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(54) Title: MILK-BASED PRODUCT AND A METHOD FOR ITS PREPARATION

(57) Abstract: The invention relates to a whey protein product having a ratio of whey protein to casein in the range from about 25:75 to about less than 50:50, a total protein content of at least 20% on dry matter basis, and a protein content of about 2.5 to about 8% by weight, based on the weight of the product. The product has a favourable amino acid composition and is especially suitable for athletes. The invention also relates to a method for producing a whey protein product, using microfiltration and ultrafiltration. The whey protein product is composed of the ultrafiltration re-tentate and a casein-containing material at a ratio of whey protein to casein of about 20:80 to about less than 50:50 and a total protein content of at least about 20% on dry matter basis.

## Milk-based product and a method for its preparation

### Field of the invention

**[0001]** The invention relates to a milk-based product enriched with whey protein and a method for the preparation thereof.

### Background of the invention

**[0002]** It has been shown that the whey proteins are excellent protein sources, i.a. in nutrition of athletes, in increase and maintenance of muscle mass. Therefore, there are lots of whey protein powders, and beverages produced thereof in the market. In general, as a raw material for said whey protein products, a whey protein concentrate as a powder is used which is prepared by ultrafiltration of cheese, quark, or casein whey and by subsequent drying of the concentrate received from the ultrafiltration. These products have a problem that the taste is foul which results from proteolysis caused by starters such as cheese starters and a rennet, oxidation of residual fat, and other taste flaws. Also, removal of minerals during the production process of the whey products gives rise to a taste which is more watery than that of normal milk. It has been tried to eliminate the problems associated with the taste, whereby the whey products have been flavored up with various food additives, flavoring substances, flavoring preparations and processing aids.

**[0003]** In addition to the taste problems of the current whey protein products, there is a problem that all the whey proteins are not equal in their nutritive value. For example, nutritive value of glycomacropeptide released from casein into whey during the cheese production is minor than those of  $\alpha$ -lactalbumin and  $\beta$ -lactoglobulin. Glycomacropeptide constitutes a significant portion of the total proteins of cheese whey.

**[0004]** Still a further problem arises from the high content of lactose included in the known whey products. As it is commonly known, lactose causes intolerance symptoms for a large amount of adult people in the world.

**[0005]** It is also generally known that thermal treatment of the whey protein based product causes structural faults in the product. These products are typically described as flaky, coarse, lumpy, or sandy.

**[0006]** In view of the above problems, price-quality ratio of the known whey protein products is not attractive. Consequently, the products are not commonly available in large scale but are provided for consumers as specialty products obtainable in restricted facilities, like fitness centers.

**[0007]** Milk-based whey protein products are generally widely known. Also, various membrane techniques and combinations thereof for separating milk components into individual fractions are largely described in the literature. For example, WO 94/13148 discloses a process for producing an undenatured whey protein concentrate by means of microfiltration and ultrafiltration of skim milk. Casein is retained in the microfiltration retentate while  $\alpha$ -lactalbumin and  $\beta$ -lactoglobulin penetrate the microfiltration membrane having a pore size of about 0.1 microns quite easily.

**[0008]** WO 96/08155 discloses a separation of casein and whey proteins from a skim milk starting material utilizing microfiltration and ultrafiltration. For example, a milk beverage with a lowered whey protein content can be produced by the process.

**[0009]** WO 00/30461 discloses that microfiltration can be utilized in the preparation of infant formula to make the amino acid composition similar to that of human milk.

**[0010]** WO 03/094623 A1 discloses that several membrane techniques, i.e. ultrafiltration, nanofiltration and reverse osmosis, are utilized to prepare a lactose-free milk beverage.

**[0011]** It is desirable to provide whey protein products that do not possess the drawbacks of the known products but have a pleasant taste and favorable nutritive composition.

#### **Brief description of the invention**

**[0012]** We have surprisingly found that the problems associated with the known whey products can be avoided by including casein in the milk-based whey protein fraction prepared by membrane techniques and enriched with  $\alpha$ -lactalbumin and  $\beta$ -lactoglobulin. It is surprising that even a small amount of casein is sufficient to improve the organoleptic properties of the product, like maintain the taste as smooth and velvety. Surprisingly, also the structure and stability of the whey protein product of the invention is good without any sand, flake, deposition or gel formation etc. Also, the nutritive value of the product is increased.

**[0013]** In an embodiment of the invention, it is possible to prepare a whey protein beverage that looks and tastes like milk but has a composition which is more favourable to athletes and other exercise enthusiasts.

### **Brief description of the drawings**

**[0014]** Fig. 1 illustrates an embodiment of the method of the invention for producing a whey protein product.

### **Detailed description of the invention**

**[0015]** It is an object of the present invention to provide a whey protein product having a ratio of whey protein to casein in the range from about 25:75 to about less than 50:50, a total protein content of at least about 20% on dry matter basis, and a protein content of about 2.5% to about 8% by weight, based on the weight of the product. In an embodiment of the invention, the ratio of whey protein to casein ranges from about 25:75 to about 40:60. In a specific embodiment of the invention, said ratio is about 30:70. In further embodiments of the invention, said ratio is about 49:51, 48:52, 47:53, 46:54, and 45:55. In still further embodiments of the invention, said ratio is about 26:74, 27:73, 28:72, and 29:71.

**[0016]** In an embodiment of the invention, the total protein content of the product ranges from about 30% to about 60% on dry matter basis. In another embodiment, the total protein content ranges from 30% to 60% on dry matter basis. In a further embodiment of the invention, the total protein content is about 40% to about 60% on dry matter basis. In a still further embodiment, the total protein content is 40% to 60% on dry matter basis. In still another embodiment, the total protein content of the whey protein product is at least 20% on dry matter basis.

**[0017]** The whey protein product of the invention has good organoleptic properties and, specifically, is free from off-tastes caused by glycomacopeptides and the unpleasant metabolites present in conventional cheese, curd and casein whey. In addition, the whey protein product of the invention possesses favourable nutritive characteristics and favourable effect on health. Also, the stability of the whey protein product of the invention is good where no flakiness, settling, gelling or other phenomena causing undesirable changes in the structure is observed.

**[0018]** In the context of the present invention, the term "milk-based" means a product of milk origin, containing whey protein and casein.

**[0019]** The whey protein product can be prepared from one or more various components obtained from milk raw material by various membrane techniques or a combination thereof. The whey protein product can further

comprise minerals of milk origin. The milk raw material can be milk as such or as a concentrate or pretreated as a desired manner. The milk raw material may be supplemented with ingredients generally used in the preparation of milk products, such as fat, protein or sugar fractions, or the like. The milk raw material may thus be, for instance, full-fat milk, cream, low-fat milk or skim milk, ultrafiltered milk, diafiltered milk, microfiltered milk, lactose-free or low-lactose milk, protease treated milk, recombined milk from milk powder, organic milk or a combination of these, or a dilution of any of these. Milk can originate from a cow, sheep, goat, camel, horse or any other animal producing milk suitable for nourishment. The milk is preferably low-fat or skim milk. In a more preferred embodiment of the invention, the whey protein product is prepared from skim milk.

**[0020]** The whey protein product of the invention can be provided as a liquid, like a beverage, a concentrate or a powder. In a specific embodiment of the invention, the whey protein product is a beverage. In an embodiment of the invention, a total protein content of the beverage is about 2.5% to about 8%, based on the weight of the beverage. In another embodiment, the total protein content of the beverage is 2.5% to 8%, based on the weight of the beverage. In a further embodiment, the total protein content of the beverage is about 3.5% to about 7%. In a still further embodiment, the total protein content of the beverage is 3.5% to 7%. The casein constitutes 75% to 50%, preferably 70% to 50% of the total protein content while the whey protein enriched with  $\alpha$ -lactalbumin and  $\beta$ -lactoglobulin constitutes 25% to 50%, preferably 30% to 50%.

**[0021]** It is characteristic of the whey protein product of the invention that it contains no sugar, sweeteners or flavorings, however without limiting to this embodiment. In a specific embodiment of the invention, where the whey protein product is a beverage ready for instant use, no sugar, sweetener or flavoring is included in the beverage.

**[0022]** Like the mineral composition of cow's milk, the mineral composition of the whey protein product of the invention is highly physiological. For example, a whey protein beverage of the invention can typically contain 0.5% to 1.5%, preferably 0.6% to 0.8% of minerals. However, the calcium content of the whey protein product of the invention is lower than that of normal milk. The whey protein product can thus be provided with supplementary calcium and other milk minerals, for example, a nanofiltration permeate received from the

method of the invention described below, in order to bring the calcium content to a level present in normal milk, or higher. Supplementary calcium can thus be provided as any calcium source, like milk calcium, calcium gluconate, calcium citrate, calcium lactate etc., or mixtures thereof.

**[0023]** Also fat can be included in the whey protein product of the invention. The fat content of the product typically ranges from about 0% up to 3.5%.

**[0024]** In an embodiment of the invention, the whey protein product is low-lactose or lactose-free. The low lactose or lactose-free product can be achieved by membrane techniques used for the preparation of the product. Also, any residual lactose in the whey protein product can be hydrolyzed by means of an enzyme. In the context of the invention, 'low lactose' means a lactose content of less than 1% in the whey protein product. 'Lactose free' means that the lactose content of the whey protein product is 0.5 g/serving (e.g. for liquid milks 0.5 g/244 g, the lactose content being at most 0.21%), however not more than 0.5%. In accordance with the invention, whey protein beverages containing little carbohydrate and having flawless organoleptic characteristics may also be produced.

**[0025]** The whey protein product of the invention can be used as a raw material in the preparation of all kinds of sour milk products and/or acidified fresh products, typically yoghurt, fermented milk, viili and fermented cream, sour cream, quark, butter milk, kefir, dairy shot drinks, and other sour milk products. We surprisingly found that the organoleptic properties of the sour milk products prepared from the whey protein product of the invention are similar to those of conventional sour milk products.

**[0026]** The products of the invention may be selected from, but are not limited to, the group consisting of food products, animal feed, nutritional products, food supplements, food ingredients, health food and pharmaceutical products. In an embodiment of the invention, the product is a food or feed product. In another embodiment of the invention, the product is functional food, i.e. food having any health promoting and/or disease preventing and/or alleviating properties. The form of each of the food product, food material, and/or the pharmaceutical products, and the animal feed is not particularly limited.

**[0027]** As stated above, due to its favorable nutritive composition the whey protein product of the invention is suitable for athletes and other exercise enthusiasts as such or as a part of a regular diet. The present invention

provides a composition comprising whey protein for supporting and improving healthy eating. The product can also be useful especially in connection for alleviation and/or prevention of adult-onset diabetes, metabolic syndrome and sarcopenia.

**[0028]** Another object of the invention is to provide a use of the whey protein product as a food product, animal feed, nutritional product, food supplement, food ingredient, health food and pharmaceutical product. In an embodiment of the invention, the product is provided as a functional food and/or a nutritional product. In another embodiment, the product is provided as a pharmaceutical.

**[0029]** The whey protein product can be produced from one or more of the fractions obtained by means of membrane techniques. Two or more techniques can be combined, including microfiltration, ultrafiltration, nanofiltration, and reverse osmosis, in an appropriate manner.

**[0030]** A further object of the invention is thus to provide a method for producing a whey protein product which comprises

- subjecting a milk-based raw material to microfiltration to separate an ideal whey as a microfiltration permeate and a casein concentrate as a microfiltration retentate,

- subjecting at least a portion of the microfiltration permeate to ultrafiltration to provide an ultrafiltration permeate and a whey protein concentrate as an ultrafiltration retentate,

- composing a whey protein product from the ultrafiltration retentate and a casein-containing material so as to provide a ratio of whey protein to casein in the range of about 20:80 to about less than 50:50 and a total protein content of at least about 20% on dry matter basis, and if desired, from other ingredients.

**[0031]** The milk-based raw material is preferably skim milk.

**[0032]** Any material containing casein can be used as the casein-containing material in the present invention. In an embodiment of the invention, the casein-containing material is selected from a group consisting of the microfiltration retentate obtained in the method of the invention, milk, a sour milk product, an acidified milk product, a fermented milk product and any combination of these. The acidified milk product can be, for example, sour milk or yoghurt, or a combination of these. As used herein, the term "milk" means any normal secretion obtained from the mammary glands of mammals, such as

cow's, goat's, camel's, horse's or sheep's milk, or any other animal producing milk suitable for nourishment. The milk can be supplemented with ingredients generally used in the preparation of milk products, such as fat, protein or sugar fractions, or the like. The milk thus include, for example, full-fat milk, low-fat milk or skim milk, cream, ultrafiltered milk (UF retentate), diafiltered milk, microfiltered milk (MF permeate), milk recombined from milk powder, organic milk or a combination or dilution of any of these. In an embodiment, the milk is skim milk. In another embodiment, the milk is low lactose or lactose-free milk.

**[0033]** In an embodiment of the invention, a whey protein product is produced having a ratio of whey protein to casein of about 25:75 to about less than 50:50. In another embodiment, the ratio is about 25:75 to about 40:60. In a further embodiment, the ratio is about 30:70.

**[0034]** In an embodiment, a whey protein product is produced having a total protein content of at least 20% on dry matter basis. In another embodiment, the total protein content ranges from about 30% to about 60% on dry matter basis. In a further embodiment, the total protein content is about 40% to about 60% on dry matter basis.

**[0035]** In an embodiment, a whey protein product prepared according to the method of the invention is a beverage having a protein content of about 2.5 to about 8% by weight, preferably about 3.5% to about 7%, based on the weight of the product.

**[0036]** After composing the whey protein product, it can be heat treated as a manner known per se, if appropriate.

**[0037]** In accordance with the invention, a milk-based raw material is subjected to microfiltration. At least a portion of the microfiltration permeate is then subjected to ultrafiltration. In an embodiment of the invention, at least a portion of the ultrafiltration permeate including majority of the minerals and sugars including lactose can further be subjected to nanofiltration (NF) to separate minerals into a NF permeate and sugars to NF retentate. In another embodiment, at least a portion of the NF permeate can be still further be subjected to reverse osmosis (RO) to concentrate the minerals into a RO retentate. These fractions obtained from said further membrane filtrations can be utilized to compose a whey protein product of the invention. In an embodiment of the invention, a microfiltration retentate, ultrafiltration retentate and nanofiltration retentate are used in the preparation of the whey protein product of the invention. In another embodiment, an ultrafiltration retentate and nanofiltration retentate

tate are used in the preparation of the whey protein product of the invention. In still another embodiment of the invention, a microfiltration retentate, ultrafiltration retentate and reverse osmosis retentate are used in the preparation of the whey protein product of the invention. In an embodiment of the invention, the whey protein product is composed of milk, ultrafiltration retentate, nanofiltration retentate and water.

**[0038]** In a further embodiment of the invention, microfiltration (MF), ultrafiltration (UF) and/or nanofiltration (NF) are enhanced by diafiltration using water or a suitable fraction obtained from the membrane filtrations. When diafiltration is associated with microfiltration, an UF permeate obtained from the ultrafiltration of the MF permeate is suitably used as diawater. When the UF permeate is further subjected to nanofiltration, a NF permeate is suitably used as diawater in the ultrafiltration. When the NF permeate is still further subjected to reverse osmosis (RO), an RO permeate is suitably used as diawater in the nanofiltration. One or more of said diafiltration steps can be used in the method of the invention. Said fractions, and a combination of these can originate from a single process, or separate processes.

**[0039]** The method of the invention is illustrated in general terms in Figure 1. Milk is subjected sequentially to microfiltration, ultrafiltration, nanofiltration, and reverse osmosis. Optional measures are indicated with a dash line in the Figure. Microfiltration, ultrafiltration and nanofiltration can be performed by diafiltration technique using at least a portion of the ultrafiltration permeate, the nanofiltration permeate or the reverse osmosis (RO) permeate as diawater, respectively. The whey protein product of the invention is composed of the UF retentate and a casein containing material. If desired, the NF retentate and RO retentate can be introduced to the whey protein product. The casein containing material can include the MF retentate obtained from microfiltration. Also, the casein containing material can be composed entirely or partly of the MF retentate.

**[0040]** The method of the invention provides a whey protein product having good organoleptic properties, like taste and mouth-feel, with good stability. It is possible, by means of the method, to prevent the release of glycomaclopeptides and metabolites causing unpleasant off-tastes for the whey protein product. It is thus possible to reduce, eliminate or mask the off-tastes of the whey protein product by performing the method of the invention.

**[0041]** The previous studies show that there are differences in nutritive quality of the whey proteins. More particularly, it has been discovered that  $\alpha$ -lactalbumin has a more favorable nutritive value than  $\beta$ -lactoglobulin. Based on this knowledge, the composition of the whey protein product of the invention can be adjusted to various uses in an appropriate manner. In the present invention, the adjustment of the whey protein composition is achieved by a heat treatment of milk raw material, or by a selection of a membrane. The method of the invention uses a technique known per se in the heat treatment of milk products. Examples of heat treatments to be used in the method of the invention are pasteurization, high pasteurization, or heating at a temperature lower than the pasteurization temperature for a sufficiently long time. Specifically, UHT treatment (e.g. milk at 138°C, 2 to 4 s), ESL treatment (e.g. milk at 130°C, 1 to 2 s), pasteurization (e.g. milk at 72°C, 15 s), or high pasteurization (95°C, 5 min) can be mentioned. The heat treatment may be either direct (vapour to milk, milk to vapour) or indirect (tube heat exchanger, plate heat exchanger, scraped-surface heat exchanger).

**[0042]** In an embodiment of the invention, milk is subjected to a heat treatment at a temperature range of 65°C to 95°C, for 15 seconds to 10 minutes prior to microfiltration to selectively separate the whey protein ingredients. As a result from the heat treatment,  $\beta$ -lactoglobulin is denatured and associated with casein while  $\alpha$ -lactalbumin passes through a membrane. In this way the content of the  $\alpha$ -lactalbumin can be increased in the microfiltration permeate.

**[0043]** In an embodiment of the invention, lactose in the whey protein product of the invention is hydrolyzed into monosaccharides as is well known in the field. This can be performed with commercially available lactase enzymes in a manner known per se. In an embodiment of the invention, the lactose hydrolysis is realized after the membrane filtrations on the composed whey protein product. In another embodiment of the invention, the lactose hydrolysis step and microfiltration step are initiated simultaneously with each other. In still another embodiment of the invention, the lactose hydrolysis of the milk raw material is initiated prior to membrane filtration step.

**[0044]** The lactose hydrolysis can continue as long as the lactase enzyme is inactivated, for example by a heat treatment of a whey protein product composed at a later stage of various fractions received in the method of the invention (UF retentate and MF retentate).

**[0045]** The following examples are presented for further illustration of the invention without limiting the invention thereto.

### Example 1

**[0046]** Skim milk (1 000 L) is microfiltered by polymeric filtration membranes (Synder FR) having a pore size of 800 kDa. The concentration factor of 95 is used, including a diafiltration step. The concentration factor is calculated by Equation 1. The amount of microfiltration retentate formed is 190 L having a dry matter content of 20.0%.

$$\text{concentration factor } (-) = \left( \frac{\text{feed (L)}}{\text{retentate (L)}} \right) \times \left( \frac{\text{diafiltration feed (L)}}{\text{diafiltration retentate (L)}} \right) \quad (1)$$

**[0047]** The permeate formed in the microfiltration (1 890 L) is further filtered by polymeric ultrafiltration (UF) membranes (Koch HFK-131) having a pore size of 10 kDa. The permeate obtained from the ultrafiltration is further subjected to nanofiltration (NF) to give a NF retentate and permeate (130 L).

**[0048]** Ultrafiltration is performed by means of diafiltration using 130 L of the NF permeate above as diawater. The total concentration factor of the ultrafiltration is 24 (Equation 1). In the ultrafiltration, 100 L of ultrafiltration retentate and 1 920 L of ultrafiltration permeate are formed, of which 1 080 L is used for the diafiltration of the microfiltration. The remaining ultrafiltration permeate (840 L) is nanofiltered by filtration membranes (Desal 5-DK) having a cut-off value of 200 Da. The concentration factor of the nanofiltration is 4.25 (Equation 1), whereby 197 L of nanofiltration retentate and 644 L of nanofiltration permeate are formed, 130 L of the latter being used as diawater in the diafiltration of the ultrafiltration of the microfiltration permeate, as described above.

**[0049]** The residual nanofiltration permeate not used as diawater in the diafiltration of the ultrafiltration of the microfiltration permeate is used for other purposes or concentrated by reverse osmosis membranes (Koch HR) by using a concentration factor of 10 (Equation 1). The amount of reverse osmosis permeate of the nanofiltration permeate formed is 500 L, of which 44 L is used as diawater in the diafiltration of the nanofiltration. The amount of reverse osmosis retentate of the nanofiltration permeate formed is 55 L.

### Example 2

**[0050]** Skim milk (1 000 L) is subjected to a heat treatment at a temperature range of 65°C to 95°C, for 15 seconds to 10 minutes in a heat treatment apparatus to selectively separate the whey protein ingredients. The heat treatment of the skim milk influences the permeation of whey proteins in the microfiltration so that the microfiltration permeate is enriched with  $\alpha$ -lactalbumin that is less thermolabile having denaturation degree of 0 to 26% while  $\beta$ -lactoglobulin is denatured to a degree of 1 to 90%. After the heat treatment of the skim milk, the milk is subjected to the filtration procedures as described in Example 1.

**[0051]** As an example, the proportion of  $\alpha$ -lactalbumin of the total amount of  $\alpha$ -lactalbumin and  $\beta$ -lactoglobulin (% by weight) in the microfiltration permeate was 38% (heat treatment of 75°C for 30 seconds) to 45% (heat treatment of 90°C for 30 seconds).

### Example 3

**[0052]** A whey protein product according to the invention was composed from the microfiltration retentate, ultrafiltration retentate and nanofiltration retentate of Example 1, milk mineral powder and water as shown in Table 1. The whey protein to casein ratio of the product was 21:79 and the protein content was 52% on the dry matter basis. The product was a lactose-free milk drink in which the lactose was hydrolyzed enzymatically to a level of less than 0.1% after composing.

**[0053]** An educated expert panel evaluated the product organoleptically. The organoleptic properties were 'very good'. No taste flaws or structural faults affecting mouth-feel were observed.

**Table 1**

	MF retentate	UF retentate	NF retentate	Milk mineral powder	Water	Product 21:79 lactose-free
Portion (%)	21	14	8	0.5	57	100
Protein (%)	15.3	5.8	0	0	0	4.0
Wheyprotein (%)	0.05	5.8	0	0	0	0.8
Casein (%)	15.2	0	0	0	0	3.2
Lactose (%)	4.2	3.9	17.5	45	0	<0.1
Ash (%)	1.5	0.5	1.1	41	0.08	0.7

**[0054]** Whey protein products having a ratio of whey protein to casein of 22:78, 23:77, 24:76, and 25:75 can be prepared analogously from the same components by varying the amounts of each component accordingly.

#### **Example 4**

**[0055]** A whey protein product according to the invention was composed from the microfiltration retentate, ultrafiltration retentate and nanofiltration retentate of Example 1, milk mineral powder and water as shown in Table 2. The whey protein to casein ratio of the product was 25:75 and the protein content was 58% on the dry matter basis. The product was a lactose-free milk drink in which the lactose was hydrolyzed enzymatically to a level of less than 0.1% after composing.

**[0056]** An educated expert panel evaluated the product organoleptically. The organoleptic properties were 'very good'. No taste flaws or structural faults affecting mouth-feel were observed.

**Table 2**

	MF retentate	UF retentate	NF retentate	Milk mineral powder	Water	Product 25:75 lactose-free
Portion (%)	25	22	5	0.4	47	100
Protein (%)	15.3	5.8	0	0	0	5.1
Whey protein (%)	0.05	5.8	0	0	0	1.3
Casein (%)	15.2	0	0	0	0	3.8
Lactose (%)	4.2	3.9	17.5	45	0	<0.1
Ash (%)	1.5	0.5	1.1	41	0.08	0.7

### Example 5

**[0057]** A whey protein product according to the invention was composed from the microfiltration retentate, ultrafiltration retentate and nanofiltration retentate of Example 1, and water as shown in Table 3. The whey protein to casein ratio of the product was 30:70 and the protein content was 56% on the dry matter basis.

**[0058]** An educated expert panel evaluated the product organoleptically. The organoleptic properties were 'very good'. No taste flaws or structural faults affecting mouth-feel were observed.

**Table 3**

	MF retentate	UF retentate	NF retentate	Water	Product 30:70
Portion (%)	32	36	12	20	100
Protein (%)	15.3	5.8	0	0	7.0
Whey protein (%)	0.05	5.8	0	0	2.1
Casein (%)	15.2	0	0	0	4.9
Lactose (%)	4.2	3.9	17.5	0	4.8
Ash (%)	1.5	0.5	1.1	0.08	0.8

### Example 6

**[0059]** A whey protein product according to the invention was composed from the ultrafiltration retentate and nanofiltration retentate of Example 1, milk and water as shown in Table 4. The whey protein to casein ratio of the product was 40:60 and the protein content was 25% on dry matter basis.

**[0060]** An educated expert panel evaluated the product organoleptically. The organoleptic properties were 'very good'. No taste flaws or structural faults affecting mouth-feel were observed.

**Table 4**

	Milk	UF retentate	NF retentate	Water	Product 40:60
Portion (%)	56	11	10	23	100
Protein (%)	3.3	5.8	0	0	2.5
Whey protein (%)	0.7	5.8	0	0	1.0
Casein (%)	2.6	0	0	0	1.5
Lactose (%)	4.8	3.9	17.5	0	4.8
Ash (%)	0.8	0.5	1.1	0.08	0.6
Fat (%)	3.5	0	0	0	2.0

**Example 7**

**[0061]** A whey protein product according to the invention was composed from the ultrafiltration retentate and nanofiltration retentate of Example 1, milk and water as shown in Table 5. The whey protein to casein ratio was 49:51 and protein content was 38% on the dry matter basis. The product was a low lactose milk drink in which the lactose was hydrolyzed enzymatically after composing.

**[0062]** An educated expert panel evaluated the product organoleptically. The organoleptic properties were 'very good'. No taste flaws or structural faults affecting mouth-feel were observed.

**Table 5**

	Milk	UF retentate	NF retentate	Water	Product 49:51 low lactose
Portion (%)	63	21	6	11	100
Protein (%)	3.3	5.8	0	0	3.3
Whey protein (%)	0.7	5.8	0	0	1.6
Casein (%)	2.6	0	0	0	1.7
Lactose (%)	4.8	3.9	17.5	0	0.8
Ash (%)	0.8	0.5	1.1	0.08	0.7

**[0063]** Whey protein products having a ratio of whey protein to casein of 48:52, 47:53, 46:54, and 45:55 can be prepared analogously from the same components by varying the amounts of each component accordingly.

## Claims

1. Whey protein product having a ratio of whey protein to casein in the range from about 25:75 to about less than 50:50, a total protein content of at least about 20% on dry matter basis, and a protein content of about 2.5% to about 8% by weight, based on the weight of the product.

2. The whey protein product of claim 1 wherein the ratio of whey protein to casein is in the range from about 25:75 to about 40:60, preferably about 30:70.

3. The whey protein product of claim 1 or 2 wherein the total protein content ranges from about 30% to about 60% on dry matter basis, preferably about 40% to about 60% on dry matter basis.

4. The whey protein product of any of the preceding claims wherein the product is a beverage having a protein content of about 3.5% to about 7%, based on the weight of the product.

5. The whey protein product of any of the preceding claims wherein the product further comprises supplementary milk minerals.

6. A method for producing a whey protein product which comprises

- subjecting a milk-based raw material to microfiltration to separate an ideal whey as a microfiltration permeate and a casein concentrate as a microfiltration retentate,

- subjecting at least a portion of the microfiltration permeate to ultrafiltration to provide an ultrafiltration permeate and a whey protein concentrate as an ultrafiltration retentate,

- composing a whey protein product from the ultrafiltration retentate and 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 and a total protein content of at least about 20% on dry matter basis, and if desired, from other ingredients.

7. The method of claim 6 wherein the ratio of whey protein to casein of the whey protein product is about 25:75 to about less than 50:50, preferably about 25:75 to about 40:60, more preferably about 30:70.

8. The method of claim 6 or 7 wherein the total protein content ranges from about 30% to about 60% on dry matter basis, preferably about 40% to about 60% on dry matter basis.

9. The method of any of claims 6 to 8 wherein the product is a beverage having a protein content of about 2.5% to about 8% by weight, preferably about 3.5% to about 7%, based on the weight of the product.

10. The method of any of claims 6 to 9 wherein the casein-containing material is selected from a group consisting of the microfiltration retentate, milk, a sour milk product, an acidified milk product, a fermented milk product and any combination of these.

11. The method of any of claims 6 to 10 wherein the milk-based raw material is skim milk.

12. The method of any of claims 6 to 11 wherein the ultrafiltration permeate is subjected to nanofiltration to provide a nanofiltration retentate and permeate.

13. The method of claim 12 wherein the nanofiltration permeate is subjected to reverse osmosis to provide a reverse osmosis retentate and permeate.

14. The method of any of claims 6 to 13 wherein diafiltration is used with microfiltration, ultrafiltration and nanofiltration.

15. The method of claim 14 wherein the microfiltration retentate, ultrafiltration retentate and nanofiltration retentate are used for composing the whey protein product.

16. The method of any of claims 6 to 15 wherein the milk raw material is subjected to a heat treatment at a temperature range of 65°C to 95°C for 15 seconds to 10 minutes prior to microfiltration.

17. The method of any of claims 6 to 16 wherein supplementary milk minerals are added to the whey protein product.

18. The method of any of claims 6 to 17 wherein the release of glycomacrocpeptides in the whey protein product is prevented.

19. The method of any of claims 6 to 18 wherein the off-taste of the whey protein product is reduced, eliminated or masked.

20. The whey protein product of any of claims 1 to 5 or prepared by a method of any of claims 6 to 19 for use as a food product, animal feed, nutritional product, food supplement, food ingredient, health food and pharmaceutical product.

21. A use of the whey protein product of any of claims 1 to 5 or prepared by a method of any of claims 6 to 19 as a food product, animal feed, nutritional product, food supplement, food ingredient or health food.

22. The use of claim 21 wherein the whey protein product is used as a functional food and/or a nutritional product.

23. A use of the whey protein product of any of claims 1 to 5 or prepared by a method of any of claims 6 to 19 in the preparation of sour milk products and/or acidified fresh products, like yoghurt, fermented milk, viili, fermented cream, sour cream, quark, butter milk, kefir, and dairy shot drinks.

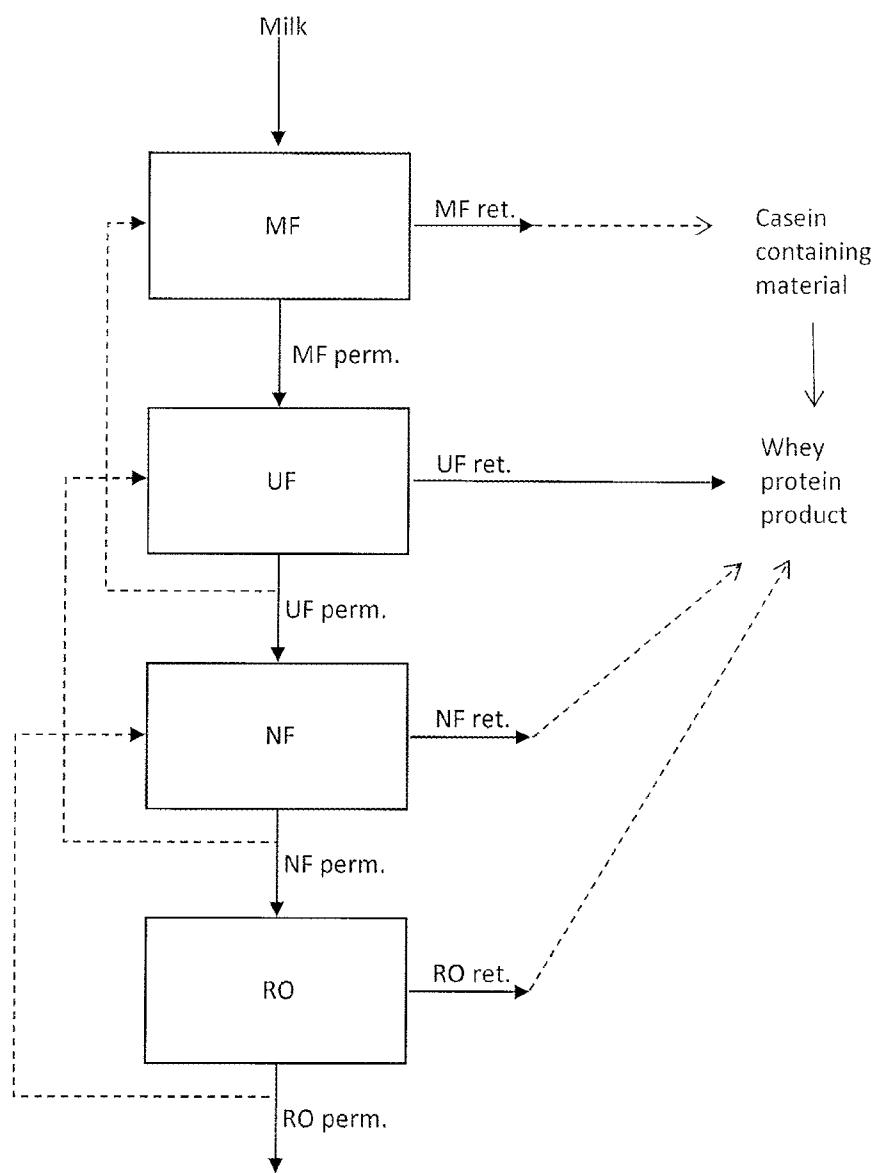


Fig. 1

# INTERNATIONAL SEARCH REPORT

International application No

PCT/FI2012/050152

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. A23C9/12 A23C9/13 A23C9/156 A23C9/20 A23C21/00  
A23J1/20

**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, FSTA

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 085 874 A (JUNGVID HANS [SE]) 4 February 1992 (1992-02-04)	1-5, 20-23
A	claim 1; examples 1-3 -----	6-19
X, P	WO 2011/051557 A1 (VALIO LTD [FI]; HARJU MATTI [FI]; HEINO ANTTI [FI]; TIKANMAEKI REETTA) 5 May 2011 (2011-05-05) the whole document -----	1-23
X	WO 00/30461 A1 (NESTLE SA [CH]; JOST ROLF [CH]; BERROCAL RAFAEL [CH]; KRATKY ZDENEK [C) 2 June 2000 (2000-06-02) cited in the application the whole document -----	6-19
A	----- -/-	1-5, 20-23



Further documents are listed in the continuation of Box C.



See patent family annex.

\* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

18 June 2012

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## INTERNATIONAL SEARCH REPORT

International application No

PCT/FI2012/050152

## 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 03/094623 A1 (VALIO LTD [FI]; TOSSAVAINEN OLLI [FI]; SAHLSTEIN JANNE [FI]) 20 November 2003 (2003-11-20) cited in the application the whole document -----	1-23

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/FI2012/050152

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
US 5085874	A	04-02-1992	DK	234190 A		28-09-1990
			EP	0407445 A1		16-01-1991
			SE	461498 B		26-02-1990
			SE	8801142 A		29-09-1989
			US	5085874 A		04-02-1992
			WO	8908991 A1		05-10-1989
<hr style="border-top: 1px dashed black;"/>						
WO 2011051557	A1	05-05-2011	AR	078779 A1		30-11-2011
			WO	2011051557 A1		05-05-2011
<hr style="border-top: 1px dashed black;"/>						
WO 0030461	A1	02-06-2000	AT	271783 T		15-08-2004
			AU	771034 B2		11-03-2004
			AU	1556600 A		13-06-2000
			BR	9915573 A		14-08-2001
			DE	69919019 D1		02-09-2004
			DE	69919019 T2		25-11-2004
			EP	1133238 A1		19-09-2001
			ES	2226466 T3		16-03-2005
			NZ	511562 A		31-10-2003
			PT	1133238 E		30-09-2004
			WO	0030461 A1		02-06-2000
<hr style="border-top: 1px dashed black;"/>						
WO 03094623	A1	20-11-2003	AT	376362 T		15-11-2007
			AU	2003227788 A1		11-11-2003
			BR	0309846 A		29-03-2005
			CN	1652690 A		10-08-2005
			DE	60317057 T2		31-07-2008
			DK	1503630 T3		11-02-2008
			EP	1503630 A1		09-02-2005
			ES	2295580 T3		16-04-2008
			FI	20020907 A		15-11-2003
			HR	20041055 A2		31-12-2004
			IL	165149 A		15-04-2010
			JP	2005525116 A		25-08-2005
			JP	2010279379 A		16-12-2010
			MX	PA04011243 A		03-06-2005
			NO	326737 B1		09-02-2009
			PL	208750 B1		30-06-2011
			PT	1503630 E		09-11-2007
			RU	2308196 C2		20-10-2007
			US	2005214409 A1		29-09-2005
			WO	03094623 A1		20-11-2003
			ZA	200408903 A		28-12-2005
<hr style="border-top: 1px dashed black;"/>						