

Title: Low-calorie milk products

The invention relates to milk products having a reduced caloric value. In particular, the invention relates to tasty low-lactose, low-calorie milk products having an attractive appearance, and methods for the preparation thereof.

5 Milk and dairy products are nutritious foods which make an important contribution to a good nutrition. The most important food components of cow's milk are water (ca. 89 %), lactose or milk sugar (ca. 4.5 %), high-quality proteins (ca. 3.6 %) (rich in essential amino acids) and fats. For consumption, typically, especially the fat content is reduced.

10 Especially skimmed milk is suitable for use in a low-calorie diet. Skimmed milk is milk from which the cream has been separated, having a fat content of virtually 0%. A drawback of skim milk, however, is that it has a flat, watery taste, a gray color and that its mouthfeel is experienced by the consumer as unappealing. Moreover, skim milk still contains a considerable

15 amount of calories, stemming for a considerable part, some 55%, from the lactose present.

Another drawback of lactose-containing milk products in general is that they are not suitable for persons having a lactose intolerance. To digest lactose, an enzyme is needed, a lactase. Lactase is produced in the small

20 intestine wall. If the lactase is not produced, or insufficiently so, lactose finds its way, undigested, into the large intestine where the intestinal bacteria present there (intestinal flora) are going to 'ferment' the lactose. This can give rise to complaints such as abdominal pain, cramps, diarrhea, flatulence and a bloated feeling. The treatment of lactose intolerance

25 consists in the prevention of the complaints by limiting or avoiding lactose in the food. Possibly, enzyme preparations with the enzyme lactase may be used. When milk (products) from food are limited or even left out altogether,

deficiencies of calcium and vitamin B2 may arise. It is important to supplement these in a different manner. Guidance from a dietician is necessary then.

For that matter, an amount of 6-7 g of lactose does not yet induce  
5 any symptoms of lactose intolerance in individuals having hypolactasia (see  
for instance Hertzler *et al.* in J Am. Diet Assoc. 1996; 96:243-6; and Vesa *et al.*  
*et al.* in Am. J. Clin. Nutr. 1996; 64:197-201). An amount of lactose (12 g) that  
normally occurs in a single cup of 240 ml of milk is still tolerated by most  
people having hypolactasia ("lactose maldigesters") (see for instance Villako  
10 & Maarros in Scand. J. Gastroenterol. Suppl. 1994; 202:36-54; Jarvis &  
Miller in J. Natl. Med. Assoc. 2002; 94:55-66; and Suarez *et al.* in N. Engl. J.  
Med. 1995 6; 333:1-4). Upon administration of an amount of 50 g of lactose,  
80-100% of this group of individuals are troubled by symptoms of lactose  
intolerance (see for instance Bayless *et al.* in N. Engl. J. Med. 1975; 292  
15 1156-9 and Newcomer *et al.* in Gastroenterology. 1978;74:44-6).

There is a need for a visually attractive low-calorie milk product,  
and which is also suitable for use in a low-lactose or non-lactose diet.  
Preferably, the milk product has an appealing taste and mouthfeel, in any  
20 case improved over ordinary skim milk. More preferably still, such a milk  
product is less slimy, and hence allows more readily of "continuous  
drinking" than conventional milk and milk drinks.

This need, and preferably also the preferences mentioned, are met  
according to the invention by the provision of a milk product comprising  
25 milk proteins, at most 1.8, but preferably at most 1.5 percent by weight  
(wt.%) of fat, at most 4 wt.% of lactose and about 1-5 wt.% of protein,  
wherein the casein to whey protein ratio is higher than that in raw milk.  
The term percent by weight denotes the weight based on the total weight of  
the end product, a liquid or semiliquid milk product.

The caloric value of a milk product according to the invention is lower than that of skim milk, that is, lower than about 162 kilojoules (kJ) or 38 kilocalories (kcal) per 100 ml. Preferably, the product has a caloric value of less than 30 kcal/100 ml. Particularly suitable for use in a low-calorie diet  
5 is a milk product with only 15-25 kcal / 100 ml, or lower still.

Preferably, the milk product contains more milk protein than lactose, based on weight. Milk protein and lactose are for instance present in a low-lactose product in a ratio of about 3:1.

The lactose content is preferably lower than 2 wt.%, more  
10 preferably lower than 1.5 wt.%. The product contains for instance between about 1.3 and 1.4 wt.% of lactose. With such a two- to threefold reduction of the amount of lactose with respect to normal milk, such a milk product is suitable for use in a limited-lactose and/or low-calorie diet.

In another embodiment, the milk product is substantially free of  
15 lactose, that is to say, it contains less than 0.1 wt.% of lactose. As a result, the product is well tolerable by individuals having a lactose intolerance.

From the viewpoint of the caloric or energetic value, the fat content of a milk product of the invention is maximally 1.8 wt.%, preferably at most about 1.5 wt.%, more preferably about 1.3 wt.% and most preferably  
20 maximally about 1.0 wt.%. For a very low caloric value, a still lower fat content is desirable, for instance less than 1 wt.% or virtually free of fat, with 0 to 0.3 wt.% of fat. However, the presence of some (milk) fat is desirable for the sake of the taste and the mouthfeel of the milk product. This appears from the watery sensation of the current skim milk with about  
25 0 wt.% of fat and a caloric value of circa 38 Kcal/100 ml. The present invention is based partly on the insight that by wholly or partly removing lactose from the milk, also the caloric value thereof is reduced. This affords the possibility of adding, or keeping present, some (milk) fat for the benefit of the taste and/or the mouthfeel, while maintaining a low-caloric value. The  
30 invention provides for instance a tasty milk product comprising about 1.4

wt.% of lactose, about 3.8% of protein and about 1 wt.% of fat, while the caloric value is only about 31 Kcal/100 ml. It has been found, especially, that the low-calorie milk products according to the invention are less slimy and hence allow well of "continuous drinking".

5           The total protein content is typically between about 1 and 5 wt.%, more preferably between about 2.5 and 4 wt.%, for instance between 3.0 and 3.5 wt.%. Although the protein will mostly consist of milk proteins, it is also possible that non-milk proteins are present in the product, such as soy proteins. Natural protein from cow's milk (i.e. milk protein) comprises  
10           roughly about 80% of micellar casein and about 20% of whey protein. The whey proteins constitute a heterogeneous mixture, of which the chief proteins are  $\beta$ -lactoglobulin,  $\alpha$ -lactalbumin, blood serum albumin (BSA) and immunoglobulins (Ig).

          In a milk product of the present invention, the ratio between casein  
15           and whey proteins is greater than that in raw milk. The product hence contains relatively more casein and/or less whey protein. The ratio of casein to whey proteins is higher than 80:20, preferably at least 85:15, more preferably at least 90:10, as 95:5, 97:3, 98:2 or 99:1. The term casein as used herein comprises all types and forms of casein and caseinates by nature  
20           present in cow's milk, including  $\alpha$ -s1-casein,  $\alpha$ -s2-casein,  $\beta$ -casein and  $\kappa$ -casein.

          A selective enrichment for casein with respect to whey proteins can be efficiently achieved using microfiltration, abbreviated to MF. MF is a pressure-driven membrane filtration process whereby a separation is made  
25           based on particle size. This separation is obtained by a semipermeable material which is called the membrane. The specific pore size for MF is in the range of 0.01 to 20  $\mu$ m. Because of the relatively large pores, only a slight pressure difference is necessary: from 0.1 to 4 bars. Casein in milk is substantially present in the form of casein micelles, which are distinguished

in size (50-500 nm) from the globular (whey) proteins which have a dimension of 3 to 6 nm. Most casein micelles have a diameter between about 150 and 200 nm (see for instance Figure 1 of NL 1015851). When using an MF membrane having for instance a pore size between 100 and 500 nm, and preferably between 150 and 450 nm, then during microfiltration of milk *inter alia* the casein micelles remain behind in the retentate, while the permeate contains mainly the smaller, soluble components such as (whey) proteins, sugars such as lactose, minerals and salts. As described below in the method, the desired casein/whey protein ratio is obtained utilizing MF to a preferred concentration factor in the retentate of at least 2-4.

Microfiltering milk therefore leads to a retentate with an increased casein content and a reduced level of *inter alia* whey proteins, sugars and milk salts with respect to the starting material. However, the loss of sugars and salts by the MF process has consequences for the taste of the milk product. In order to prepare a product that is attractive to the consumer, the (diluted) retentate is therefore supplemented with salts and/or sweeteners, preferably both salts and sweeteners, so that the taste corresponds to that of ordinary milk, or at least approximates it.

Any type of nutrient salt can be used in a milk product of the invention. Sodium and/or potassium salts are preferred, for instance NaCl and KCl. These ions already occur in milk by nature. The skilled person is able to determine the optimum salt concentration in an empirical manner. Good results were obtained by the inventors utilizing between 0.05 and 0.2 wt.% of salt, for instance 0.1 wt.% of NaCl. Incidentally, very suitably, a milk salt preparation from cow's milk may be used. Such salt preparations are commercially available, such as the product Vivinal MCA (*ex Domo*, Netherlands).

All current (soluble) sweeteners can be used, such as natural and synthetic sweeteners which are customary in the food industry at present. Preferred for use in a low-calorie product as described herein are low-calorie

sweeteners, such as aspartame, saccharin, sucralose, acesulfame, neohesperidin, and combinations thereof. The skilled person is able to determine the optimum concentration of sweetener in an empirical manner. A good taste sensation was achieved by the inventors utilizing between  
5 about 25 and 50 mg/liter of sweetener, preferably chosen from the group just mentioned, e.g. 40 mg/ml of aspartame.

Studies have shown that the visual properties of milk have a great influence on the taste sensation and the mouthfeel of a low-fat or non-fat milk product. An increase of the so-called whitening power proves to make  
10 the largest contribution towards increasing the appeal of a low-fat milk product for the consumer. Several techniques have been developed for improving the appearance of low-fat or non-fat milk products. These concern especially the addition of chemical or biological additives. See for instance WO/2000/005971 and the references cited therein.

15 Surprisingly, it has been found that the above-mentioned MF step yields a low-calorie milk product with a high whitening power. For instance, a low-calorie milk according to the invention was appreciably whiter in color than a non-fat milk from the prior art. This whitening power can be qualified with the CIE-L\*a\*b method or CIELAB system. The CIELAB  
20 system is a color space. CIELAB has been developed by the Commission Internationale de l'Eclairage (CIE) and is based on additive color mixing. At the angles of an equilateral triangle are the three main colors B (blue, 435.8 nm), G (green, 541.6 nm) and R (red, 700 nm). The tristimulus values used by the CIE are based on these primary colors.  $B = Z$ ,  $G = Y$ , and  $R = X$ . Each  
25 color can be represented with unique values of X, Y and Z. Because in the denotation with x, y and z it is difficult to assess on the basis of the numbers what color you are describing, often a conversion to L\*a\*b\* values is made. That conversion is described in the CIE standards and for that reason is called CIELAB. L\* is the lightness axis, going from 0 which is black to + 100  
30 which is white. The a\*-axis goes from -60 (green) to +60 (red). The b\*-axis

also goes from -60 (blue) to +60 (yellow). So, with three  $L^*a^*b^*$  axes which are perpendicular to each other, an elliptical space is described into which all colors fit.

With this method, for a 0%-fat milk (reference), an L-value of 88.22  
5 ( $\pm 0.11$ ), an a-value of -5.70 ( $\pm 0.02$ ), and a b-value of 10.63 ( $\pm 0.12$ ) are found, while a low-calorie milk according to the invention shows the following values: L-value 89.13 ( $\pm 0.02$ ), a-value -4.73 ( $\pm 0.02$ ) and b-value 7.68 ( $\pm 0.02$ ).

In a preferred embodiment, the invention provides a low-calorie  
10 milk product with an L-value greater than 88.5 and/or an  $a^*$ -value within the range of 0 plus or minus 5.5 and/or a  $b^*$ -value within the range of 0 plus or minus 10.0. More preferably, the L-value is greater than 89 and/or an  $a^*$ -value within the range of 0 plus or minus 5.0 and/or a  $b^*$  value within the range of 0 plus or minus 9.0.

15 To improve the organoleptic properties of a milk product according to the invention, in a preferred embodiment, soluble dietary fibers may be added, such as polydextrose, galacto-oligosaccharides (GOS), inulin, oligofructose or a combination thereof. Inulin, oligofructose and GOS are prebiotic ingredients which are known in the food and beverage industry for  
20 their favorable properties, and are used as fat imitations, stabilizers and sugar replacements.

Good results were obtained by addition of between about 0.5 and 2 wt.% of dietary fiber, but other amounts may also be used, depending on the type of fiber and/or the desired properties of the milk product.

25 Further, one or more additives may be added which are capable of favorably influencing in any way the properties of the product, such as the taste, the consistency, the stability, the appearance, the storage life or the nutritional value of the product. Examples of useful additives comprise flavoring, vitamins such as vitamin C, B2, B6, B12, thickeners such as  
30 starch, guar gum or (bovine) gelatin, coloring such as  $\beta$ -carotene or carminic

acid, emulsifiers, nutrient acids such as citric acid, fruit preparations and fruit juices.

It will be clear that a milk product according to the invention can have different qualities, depending on the method of preparation and/or additional ingredients. As will be further elucidated below, it is for instance possible to ferment the milk product to yield a low-calorie, low-lactose, fermented milk product. The milk product is for instance a milk, a (fruit) yogurt, a (fruit) yogurt drink, a kwark (soft curd cheese) or a vla (Dutch-type custard).

Further, the present invention is not limited to cow's milk products, and the present invention can also be used for the preparation of low-calorie, low-lactose or non-lactose products from milk from other mammals. Preferably, the milk to be used contains comparable amounts of lactose and casein to cow's milk, or possibly less lactose and/or more casein. Suitable are *inter alia* buffalo milk and goat's milk. Thus, the invention also provides a buffalo milk product (which usually has a higher protein content and contains comparatively slightly more casein than cow's milk), a horse milk product (about 1.9% of protein, 6.9% of lactose, 35-40% of whey protein) or a goat's milk product (about 22.5-24.0% of whey protein of the total protein).

Another aspect of the present invention concerns a method for the preparation of a tasty low-calorie milk product. The method comprises the steps of a) filtering skim milk by means of microfiltration utilizing a membrane having a pore size between about 50-1,000 nm, preferably 100-500 nm, preferably to a concentration factor of the retentate with a factor of at least 2-4 to result in a retentate having a reduced lactose content and an increased ratio between casein and whey proteins (also referred to as "casein concentrate"); b) diluting the retentate to about 2.5-4 wt.% of protein, preferably with water, and c) adding salt and/or sweeteners and/or

soluble dietary fibers in an amount sufficient to give the product an attractive taste.

For instance, when the starting material is skimmed cow's milk, which has optionally, though preferably so, been subjected to a thermizing treatment (heating to maximally 60 °C) and/or bactofugation, then, by the microfiltration process, the total protein level is increased in the MF retentate from about 3.6 wt.% to 10-12 wt.%, with the ratio of casein to whey protein increasing to about 85/15 and preferably to about 90/10 and higher. The lactose content of the MF retentate is reduced to about 4 wt.%.  
Diluting the MF retentate to a protein content corresponding to current milk products, i.e. 3-4 wt.%, yields a low-calorie consumption milk product according to the invention with less than 1.6 wt.% of lactose. The diluted retentate has a strikingly white color, presumably because it no longer contains any whey proteins which have a green basic color. Further, this milk gives a less slimy mouthfeel.

To "correct" the taste and the mouthfeel of the diluted casein concentrate, the above-mentioned salts, sweeteners and dietary fibers can be used in the preferred amounts mentioned.

To prepare a product that is suitable for a non-lactose diet, the method can furthermore comprise a treatment with lactose-hydrolyzing enzyme. Such a treatment is known from the art (see for instance CA 2 260 673) and usually comprises the use of the enzyme lactase which breaks down lactose to galactose and glucose. Usually, the lactase treatment is carried out after the diluted retentate has undergone a heat treatment, for instance a pasteurization at 80°C for about 15 seconds or a very brief heating at 135°C, a conventional UHT treatment. Suitable lactase enzymes are  $\beta$ -galactopyranosidase,  $\beta$ -galactosidase,  $\beta$ -D-galactoside galactohydrolase, and mixtures thereof. Through the lactase treatment, the lactose content in the diluted retentate, being for instance less than 2 wt.%, may be

reduced to less than 1 and preferably to less than 0.1 wt.%. In a preferred embodiment, the lactose content after the enzymatic treatment is not detectable.

Another possibility of removing residual lactose from the diluted  
5 retentate comprises washing out lactose by means of diafiltration with water being added to the retentate during microfiltration or possibly ultrafiltration to further remove the lactose.

The low-lactose or non-lactose diluted retentate is preferably  
subjected to a heat treatment (sterilization) in order to increase the storage  
10 life of the milk product. This comprises for instance heating to circa 72°C, followed by brief heating above 100°C (usually 0.5 to 1 second at 135°C) to kill all bacteria, and fast cooling to 72°C. After cooling to below room temperature, the product may be aseptically filled into a suitable package such as 0.5- or 1-liter containers.

15 Optionally, prior to the heat treatment, an amount of fat, preferably milk fat, is added to the diluted retentate in order to give the product a fuller taste. For instance, cream is added up to 1 wt.% of fat.

As indicated above, the invention further provides a method for the preparation of a fermented low-calorie milk product, such as a low-calorie  
20 yogurt or a fermented milk drink. To this end, the diluted retentate may be subjected to a pasteurization step (e.g. heating for 5 minutes at 92°C) followed by a fermentation step in which, using lactic acid bacteria, the lactose present is converted to lactic acid. For the preparation of yogurt, minimally 1 wt.% of lactose still needs to be present in the diluted retentate.  
25 Optionally, conventional thickeners such as starch and gelatin and other conventional additives may be added. In a specific embodiment, for a fermented milk product, goat's milk is used.

A method according to the invention may further comprise the addition of fruit preparation, for instance a fruit pulp, fruit parts, fruit

puree or fruit juice. In a specific embodiment, the method comprises adding a fruit preparation to a fermented milk product according to the invention, for instance to produce a sour fruit drink or fruit yogurt. The amount of fruit preparation to be added depends on the kind of preparation (e.g.  
5 concentration) and the desired properties of the product, such as taste and consistency.

Further, a method for the preparation of a low-calorie milk product, whether fermented, unfermented, low-lactose or non-lactose, can comprise the addition of one or more additives. Useful additives are *inter alia*  
10 flavoring, vitamins such as vitamin C, B2, B6, B12, thickeners such as starch, guar gum, carrageen or bovine gelatin, coloring such as  $\beta$ -carotene or carminic acid, emulsifiers and nutrient acids such as citric acid. The addition of additives is preferably carried out prior to the earlier-mentioned heat treatment.

15 The prepared product may subsequently be (aseptically) filled into a suitable package, such as a cup, bottle or carton made of standard material such as laminated paperboard, plastic or glass.

The invention furthermore provides a (packaged) milk product preparable by means of a method according to the invention.

20 A milk product as described herein can be used with advantage as a food, in particular in a low-calorie and/or low-lactose or non-lactose diet. Also, sports or recovery drinks or food supplements may be prepared; these typically contain a high protein content higher than 3.5 wt.%.

## 25 Description of the drawing

Fig. 1 shows a schematic representation of the different parts of the process according to the invention, leading to different products. A fluid MF retentate is prepared through microfiltration of skimmed milk. This MF  
30 retentate is diluted with water, whereupon different products can be

prepared. Examples of products are a non-fat or 1%-fat milk with extended shelf life (ESL), a fermented fruit drink or a non-lactose milk.

### Examples

5           The invention is illustrated further in and by the following non-limiting examples.

#### Example 1 : Preparation of a casein concentrate

10           Fresh raw (cow's) milk was first skimmed, rendered germfree with a bactofuge and thermized (15 seconds at 68°C). Then the milk was microfiltered in a system which was equipped with spirally wound membranes having an average pore size of 0.15  $\mu\text{m}$  (DSS, FSM 0.15PP/48 mil). Microfiltration was carried out at 10°C and an average transmembrane pressure of 1.5 bar, whereby the milk was concentrated to a concentration  
15           factor of 3.3. In Table 1.1 the composition of the obtained retentate is represented in comparison with that of the skim milk before microfiltration.

Table 1.1: Composition MF retentate in comparison with skim milk.

|                       | Skim milk | MF retentate |
|-----------------------|-----------|--------------|
| True protein          | 3.39      | 10.39        |
| Casein                | 2.84      | 8.90         |
| Whey protein          | 0.55      | 1.49         |
| Lactose               | 4.88      | 4.39         |
|                       |           |              |
| Casein : whey protein | 84:16     | 86:14        |
| Protein : lactose     | 41:59     | 70:30        |

**Example 2 : Preparation of a low-lactose, non-fat milk (TLB)**

To the MF retentate (MCC) from Example 1 were added: water, salt, sweetener and dietary fibers according to the recipe in Table 2.1.

Thereupon the obtained TLB milk was heated for 1 sec at 135°C (High  
 5 Pasteurization). This was followed by cooling to circa 65 °C, after which homogenization was carried out at 150 bar; this was followed by deep cooling to 5°C . After filling into packaging, this milk was found to have a storage life of minimally three weeks at 7°C in the cold store.

10 Table 2.1: Recipe, composition and some properties of low-lactose, non-fat milk (TLB)

|                       | skim milk<br>reference | low-lactose<br>non-fat milk |
|-----------------------|------------------------|-----------------------------|
| Recipe:               |                        |                             |
| MCC                   |                        | 32%                         |
| skim milk             | 100 %                  |                             |
| water                 |                        | 67%                         |
| milk fat              | 0%                     | 0 %                         |
| K / Na salts          |                        | 0.15%                       |
| sweeteners            |                        | 0.01%                       |
| dietary fiber         |                        | 0.5%                        |
| Composition:          |                        |                             |
| protein               | 3.5%                   | 3.4%                        |
| lactose               | 4.6%                   | 1.4%                        |
| whey protein : casein | 20 : 80                | 14 : 86                     |
| Properties:           |                        |                             |
| kCal                  | 32                     | 23                          |
| color                 | gray/yellow            | white                       |
| taste                 |                        | like skim milk              |

**Example 3 : Preparation of a low-lactose, 1% fat milk (TLC)**

To the MF retentate (MCC) from Example 1 were added: water, salt, sweetener and dietary fibers according to the recipe in Table 3.1. Thereupon the obtained TLC milk was heated for 1 sec at 135°C (High  
 5 Pasteurization). This was followed by cooling to circa 65 °C, and a homogenization was carried out at 150 bar; this was followed by deep cooling to 5°C . After filling into packaging, this milk was found to have a storage life of minimally three weeks at 7°C in the cold store:

10 Table 3.1: Recipe, composition and some properties of low-lactose, 1% fat milk (TLC)

|                       | low-fat milk<br>reference | low-calorie milk  |
|-----------------------|---------------------------|-------------------|
| Recipe:               |                           |                   |
| MCC                   |                           | 32%               |
| skim milk             | 100 %                     |                   |
| water                 |                           | 66%               |
| milk fat              | 1.5%                      | 1.0 %             |
| K / Na salts          |                           | 0.15%             |
| sweeteners            |                           | 0.01%             |
| dietary fiber         |                           | 0.25%             |
| Composition:          |                           |                   |
| protein               | 3.5%                      | 3.4%              |
| lactose               | 4.6%                      | 1.4%              |
| whey protein : casein | 20 : 80                   | 14 : 86           |
| Properties:           |                           |                   |
| kCal                  | 46                        | 32                |
| color                 | grey/white                | very white        |
| taste                 |                           | like low-fat milk |

**Example 4: Preparation of a yogurt**

Table 4.1. Recipe, composition and properties of low-lactose yogurt

|                       | Low-fat Yogurt<br>reference | low-lactose yogurt  |
|-----------------------|-----------------------------|---------------------|
| Recipe:               |                             |                     |
| MCC                   |                             | 33%                 |
| skim milk             | 97.5%                       | 10                  |
| skim milk powder      | 1%                          |                     |
| water                 |                             | 66%                 |
| milk fat              | 1.5%                        | 1.0 %               |
| K / Na salts          |                             | 0.15%               |
| sweeteners            |                             | 0.01%               |
| dietary fiber         |                             | 0.5%                |
| Composition:          |                             |                     |
| protein               | 4 %                         | 4 %                 |
| lactose               | 5.2                         | 2.0                 |
| whey protein : casein | 20 : 80                     | 14: 86              |
| Properties:           |                             |                     |
| kCal                  | 50                          | 33                  |
| color                 | gray/white                  | white               |
| taste                 | like low-fat yogurt         | like low-fat yogurt |

5           Yogurt milk prepared according to the above recipe was heated to ca. 65°C, homogenized at 150 bar, then pasteurized for 5 minutes at 92°C and cooled to ca. 35°C (=fermentation temperature).

          After inoculation with a yogurt starter (Code 96 and Code 95 CSK Netherlands) the milk was fermented to a pH of ca. 4.3. The fermented milk  
10   was stirred smooth, cooled and filled into packaging.

**Example 5: Preparation of a low-lactose vla****Table 5.2. Recipe, composition and properties of lactose- and low-sugar vla**

|                          | skimmed vla<br>reference | low-lactose and<br>low-sugar vla |
|--------------------------|--------------------------|----------------------------------|
| Recipe:                  |                          |                                  |
| MCC                      |                          | 29%                              |
| skim milk                | 88 %                     |                                  |
| water                    |                          | 61%                              |
| milk fat                 | 0                        | 1.0 %                            |
| starch                   | 4%                       | 4.5                              |
| sugar                    | 7%                       | 3                                |
| carrageen                | 0.03                     | 0.04                             |
| coloring / flavoring     | 0.02                     | 0.02                             |
| K / Na salts             |                          | 0.15%                            |
| sweeteners               |                          | 0.05%                            |
| dietary fiber            |                          | 1.0%                             |
| Composition:             |                          |                                  |
| protein                  | 3.2 %                    | 3.2%                             |
| sugars including lactose | 11                       | 5.0                              |
| whey protein : casein    | 20 : 80                  | 14: 86                           |
| Properties:              |                          |                                  |
| kCal                     | 75                       | 45                               |
| color                    | gray/yellow<br>glassy    | warm yellow                      |
| taste                    | like skim vanilla<br>vla | more creamy<br>vanilla vla       |

Vlamix was prepared according to the above recipe, followed by a heat  
5 treatment of 10 seconds at 125 °C, cooling to 7°C and filling.

## CLAIMS

1. Low-calorie milk product having a fat content lower than 1.5 wt.%, a lactose content lower than 4 wt.% and a protein content between 1 and 5 wt.%, wherein the casein/whey protein weight ratio is at least 82:18, and wherein the product has a whitening power expressed by an L-value greater than 88.5 according to the CIELAB system.
2. A milk product according to claim 1, having a caloric value lower than 35 kcal/100 ml, preferably lower than 25 kcal/100 ml.
3. A milk product according to claim 1 or 2, wherein on a weight basis more protein than lactose is present, preferably wherein protein and lactose are present in a ratio of at least about 2.8-3.0 : 1.
4. A milk product according to any one of claims 1 to 3, having a lactose content lower than 2 wt.%, preferably lower than 1.5 wt.%.
5. A milk product according to any one of claims 1 to 4, being substantially lactose-free.
6. A milk product according to any one of claims 1 to 5, having a protein content between about 2.5 and 4 wt.%.
7. A milk product according to any one of the preceding claims, wherein the weight ratio of casein to whey proteins is at least 85:15, preferably at least 90:10.
8. A milk product according to any one of claims 1 to 7, having a fat content of at most 1 wt.%.
9. A milk product according to any one of the preceding claims, wherein the L-value is than 89.
10. A milk product according to any one of the preceding claims, having an a\*-value within the range of  $0 \pm 5.5$ , preferably  $0 \pm 5$ , and/or a b\*-value within the range of  $0 \pm 10.0$ , preferably  $0 \pm 9.0$ .

11. A milk product according to any one of the preceding claims, furthermore comprising one or more sweeteners, preferably low-calorie sweeteners such as aspartame, saccharin, acesulfame and/or neohesperidin, and/or one or more salts, preferably sodium and/or potassium salts, more preferably both sodium and potassium salts; as well as milk salts.

12. A milk product according to any one of the preceding claims, furthermore comprising one or more at least partly indigestible dietary fibers, such as inulin, oligofructose, galacto-oligosaccharides and polydextrose.

13. A milk product according to any one of the preceding claims, comprising about 1% of fat, about 3.5 wt.% of protein, about 1.4 wt.% of lactose, about 1% of dietary fiber, about 0.1% of salt and about 40 mg/liter of low-calorie sweetener.

14. A milk product according to any one of the preceding claims, comprising one or more additives chosen from the group consisting of fruit preparation, flavoring, vitamins, thickeners, coloring, nutrient acids, minerals, cocoa, bioactive components and stabilizers.

15. A milk product according to any one of the preceding claims, wherein the product is a fermented milk product.

16. A milk product according to any one of the preceding claims, wherein the product is a cow's milk product, buffalo milk product, horse milk product or goat's milk product.

17. A milk product according to any one of the preceding claims, wherein the product is milk, yogurt, vla (Dutch-type custard), quark (soft curd cheese), yogurt drink, chocolate milk, buttermilk, shake or mousse.

18. A method for the preparation of a tasty low-calorie milk product, comprising:

- filtering skim milk by means of microfiltration (MF) utilizing a membrane having a pore size between about 50-1,000 nm, preferably 100-500 nm, to a concentration of the retentate up to a factor of 2-4;

- diluting the MF retentate to about 2.5-4 wt.% of protein, preferably with water, and

- adding salt and/or sweeteners and/or soluble dietary fibers in an amount sufficient to give the product an attractive taste.

19. A method according to claim 18, further comprising a treatment with a lactose-hydrolyzing enzyme.

20. A method according to claim 18 or 19, further comprising a heat treatment.

21. A method according to any one of claims 18-20, further comprising a pasteurization and a fermentation step wherein the product to be fermented contains minimally 1 wt.% of lactose.

22. A method according to any one of claims 18-21, further comprising adding fat, preferably milk fat, up to a fat content of at most 1.5 wt.% and preferably about 1 wt.%.

23. A method according to any one of claims 18-22, further comprising adding one or more additives chosen from the group consisting of fruit preparations, flavoring, vitamins, thickeners, coloring, nutrient acids, minerals, cocoa, bioactive components and stabilizers.

24. A method according to any one of claims 19-23, further comprising filling the product into a suitable package, such as a carton, cup, pack, glass, bag, bag-in-box or can.

25. A milk product or packaged milk product obtainable according to a method according to any one of claims 18-24.

26. Use of a milk product according to any one of claims 1-17 or claim 25 in a low-calorie and/or low-lactose or non-lactose diet.