-05-2010
		PT 2120591 E	14-01-2013
		SI 2120591 T1	28-02-2013
		US 2008187623 A1	07-08-2008
		US 2011217416 A1	08-09-2011
		WO 2008092458 A1	07-08-2008
EP 0184267	A1	11-06-1986	
		DE 3562112 D1	19-05-1988
		EP 0184267 A1	11-06-1986
		ES 8605144 A1	16-08-1986
		IE 57112 B1	22-04-1992
		NL 8403700 A	01-07-1986
WO 2009108074	A1	03-09-2009	
		AU 2009217862 A1	03-09-2009
		CN 102164497 A	24-08-2011
		EP 2262375 A1	22-12-2010
		JP 2011512816 A	28-04-2011
		NZ 566358 A	26-11-2010
		RU 2010139847 A	10-04-2012
		US 2011097472 A1	28-04-2011
		WO 2009108074 A1	03-09-2009