(12) UK Patent (19) GB (11) 2 159 034 (13) B

(54) Title of Invention

A process for the production of a skimmed milk

(51) INT CL⁴ ; **A23C 9/146, 11/02**

(21) Application No
8511642

(22) Date of filing
8 May 1985

(30) Priority data

(31) **2512/84**

(32) **22 May 1984**

(33) **Switzerland (CH)**

(43) Application published
27 Nov 1985

(45) Patent published
21 Sep 1988

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(52) Domestic classification
(Edition J)
A2B MD22 MD4

(56) Documents cited
GB 1137060
GB 0993719
GB 0958048
GB 0394314

(58) Field of search
A2B
Selected US specifications from IPC sub-class A23C

2159034

A PROCESS FOR THE PRODUCTION OF A SKIMMED MILK

This invention relates to a process for the production of a skimmed milk of reduced phosphate and calcium contents.

It is known that cow's milk can be better adapted to the nutritional and physiological needs of infants by depletion in mineral salts and enrichment with milk serum proteins more readily digestible than casein. It is also known that the gastric secretion of acid and pepsin is relatively low in infants and that a milk adapted to the needs of infants should thus have a low buffering power.

Accordingly, one known process for the production of a milk better adapted to the needs of infants comprises demineralizing a lactoserum by ion exchange or by electrodialysis and adding a caseinate to the demineralized lactoserum. Another known process comprises recombining the constituents of milk, particularly casein or caseinates, ultrafiltered lactoserum proteins, lactose, salt and vitamins, in adequate proportions.

However, these processes are open to criticism in that they involve the elimination of substantial quantities of minor, known or unknown constituents of milk. However, some of these minor constituents can be of considerable value to the metabolism and physiology of infants.

The object of the present invention is to propose a new approach to these problems by adequate reduction of the phosphate and calcium contents of the skimmed milk itself and the use of the product obtained for the production of a milk adapted to the needs of infants. Another object of the present invention is to provide a milk adapted to the needs of infants thus obtained which itself has a reduced calcium content and a reduced phosphate content.

To this end, the process for producing a skimmed milk

of reduced phosphate and calcium contents according to the present invention is characterised in that a skimmed milk is acidified to a pH of from 5.2 to 6.0 and from 3.5 to 18 litres of the acidified skimmed milk per equivalent of exchanger are passed over an anion exchanger, followed by neutralization. The skimmed milk is preferably acidified to a pH of from 5.4 to 5.6.

It has been found that, if a skimmed milk is acidified within the indicated limits, the phosphate ions are unexpectedly retained on the anion exchanger preferentially to the citrate and Cl^- ions in contrast to what is observed during the demineralization of lactoserum by ion exchange. It has also been found, again surprisingly, that not only the phosphate ions, but also the Ca^{++} ions are thus retained on the anion exchanger.

In the context of the invention, an "acidified skimmed milk" is understood to be a mixture of skimmed milk and an acidifying agent, irrespective of type. Thus, in one embodiment of the process according to the invention where a skimmed milk is acidified by addition of a decationized lactoserum, the "acidified skimmed milk" is the mixture of skimmed milk and decationized lactoserum.

In addition, the expression "demineralized lactoserum" is used hereinafter to designate a decationized and deanionized lactoserum as opposed to a decationized but not deanionized lactoserum.

Finally, the expression "total serum proteins" is used to designate the total nitrogenous matter of the lactoserum determined as total nitrogen multiplied by 6.38.

The use of the skimmed milk of reduced phosphate and calcium contents obtained by the process according to the invention for the production of a milk adapted to the needs of infants is characterized in that a mixture is prepared which contains, in percent by weight based on the dry matter of the mixture, from 15 to 25% of dry matter of the skimmed milk of reduced phosphate and calcium contents, from 45 to 55%

of dry matter of a demineralized lactoserum and from 25 to 30% of fats.

The milk adapted to the needs of infants obtained by the use of the product of the process according to the present invention is characterized in that it contains, in percent by weight of dry matter,

from 4.5 to 5.5% of casein,
from 7.0 to 8.0% of total serum proteins,
from 25 to 30% of fats,
from 54 to 62% of lactose,
from 0.2 to 0.4% of calcium,
from 0.015 to 0.05% of magnesium,
from 0.10 to 0.17% of sodium,
from 0.4 to 0.6% of potassium,
from 0.4 to 0.6% of phosphate,
from 0.3 to 3% of citrate,
from 0.3 to 0.45% of chlorine.

The starting material used for caryring out the process according to the invention may be fresh or reconstituted skimmed cow's milk. This milk is acidified to a pH of from 5.2 to 6.0 and preferably to a pH of from 5.4 to 5.6. The pH range is limited at the lower end by the precipitation of casein. At its upper end, it is limited by the disappearance of the surprising preferential retention of the phosphate to the benefit of the retention of citrate and chloride.

Acidification may be carried out, for example, with citric acid or hydrochloric acid.

In a preferred variant mentioned earlier on, a decationized lactoserum is used. It is preferred to use a soft lactoserum, of the type produced, for example, by cheesemakers making pressed curd and cooked curd cheeses and by manufacturers of rennet casein, decationized by passage over a cation exchanger, particularly an exchanger of the sulfonic type. A lactoserum such as this may

advantageously have a pH of from 1.2 to 3.0. It is assumed that, if a decationized lactoserum is particularly suitable for carrying out the process according to the invention, it is because, by dilution, chelation and acidification, it exerts a triple effect in releasing the Ca from the casein micelle which in turn releases the inorganic phosphate from the casein micelle.

In the following step of the process according to the invention, the acidified skimmed milk is passed over an anion exchanger. This exchanger may be in particular of the quaternary ammonium or secondary or tertiary amine type. The anion exchanger may be used in the OH^- form. In that case, the skimmed milk which was passed over the exchanger has a mean pH of from about 7.5 to 9 and is neutralized, preferably with citric acid. The anion exchanger may also be used in the form of citrate and/or Cl^- anions. In that case, the phosphate anions are directly exchanged for the citrate and/or Cl^- anions and no increase in the pH is observed during passage over the exchanger.

The skimmed milk is passed over the anion exchanger in a quantity of from 3.5 to 18 liters of skimmed milk per equivalent of exchanger capacity. By remaining below the minimum ratio thus indicated, an unnecessarily high volume of exchanger is used. By exceeding the maximum ratio thus indicated, the phosphate content of skimmed milk is not sufficiently reduced.

The skimmed milk of reduced phosphate and calcium contents obtained by the process according to the invention is thus an intermediate product intended for use in the production of milks adapted to the needs of infants. As indicated above, this use is best effected by preparing a mixture containing, in percent by weight based on the dry matter of the mixture, from 15 to 25% of dry matter of the skimmed milk of reduced phosphate and calcium contents, from 45 to 55% of dry matter of a demineralized lactoserum

and from 25 to 30% of fats. A lactoserum demineralized by ion exchange or by electrodialysis for example may be used to prepare this mixture, although it is preferred to use a sweet lactoserum demineralized by decationization on a cation exchanger followed by deanionization on an anion exchanger. So far as the fat is concerned, it is preferred to use a milk fat containing a small amount of added vegetable fat.

A dry or liquid mixture may be prepared, depending on whether or not the skimmed milk of reduced phosphate and calcium contents and/or the demineralized lactoserum was dried beforehand, for example by spray-drying. If necessary, the liquid mixture itself may be spray-dried for example. The milk thus obtained adapted to the needs of infants itself has a reduced phosphate content and a reduced calcium content. Its composition is shown above.

The invention is illustrated by the following Examples in which the percentages quoted are by weight.

EXAMPLE 1

A skimmed milk having a pH of 6.6 and a dry matter content of 9% and containing, expressed in mg of ions per 100 ml of skimmed milk,

270 mg/100 ml of phosphate
180 mg/100 ml of citrate
120 mg/100 ml of calcium

is acidified to pH 5.5 by addition of 1.9 g of citric acid per liter of skimmed milk.

The acidified skimmed milk is passed over an anion exchanger in the OH^--form in a quantity of 3.5 l of milk per equivalent of exchanger capacity. The pH of the acidified skimmed mik which was passed over the exchanger initially rises to around 11.5 and then drops back to about 8.5. The mean pH of the milk passed over the exchanger is 9.0. After neutralization to pH 7.0 with citric acid, a skimmed milk of reduced phosphate and calcium contents is obtained which

has a dry matter content of 9% and contains, in mg of ions per 100 ml of skimmed milk,

120 mg/100 ml of phosphate
150 mg/100 ml of citrate
57 mg/100 ml of calcium

COMPARISON EXAMPLE

The procedure is as described in Example 1, except that the skimmed milk is passed directly over the anion exchanger without acidification. The pH of the skimmed milk which was passed over the exchanger again rises but the phosphate content remains constant. Only the citrate and Cl^- ions are exchanged for OH^-.

EXAMPLE 2

The same skimmed milk as in Example 1 is acidified to pH 5.5 by addition of decationized soft lactoserum having a pH of 1.8 and a dry matter content of 5.5% in a quantity of 0.4 1 of lactoserum per liter of skimmed milk.

The acidified skimmed milk is passed over an anion exchanger in the OH^--form in a quantity of 3.5 1 of milk per equivalent of exchanger capacity. The mean pH of the milk which was passed over the exchanger is 9.0. After neutralization to pH 7.0 with citric acid, a skimmed milk of reduced phosphate and calcium contents is obtained which has a dry matter content of 8% and which contains, in mg of ions per 100 ml of skimmed milk,

134 mg/100 ml of phosphate
134 mg/100 ml of citrate
46 mg/100 ml of calcium.

EXAMPLES 3-5

Various skimmed milks of reduced phosphate and calcium contents are prepared in the same way as in Example 2, except that the acidified skimmed milk is passed over the ion exchanger in different volumes of milk per equivalent of exchanger capacity.

The respective values of the volumes of acidified skimmed

milk passed over the anion exchanger (vol. passed), the mean pH's of the milk which was passed over the exchanger (mean pH), the dry matter content of the skimmed milk which was passed over the exchanger (dry matter) and the ion content of the milk after neutralization to pH 7.0 (ions) are shown in the following Table. The corresponding values taken from Examples 1 and 2 are repeated therein. The data of the starting skimmed milk are shown in the extension of the pH, dry matter and ions columns to facilitate comparison.

Ex. No.	Vol. passed l/equ.	Mean pH	Dry matter %	Ions phosphate	Ions citrate	Ions Ca
				mg/100 ml		
1	3.5	9	9	120	150	57
2	3.5	9	8	134	134	46
3	7	8.9	8	120	121	44
4	10.5	8	8	140	143	51
5	17.5	7.7	8	150	130	55
Starting skimmed milk		6.6	9	270	180	120

EXAMPLE 6

A skimmed milk is acidified by addition of a decationized sweet lactoserum. The acidified skimmed milk is passed over an anion exchanger in the OH^--form in a quantity of 10.5 l of acidified skimmed milk per exchanger equivalent.

A powdered milk adapted to the needs of infants is prepared by mixing the skimmed milk of reduced phosphate

and calcium contents thus obtained with a demineralized lactoserum and fat in such proportions that the mixture contains, in percent based on the dry matter of the mixture, 21% of dry matter of this skimmed milk of reduced phosphate and calcium contents, 51.5% of dry matter of the demineralized lactoserum and 27.5% of fat. The mixture is concentrated by evaporation in vacuo to a dry matter content of 40% and then spray-dried. The powder obtained has a moisture content of approximately 5%.

The details concerning the characteristics and composition of the various products involved or obtained in this Example are shown in the following Table in which the percentages quoted are based on the total weight in the first four columns and on the weight of dry matter in the last three columns. To accommodate them on the page, the column headings have been abbreviated. The full headings are as follows:

1st column (sk. milk):	starting skimmed milk
2nd column (dec. lact.):	decationized lactoserum
3rd column (ac. sk. milk):	acidified skimmed milk
4th column (red. sk. milk):	skimmed milk of reduced phosphate and calcium contents
5th column (red. sk. milk):	skimmed milk of reduced phosphate and calcium contents
6th column (dem. lact.):	demineralized lactoserum
7th column (adapt. milk):	milk adapted to the needs of infants.

	Sk. milk	dec. lact.	ac. sk. milk	red sk. milk	red. sk. milk	dem. lact.	adapt. milk
pH	6.7	1.8	5.5	7.5	7.5	6.7	6.8
Dry matter %	9.0	5.5	8.0	8.0	8.0	20	95
Casein %	2.8	0	2.0	2.0	25	0	5.0
Total Serum proteins %	0.6	0.6	0.6	0.6	7.5	12	7.4
Fats %	0.1	0.05	0.08	0.08	1.0	1.0	27.5
Lactose %	5.5	4.9	5.3	5.3	61	86	58
Ca %	0.115	0.002	0.081	0.042	0.58	0.34	0.28
Mg %	0.011	0.001	0.008	0.006	0.06	0.02	0.02
Na %	0.048	0.06	0.036	0.038	0.40	0.10	0.15
K %	0.165	0.016	0.116	0.122	1.40	0.30	0.45
Phosphate %	0.270	0.150	0.235	0.130	1.70	0.35	0.51
Citrate %	0.180	0.160	0.174	0.106	1.25	0.50	0.50
Cl %	0.120	0.100	0.112	0.093	0.90	0.08	0.22

The Cl content of the adapted milk is standardized during mixing to a value of from 0.3 to 0.45% by addition of KCl, $MgCl_2$ and/or $CaCl_2$.

CLAIMS

1. A process for the production of a skimmed milk of reduced phosphate and calcium contents, wherein a skimmed milk is acidified to a pH of from 5.2 to 6.0 and from 3.5 to 18 litres of the acidified skimmed milk per equivalent of exchanger are passed over an anion exchanger, followed by neutralization.

2. A process as claimed in Claim 1, wherein the skimmed milk is acidified to a pH of from 5.4 to 5.6.

3. A process as claimed in Claim 1, wherein the skimmed milk is acidified with citric acid, hydrochloric acid, or a decationized lactoserum.

4. A process as claimed in Claim 1, wherein the skimmed milk is acidified with a decationized lactoserum having a pH of from 1.2 to 3.0.

5. A process as claimed in Claim 1, wherein the anion exchanger resin is of the quaternary ammonium type or secondary or tertiary amine type.

6. A process as claimed in Claim 1 wherein the anion exchanger is in the OH^-- form or in the form of citrate and/or Cl^-- anions.

7. The use of the skimmed milk of reduced phosphate and calcium content obtained by the process claimed in Claim 1

for the production of a milk adapted to the needs of infants, wherein a mixture is prepared which contains, in percent by weight based on the dry matter of the mixture, from 15 to 25 % of dry matter of the skimmed milk of reduced phosphate and calcium contents, from 45 to 55 % of dry matter of a demineralized lactoserum and from 25 to 30 % of fats.

8. A milk adapted to the needs of infants obtained by the use claimed in Claim 7, which contains in percent by weight of dry matter,

from 4.5 to 5.5 % of casein,
from 7.0 to 8.0 % of total serum proteins,
from 25 to 30 % of fats,
from 54 to 62 % of lactose,
from 0.2 to 0.4 % of calcium,
from 0.015 to 0.05 % of magnesium,
from 0.10 to 0.17 % of sodium,
from 0.4 to 0.6 % of potassium,
from 0.4 to 0.6 % of phosphate,
from 0.3 to 3 % of citrate,
from 0.3 to 0.45 % of chlorine.

Publication No.
2159034 A dated 27 November 1985

Patent Granted:

WITH SECTION 21 SEP 1988

Application No.
8511642 filed on 8 May 1985

Priority claimed:
22 May 1984 in Switzerland doc: 2512/84

Title:
A process for the production of a skimmed milk

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Examination Requested: 6 May 1986

Classified to:
A2B

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Printed by the Patent Office at St. Mary Cray, 26 SEP 85