



(19)



(10) **FI 129057 B**  
(12) **PATENTIJULKAISU**  
**PATENTSKRIFT**  
**PATENT SPECIFICATION**

|      |   |            |
|------|---|------------|
| (45) | Patentti myönnetty - Patent beviljats - Patent granted  | 15.06.2021 |
| (51) | Kansainvälinen patenttiluokitus - Internationell patentklassifikation - International patent classification |            |
|      | <b>A23J 1/20</b> (2006.01)  |            |
|      | <b>A23C 9/15</b> (2006.01)  |            |
|      | <b>A23C 21/06</b> (2006.01)   |            |
|      | <b>A23C 9/12</b> (2006.01)  |            |
|      | <b>A23C 9/123</b> (2006.01)   |            |
|      | <b>A23C 21/02</b> (2006.01)   |            |
| (21) | Patentihakemus - Patentansökan - Patent application   | 20146133   |
| (22) | Tekemispäivä - Ingivningsdag - Filing date  | 22.12.2014 |
| (23) | Saapumispäivä - Ankomstdag - Reception date   | 22.12.2014 |
| (43) | Tullut julkiseksi - Blivit offentlig - Available to the public  | 23.06.2016 |

(73) Haltija - Innehavare - Proprietor

1 • Valio Oy, Meijeritie 6, 00370 HELSINKI, SUOMI - FINLAND, (FI)

(72) Keksijä - Uppfinnare - Inventor

1 • Ollikainen, Pia, HELSINKI, SUOMI - FINLAND, (FI)  
2 • Partanen, Riitta, HELSINKI, SUOMI - FINLAND, (FI)  
3 • Laiho, Saara, HELSINKI, SUOMI - FINLAND, (FI)

(74) Asiamies - Ombud - Agent

Kolster Oy Ab, Salmisaarenaukio 1, 00180 Helsinki

(54) Keksinnön nimitys - Uppfinningens benämning - Title of the invention

**Menetelmä lisikoitavan hapatetun maitotuotteen valmistamiseksi**  
**Förfarande för att producera en syrad mjölkprodukt som kan ätas med sked**  
**A method for producing a spoonable acidified milk product**

(56) Viitejulkaisut - Anförläda publikationer - References cited

WO 2005041677 A1, WO 2013068653 A2, WO 2013009182 A1, WO 2014087054 A1, WO 2012110705 A1, WO 2011051557 A1, VAN HEKKEN et al. Use of cold microfiltration to produce unique b-casein enriched milk gels. Le Lait, 2000, Vol. 80, No. 1, pp. 69-76.  
[Retrieved 18.8.2015] From Internet-address: <https://hal.archives-ouvertes.fr/hal-00895388/document>

(57) Tiivistelmä - Sammandrag - Abstract

Keksintö koskee menetelmää ideaaliheraproteiini-konsentraatin valmistamiseksi. Keksintö koskee myös ideaaliheraproteiinikonsentraattia ja sen käyttöjä lisikoitavan hapatetun maitotuotteen kokonaisproteiini-pitoisuuden alentamisessa ja/tai heraproteiinipitoisuuden lisäämisessä. Lisäksi eksintö koskee menetelmää lisikoitavan hapatetun maitotuotteen, jolla on korkea heraproteiinipitoisuus mutta alentunut kokonaisproteiini-pitoisuus, valmistamiseksi. Keksintö koskee myös lisikoitavaa hapatettua maitotuotetta, jolla on korkea heraproteiinipitoisuus mutta alentunut kokonaisproteiini-pitoisuus.

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.

## A METHOD FOR PRODUCING A SPOONABLE ACIDIFIED MILK PRODUCT

### 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 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.

WO 2013/068653 discloses a liquid neutral or acidified infant milk formula containing an ideal whey protein solution.

WO 2013/009182 discloses to a method for producing a microbiologically safe dairy based food composition using microfiltration to provide a casein rich fraction and a serum protein rich fraction.

WO 2014/087054 discloses a method for producing an acidified milk base. In the method, an ideal whey protein solution produced by microfiltration of milk is used.

WO 2012/110705 discloses a method for producing a whey protein product in which casein and whey protein are first separated by microfiltration to different fractions. The whey protein fraction is concentrated by ultrafiltration followed by combining it with a casein-containing material so as to provide a ratio of whey protein to casein of about 20:80 to about less than 50:50.

WO 2011/051557 discloses a method for producing a whey protein product in which casein and whey protein are first separated by microfiltration to different fractions. The whey protein fraction is concentrated by ultrafiltration followed by combining it with a casein-containing material so as to provide a ratio of whey protein to casein of about 90:10 to about 50:50.

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 reduc-

tion 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.

5 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 5 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, 10 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 15 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 20 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 25 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 30 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 35 formed  $\kappa$ -casein  $\beta$ -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  $\beta$ -casein, but it contains other casein monomers to a lesser extent than milk. Further, it is free of caseinomacropeptides and thermally formed  $\kappa$ -casein  $\beta$ -lactoglobulin complexes. It may contain traces of fat. 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  $\beta$ -casein. In an embodiment, the content of  $\beta$ -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  $\beta$ -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 concentrate contains more  $\alpha$ -lactalbumin ( $\alpha$ -LA) and  $\beta$ -lactoglobulin ( $\beta$ -LG) in total whey protein than WPC or WPI manufactured from cheese whey because the caseinomacropeptide fraction does not exist in ideal whey protein concentrate. In addition, the amino acid composition of the ideal whey protein solution resembles that of the breast milk.

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  $\beta$ -casein, but it contains other casein monomers to a lesser extent than milk. Further, it is free of caseinomacropeptides and thermally formed  $\kappa$ -casein  $\beta$ -lactoglobulin complexes. The casein content of the total milk proteins in the ideal whey protein concentrate is about 10-30%, of which about 50-80% is  $\beta$ -casein. In an embodiment, the content of  $\beta$ -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  $\beta$ -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.

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 properties 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 proteins 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;
- 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 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 5 for 5 minutes.

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.

10 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 15 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.

20 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 25 50-80% of casein is  $\beta$ -casein. 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:

- 30 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;
- 35 acidifying the mixture to provide a spoonable acidified milk product.

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;
- 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.

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;
- 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;
- 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;
- 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 yogurt;
- heat-treating the starting ingredients;
- combining/mixing the ideal whey protein concentrate and the heat-treated ingredients;
- acidifying the mixture to provide yogurt;
- 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:

- 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
- 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:

- 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 yogurt;

- heat-treating the starting ingredients;
- 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

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

- 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;
- 15 - combining/mixing the ideal whey protein concentrate and the heat-treated ingredients;
- 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;
- 20 - 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.

25 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 30 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;
- 35 - 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.

5 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.

10 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.

15 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 20 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 25 135°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 30 may also be a combination of different techniques.

35 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.

5 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.

10 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.

15 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 available 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 be-

cause 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.

5 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.

10 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.

15 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**

20 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 25 10°C to provide an ideal whey solution as an ultrafiltration retentate. The protein content of the ideal whey solution was 9%.  $\beta$ -casein content is about 20% based on total protein.

#### **Example 2 – Preparation of an infant yogurt**

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

| <b>Ingredients</b>   | <b>Formulation 1</b> | <b>Formulation 2</b> |
|--|----------------------|----------------------|
| Cream (35% fat)  | 5%                   | 10%                  |
| Skimmed milk   | 45%                  | 42.5%                |
| Lactose concentrate<br>(lactose 15.8-21.8%,<br>ash 0.52-1.19%) | 22%                  | 22%                  |
| Whey protein concentrate                                       | 17.3%                | 17.3%                |
| Vegetable oil  | 1.8%                 | 0%                   |
| RO-retentate<br>(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 yogurts was determined. Those produced by the method of the invention had a structure typical for stirred yoghurt, whereas the reference yogurts 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.

| <b>Sample</b> | <b>Viscosity<br/>(mPas)</b> | <b>Whey separation</b> |
|---------------|-----------------------------|------------------------|
| Formulation 1 | 815                         | +++                    |
| Reference 1   | 16                          | -                      |
| Formulation 2 | 870                         | -                      |
| Reference 2   | 97                          | -                      |

### Example 3 Preparation of a creamy yogurt

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%          |

5

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 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 viscous 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) | Titratable 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:

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 5 about 6.7%.

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

10 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%.

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.

20 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 for use in preparing spoonable acidified milk product, comprising the steps of:

- providing an ideal whey protein solution containing whey proteins 70-90% and caseins 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;
- optionally cooling the concentrate;
- optionally storing the concentrate at a temperature of 4-8°C, wherein the ideal whey protein solution is an ultrafiltration retentate of the microfiltration permeate of skim milk.

2. An ideal whey protein concentrate produced according to claim 1, wherein the pH of the concentrate is 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.

3. The method of claim 1 or the concentrate of claim 2, wherein 50-80% of the caseins is  $\beta$ -casein.

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

- providing an ideal whey protein solution having whey proteins 70-90% and caseins 10-30% of the total protein, wherein the ideal whey protein solution is an ultrafiltration retentate of the microfiltration permeate of skim milk;
- 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.

5. The method of claim 4, wherein the spoonable acidified milk product is yogurt or a quark or quark-type product.

6. The method of claim 4 or 5, wherein the method does not contain addition of a hydrocolloid.

5 7. A spoonable acidified milk product produced according to any one of claims 4-6, containing whey proteins at least 30% by weight of the total milk proteins in the product, wherein the product is yogurt containing milk proteins 3 weight-%, at the maximum or wherein the product is quark or quark-type product containing milk proteins 7 weight-%, at the maximum.

10 8. The spoonable acidified milk product of claim 7, wherein the product contains whey proteins at least 50% by weight of the total milk proteins in the product.

9. The spoonable acidified milk product of claim 7 or 8, wherein the product does not contain a hydrocolloid.

15 10. Use of an ideal whey protein concentrate produced by the method of claim 1, having whey proteins 70-90% and caseins 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 11. Use of an ideal whey protein concentrate produced by the method of claim 1, having whey proteins 70-90% and caseins 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.

12. The use of claim 10 or claim 11, wherein 50-80% of the caseins in the ideal whey protein concentrate is  $\beta$ -casein.

25 13. The use according to any one of claims 10 to 12, wherein the spoonable milk product is a yogurt or a quark or quark-type product.

## Patenttivaatimukset

1. Menetelmä ideaaliheraproteiinikonsentraatin valmistamiseksi, jota konsentraattia käytetään lusikoitavan hapatetun maitotuotteen valmistamiseksi, joka menetelmä käsittää vaiheet:
  - 5 - otetaan ideaaliheraproteiiniliuos, joka sisältää 70-90 % heraproteiineja ja 10-30 % kaseiineja kokonaisproteiinista;
  - säädetään liuoksen pH arvoon 6,8-7,5;
  - lämpökäsitellään liuos lämpötilassa 88-95 °C 1-10 minuutin ajan, jolloin saadaan ideaaliheraproteiinikonsentraatti;
- 10 - valinnaisesti jäähdytetään konsentraatti;
- valinnaisesti säilytetään konsentraatti lämpötilassa 4-8 °C, jolloin ideaaliheraproteiinikonsentraatti on rasvattoman maidon mikrosuodatuspermeaatin ultrasuodatusretentaatti.
2. Ideaaliheraproteiinikonsentraatti, joka on valmistettu patenttivaatimukseen 1 mukaisesti, jolloin konsentraatin pH on välillä 6,8-7,5 ja 70-90 % konsentraatin kokonaisproteiineista on heraproteiineja ja 10-30 % konsentraatin kokonaisproteiineista on kaseiineja.
- 15 3. Patenttivaatimuksen 1 mukainen menetelmä tai patenttivaatimuksen 2 mukainen konsentraatti, jolloin 50-80 % kaseiineista on β-kaseiinia.
- 20 4. Menetelmä lusikoitavan hapatetun maitotuotteen valmistamiseksi, joka menetelmä käsittää vaiheet:
  - otetaan ideaaliheraproteiiniliuos, joka sisältää 70-90 % heraproteiineja ja 10-30 % kaseiineja kokonaisproteiinista, jolloin ideaaliheraproteiinikonsentraatti on rasvattoman maidon mikrosuodatuspermeaatin ultrasuodatusretentaatti;
  - säädetään liuoksen pH arvoon 6,8-7,5;
  - lämpökäsitellään liuos lämpötilassa 88-95 °C 1-10 minuutin ajan, jolloin saadaan ideaaliheraproteiinikonsentraatti;
  - valinnaisesti jäähdytetään konsentraatti;
- 25 30 35 - otetaan lusikoitavan hapatetun maitotuotteen tyypillisiä lähtöaineosia;
  - lämpökäsitellään ainesosat;
  - yhdistetään/sekoitetaan ideaaliheraproteiinikonsentraatti ja lämpökäsitellyt ainesosat;
  - hapatetaan seos, jolloin saadaan lusikoitava hapatettu maitotuote.

5. Patenttivaatimuksen 4 mukainen menetelmä, jolloin lusikoitava  
hapatettu maitotuote on jogurtti, rahka tai rakhantyyppinen tuote.
6. Patenttivaatimuksen 4 tai 5 mukainen menetelmä, jolloin mene-  
telmä ei sisällä hydrokolloidin lisäämistä.
- 10 7. Lusikoitava hepatettu maitotuote, joka on valmistettu jonkin pa-  
tenttivaatimuksen 4-6 mukaisesti ja joka sisältää heraproteiineja vähintään 30  
paino-% tuotteen kokonaismaitoproteiineista, jolloin tuote on jogurtti, joka sisäl-  
tää maitoproteiineja enintään 3 paino-%, tai jolloin tuote on rahka tai rakh-  
antyyppinen tuote, joka sisältää maitoproteiineja enintään 7 paino-%.
- 15 8. Patenttivaatimuksen 7 mukainen lusikoitava hepatettu maitotuote,  
jolloin tuote sisältää heraproteiineja vähintään 50 paino-% tuotteen kokona-  
maitoproteiineista.
9. Patenttivaatimuksen 7 tai 8 mukainen lusikoitava hepatettu maito-  
tuote, jolloin tuote ei sisällä hydrokolloidia.
- 20 10. Ideaaliheraproteiinikonsentraatin, joka on valmistettu patentti-  
vaatimuksen 1 mukaisella menetelmällä ja jossa on heraproteiineja 70-90 % ja  
kaseiineja 10-30 % kokonaisproteiineista ja jonka pH on välillä 6,8-7,5, käyttö  
lusikoitavan hepatetun maitotuotteen kokonaismaitoproteiinipitoisuuden alen-  
tamisessa.
- 25 11. Ideaaliheraproteiinikonsentraatin, joka on valmistettu patentti-  
vaatimuksen 1 mukaisella menetelmällä ja jossa on heraproteiineja 70-90 % ja  
kaseiineja 10-30 % kokonaisproteiineista ja jonka pH on välillä 6,8-7,5, käyttö  
lusikoitavan hepatetun maitotuotteen heraproteiinipitoisuuden lisäämisessä.
12. Patenttivaatimuksen 10 tai 11 mukainen käyttö, jolloin noin 50-  
80 % kaseiineista ideaaliheraproteiinikonsentraatissa on  $\beta$ -kaseiinia.
13. Minkä tahansa patenttivaatimuksen 10-12 mukainen käyttö, jol-  
loin lusikoitava hepatettu maitotuote on jogurtti, rahka tai rakhantyyppinen tuo-  
te.

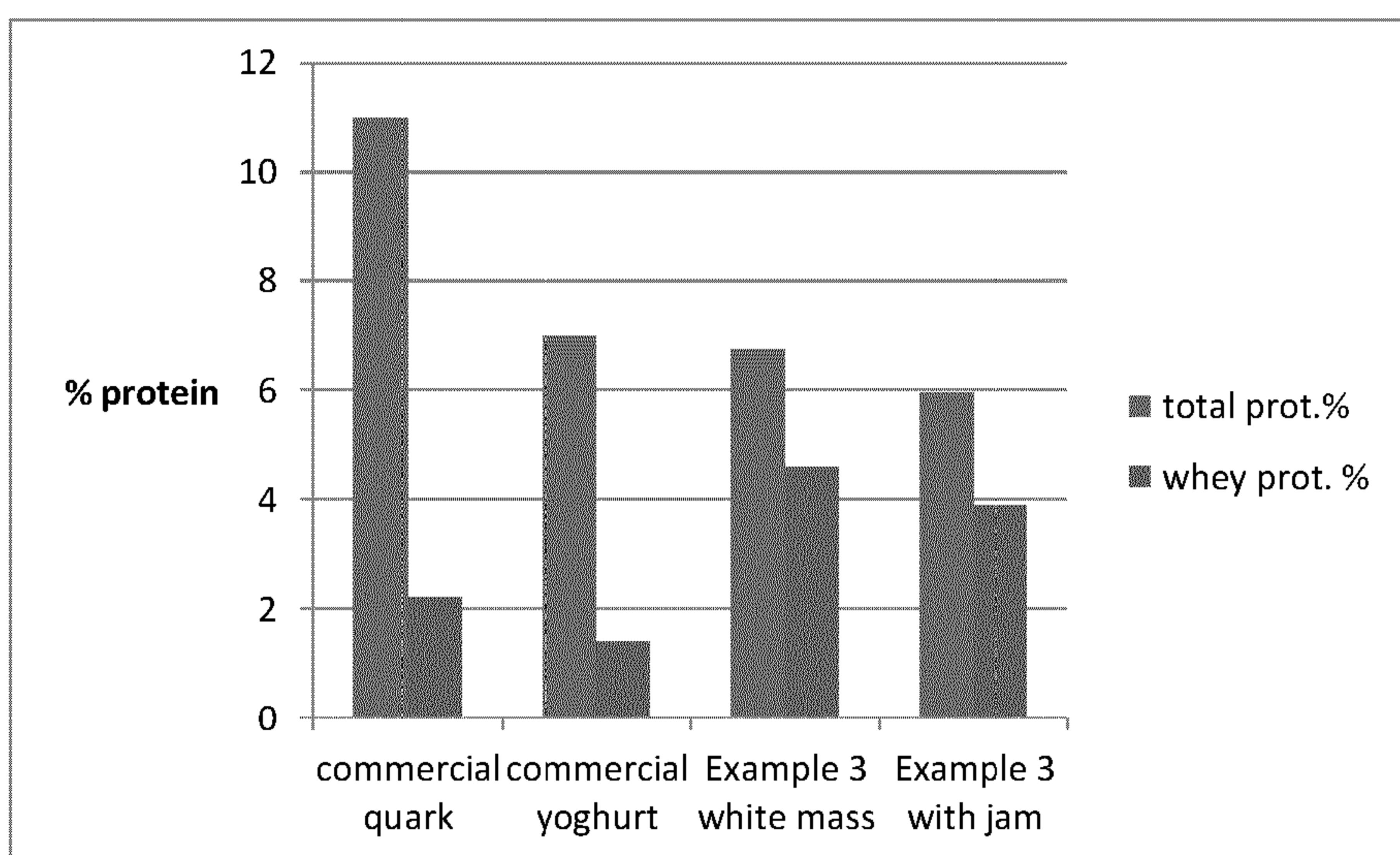


FIG.1