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Dextran production

The present invention relates to a bacterial strain which
5 produces dextran, to a process for the production of
dextran, to a process for the production of an additive
containing an enzyme involved in the biosynthesis of
dextran, and to the use of this dextran, this enzyme
and/or a strain producing this dextran and this enzyme in
10 the manufacture of a food product or cosmetic composition.

STATE OF THE ART

Dextran is a polysaccharide formed of glucose units, the
15 chain lengthening of which is catalyzed by dextran
sucrase. The biosynthesis of dextran has been
demonstrated in numerous bacteria, especially in
Streptococcus mutans, *Leuconostoc mesenteroides ssp.*
mesenteroides and *Leuconostoc mesenteroides ssp.*
20 *dextranicum*. *Leuconostoc* produce the enzyme dextran
sucrase and secrete it into the culture medium in the
presence of sucrose. This enzyme, dextran sucrase, then
synthesizes dextran from the sucrose substrate. Dextran
has applications in several fields. It is used especially
25 in biochemistry as a support for filtration chromatography
on a gel of the Sephadex type. Additionally, in the field
of therapeutics, it is used as a substitute for blood
plasma (Biochimie générale (General Biochemistry) - J.H.
WEIL - Masson, 6th edition - 1990 - p. 171).

30 Furthermore, dextran synthesized by a strain of
Leuconostoc dextranicum is applied in the food industry
for the texturing of food products such as yoghurts, cream
desserts, milk-based drinks and salad dressings. Thus
35 EP 0363633 demonstrates the synthesis of dextran by a
strain of *Leuconostoc dextranicum* and in particular by the
strain *Leuconostoc dextranicum* NRRL-B-18242. Said
document describes especially a composition containing
dextran synthesized by this bacterium and the use of this
40 composition in the food sector.

Moreover, the taxonomy of the bacterial strains of the genus *Leuconostoc* has been revised several times.

Thus Garvie et al. (International Journal of Systematic Bacteriology, 118-119, 1983) describe the taxonomy of the bacterial strains of the genus *Leuconostoc*, established according to a criterion of homology in terms of the deoxyribonucleic acid (DNA). The bacteria, previously classed as *Leuconostoc mesenteroides*, *Leuconostoc dextranicum* and *Leuconostoc cremoris*, although of different phenotype, have a very high degree of homology in respect of their DNA. Therefore, according to this taxonomy, these bacteria are subspecies of *Leuconostoc mesenteroides* and are respectively called *Leuconostoc mesenteroides ssp. mesenteroides*, *Leuconostoc mesenteroides ssp. dextranicum* and *Leuconostoc mesenteroides ssp. cremoris*.

In addition, J.B. Milliere et al. (Journal of Applied Bacteriology, 67, 529-542, 1989) describe a taxonomic analysis performed on 81 strains of the genus *Leuconostoc*, including 11 strains of *Leuconostoc mesenteroides ssp. cremoris*. This analysis relies on the taxonomy established by Garvie et al. and is based on the following criteria in particular: the capacity of these strains to ferment various sugars, the capacity of these strains to utilize citrate and the capacity of these strains to produce dextran. Said document notes the fact that a strain of *Leuconostoc mesenteroides ssp. cremoris* does not synthesize dextran. Also, such a strain is distinguished and defined by the fact that it does not ferment pentoses.

No strain of *Leuconostoc mesenteroides ssp. cremoris* has yet been isolated which is capable of synthesizing dextran. Now, *Leuconostoc mesenteroides ssp. cremoris* is of major importance in the manufacture of dairy products such as, for example, yoghurt-type fermented specialities or dairy creams. It would therefore be very valuable to be able to use such bacteria, capable of synthesizing dextran of pleasant texture and taste, especially for texturing this type of food product.

The object of the present invention is to meet this need.

SUMMARY OF THE INVENTION

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For this purpose the present invention relates to a strain of *Leuconostoc mesenteroides ssp. cremoris* which produces dextran, especially the strains *Leuconostoc mesenteroides ssp. cremoris* CNCM I-1692 and CNCM I-1693.

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The present invention further relates to a method of using a strain of *Leuconostoc mesenteroides ssp. cremoris* for the manufacture of a food product or cosmetic composition.

15 The present invention further relates to a process for the production of dextran from *Leuconostoc mesenteroides ssp. cremoris*.

The present invention further relates to a food product or
20 cosmetic composition into which dextran obtained by carrying out this process is incorporated during its preparation.

The present invention further relates to a process for the
25 production of an additive containing active dextran sucrase from *Leuconostoc mesenteroides ssp. cremoris*.

The present invention finally relates to a food product or
cosmetic composition into which an additive containing
30 active dextran sucrase from *Leuconostoc mesenteroides ssp. cremoris* is incorporated during its preparation.

DETAILED DESCRIPTION OF THE INVENTION

35 The present invention therefore relates to a strain of *Leuconostoc mesenteroides ssp. cremoris* which produces dextran. It was possible to isolate strains of *Leuconostoc mesenteroides ssp. cremoris* which produce dextran. All the strains of *Leuconostoc mesenteroides*
40 *ssp. cremoris* which produce dextran are therefore covered by the present invention.

A strain of *Leuconostoc mesenteroides ssp. cremoris* was isolated particularly from a Swiss cream and it was found, surprisingly, to have the remarkable property of synthesizing dextran of pleasant texture and taste. This strain was deposited on 18/04/96, under the terms of the Budapest Treaty, in the Collection Nationale de Cultures de Microorganismes, INSTITUT PASTEUR, 25, rue du Docteur Roux, F-75724 PARIS CEDEX 15, where it was given the deposit number CNCM I-1692.

Furthermore, a strain of *Leuconostoc mesenteroides ssp. cremoris* which also has the remarkable property of synthesizing dextran of pleasant texture and taste was isolated by natural selection from the strain CNCM I-1692. This strain was deposited on 18/04/96, under the terms of the Budapest Treaty, in the Collection Nationale de Cultures de Microorganismes, INSTITUT PASTEUR, 25, rue du Docteur Roux, F-75724 PARIS CEDEX 15, where it was given the deposit number CNCM I-1693.

Details of these strains, concerning especially their morphology, the fermentation of sugars and other aspects, are given below.

25

Morphology

- Gram-positive microorganisms,
- Negative catalase,
- Facultative aerobe,
- 30 - Cocci.

Fermentation of sugars

- No lactic acid production from pentoses, D- and L-arabinose, D- and L-xylose and D- and L-ribose,
- 35 - Lactic acid production from lactose by the strain CNCM I-1692,
- No lactic acid production from lactose by the strain CNCM I-1693.

Other aspects

- Strains synthesizing dextran, a polysaccharide with remarkable texturing properties.

- 5 According to the present invention, it is therefore possible also to isolate a strain of *Leuconostoc mesenteroides ssp. cremoris* which does not ferment lactose, an example being CNCM I-1693.
- 10 A preferred strain according to the present invention produces the same dextran as the strain CNCM I-1692 or the strain CNCM I-1693.

The present invention further relates to a process for the
15 production of dextran wherein a medium containing sucrose is inoculated with a preculture of a strain of *Leuconostoc mesenteroides ssp. cremoris* according to the invention, it is allowed to ferment at 25-35°C for 10-20 h and the pH of the resulting culture is then lowered to 5-5.5 prior to
20 storage at 0-10°C for 16-48 h.

A medium containing at least 2% of sucrose can be inoculated with a preculture of a strain of *Leuconostoc mesenteroides ssp. cremoris* according to the invention,
25 for example in order to allow the production of dextran sucrose and the synthesis of dextran in the culture medium.

A medium containing 5-12% of MSK medium (skimmed cow's
30 milk) supplemented with 0.05-0.2% of yeast extract and at least 2% of sucrose, for example, can be inoculated with 0.2-3% of a preculture of a strain of *Leuconostoc mesenteroides ssp. cremoris* according to the present invention, particularly the strain CNCM I-1692 or the
35 strain CNCM I-1693. The medium can be allowed to ferment at 25-35°C for 10-20 h with the pH being maintained at 6-7.3, for example. Then, when fermentation has ended, the pH of the resulting culture can be lowered to 5-5.5 by the addition of lactic acid, for example. The culture is then
40 stored at 0-10°C for 16-48 h.

Also, a medium containing 0.05-0.2% of yeast extract with at least 2% of sucrose, for example, can be inoculated with 0.2-3% of a preculture of a strain of *Leuconostoc mesenteroides ssp. cremoris* according to the present invention, particularly the strain CNCM I-1692 or the strain CNCM I-1693. The medium can be allowed to ferment at 25-35°C for 10-20 h with the pH being maintained at 6-7.3, for example. When fermentation has ended, this culture can be mixed with an equal volume of 20% MSK medium so that inhibition of the production of the enzyme dextran sucrose by the lactose contained in the MSK medium, for example, is avoided during the fermentation. The pH of the resulting culture can then be lowered to 5-5.5 by the addition of lactic acid, for example. The culture is then stored at 0-10°C for 16-48 h.

This culture can then be dried to give a dextran powder, for example. This culture can be dried by lyophilization or spray drying, for example.

The present invention further relates to a food product or cosmetic composition comprising dextran from *Leuconostoc mesenteroides ssp. cremoris* which is obtainable by carrying out the above process.

To prepare such a product or composition, dextran obtained in this way can be incorporated into a food or cosmetic product, such as a milk powder, a yoghurt, a ketchup, a mayonnaise or a skin cream, during its manufacture, for example.

The present invention further relates to a process for the production of an additive containing active dextran sucrose wherein a medium containing sucrose is inoculated with a preculture of a strain of *Leuconostoc mesenteroides ssp. cremoris* according to the invention and is then allowed to ferment at 25-35°C for 10-20 h.

A medium containing at least 2% of sucrose can be inoculated with a preculture of a strain of *Leuconostoc mesenteroides ssp. cremoris* according to the invention in

order to allow the production of dextran sucrose in the culture medium, for example.

A medium containing 5-12% of MSK medium (skimmed cow's milk) supplemented with 0.05-0.2% of yeast extract and at least 2% of sucrose, for example, can be inoculated with 0.2-3% of a preculture of a strain of *Leuconostoc mesenteroides ssp. cremoris* according to the present invention, particularly with 0.2-3% of a preculture of the strain CNCM I-1692 or the strain CNCM I-1693. It can be allowed to ferment at 25-35°C for 10-20 h with the pH being maintained at 6-7.3, for example.

A medium containing 0.05-0.2% of yeast extract and at least 2% of sucrose, for example, can be inoculated with 0.2-3% of a preculture of a strain of *Leuconostoc mesenteroides ssp. cremoris* according to the present invention, particularly with 0.2-3% of a preculture of the strain CNCM I-1692 or the strain CNCM I-1693. It can be allowed to ferment at 25-35°C for 10-20 h with the pH being maintained at 6-7.3, for example. When fermentation has ended, this culture can be mixed with an equal volume of 20% MSK medium so that inhibition of the production of the enzyme dextran sucrose by the lactose contained in the MSK medium, for example, can be avoided during the fermentation.

Also, a synthetic culture medium containing at least 2% of sucrose, 1-3% of K_2HPO_4 , 0.2-1% of yeast extract, 0.2-1% of peptone and 0.0005-0.001% of $MnSO_4$ can be inoculated with 0.2-3% of a preculture of a strain of *Leuconostoc mesenteroides ssp. cremoris* according to the present invention, particularly with 0.2-3% of a preculture of the strain CNCM I-1692 or the strain CNCM I-1693. It can be allowed to ferment at 25-35°C for 7-12 h with the pH being maintained at 6-7.3, for example.

In a first preferred embodiment of the process for the preparation of an additive containing active dextran sucrose, the pH of the culture is adjusted to 5-5.5 after fermentation and this culture is then dried to give a

powder containing the active dextran sucrase. The pH of the culture can be adjusted by the addition of lactic acid, for example. The culture can be dried by lyophilization or by spray drying, for example.

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In a second preferred embodiment of the process for the preparation of active dextran sucrase, the culture is separated after fermentation so as to isolate the supernatant containing the active dextran sucrase. This separation can be effected by centrifugation at 15,000-20,000 g for 10-35 min at 2-6°C, for example.

It is possible to adjust the pH of the supernatant to 4.9-5.7, store this supernatant at 0-10°C for 15-30 h and then precipitate the macromolecules contained in this supernatant so as to isolate a precipitate containing the dextran sucrase, for example. The macromolecules in the supernatant can be precipitated with polyethylene glycol or ammonium sulphate at 2-6°C, with stirring, for example.

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The precipitate containing the dextran sucrase can then be dialyzed so as to eliminate the precipitating agents, for example.

Finally, in this second preferred embodiment of the present process, the precipitate containing the dextran sucrase can be stored at a temperature below -4°C after the precipitation step or after the dialysis step, for example.

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The present invention further relates to a food product or cosmetic composition comprising an additive containing active dextran sucrase from *Leuconostoc mesenteroides* ssp. *cremoris* obtainable by carrying out the above process.

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To prepare such a product or composition, an additive containing active dextran sucrase obtained in this way can be incorporated into a food or cosmetic product, such as a milk powder, a yoghurt, a ketchup, a mayonnaise or a skin cream, during its manufacture, for example.

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Finally, the present invention further relates to a method of using a strain of *Leuconostoc mesenteroides ssp. cremoris* according to the present invention for the manufacture of a food product or cosmetic composition.

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The strains of *Leuconostoc mesenteroides ssp. cremoris*, the dextran sucrase produced by these strains and the dextran synthesized by these strains according to the present invention are characterized in greater detail below by means of different microbiological and biochemical data illustrating their properties. The percentages are given by weight, unless indicated otherwise.

10

15 **Testing for the strains of *Leuconostoc* which produce dextran**

Tests for the strains which produce dextran were performed on 150 strains isolated either from dairy products or from non-dairy products such as wine, coffee and sauerkraut.

20

The production of dextran in a medium containing sucrose is measured.

To do this, 10 ml of DEX medium comprising 1% of B. tryptone, 0.5% of yeast extract, 0.5% of K_2HPO_4 , 0.5% of ammonium citrate and 5% of sucrose are inoculated with 1% of a preculture of each of the 150 strains. The medium is then allowed to ferment at 30°C for 24 h.

30

16 strains capable of producing dextran were thus selected from the 150 starting strains.

150 ml of DEX medium, as described above, are then inoculated with 1% of a preculture of each of these 16 selected strains and then allowed to ferment at 30°C for 24 h prior to measurement of the viscosity of the product of these 16 cultures obtained in this way. The viscosity is measured with a gravity viscometer of diameter 25 mm.

40

Table I below shows the values in seconds for the passage of 100 ml of the product of each culture through the gravity viscometer. The strain A1, shown in Table I, was used as a negative control strain.

5

In said Table, the strains A are strains of *Leuconostoc* sp., the strains B are strains of *Leuconostoc mesenteroides* ssp. *cremoris*, the strain C1 is a strain of *Leuconostoc lactis* and the strains D are strains of

10 *Leuconostoc mesenteroides* spp. *mesenteroides*.

Table I

Strain	Viscosity (s)
A1	11
A2	16
A3	14
A4	13
A5	18
A6	20
A7	19
A8	19
C1	17
CNCM I-1692	22
B1	12
B2	14
B3	15
D1	12
D2	14
D3	15
D4	17

15

The results shown in Table I above demonstrate the fact that the strain *Leuconostoc mesenteroides* ssp. *cremoris* CNCM I-1692 has the highest viscosity of the 16 selected strains, so it is acknowledged that the strain *Leuconostoc*

20 *mesenteroides* ssp. *cremoris* CNCM I-1692 produces the greatest amount of dextran.

**Study of the concentration of the enzyme dextran sucrose
as a function of fermentation time**

A synthetic medium containing 2% of sucrose, 2% of K_2HPO_4 ,
5 0.5% of yeast extract, 0.5% of peptone, 0.02% of $MgSO_4$,
0.001% of $MnSO_4$, 0.001% of $FeSO_4$ and 0.001% of NaCl is
inoculated with 1% of a preculture of the strain
Leuconostoc mesenteroides ssp. cremoris CNCM I-1692. It
is allowed to ferment at 30°C for 12 h in a 5 l fermenter.

10

After 4 h of fermentation, a sample of the resulting
culture is taken every 2 hours, up to a fermentation time
of 12 h, for measurement of the growth of the strain by
means of the optical density at 600 nm.

15

Each sample is then centrifuged at 18,000 g for 20 min at
4°C, the supernatant is recovered, its pH is adjusted to
5.2 and the activity of the dextran sucrose contained in
the supernatant is verified by measurement of the
20 incorporation of radioactivity into the dextran from
radioactive sucrose (J. Dent. Res. 1974, 53, 1355-1360).

Table II below shows the results obtained for measurement
of the growth of the strain on the basis of samples taken
25 every 2 hours between fermentation times of 4 and 12 h.
Table II also shows the results of measurement of the
activity of the dextran sucrose contained in the
supernatant of these samples.

30 **Table II**

fermentation time (h)	4	6	8	10	12
growth (OD_{600})/10	0.034	0.085	0.21	0.51	0.53
activity (u/ml)	-	0.1	0.17	0.6	0.61

The results given in Table II demonstrate the fact that
35 the concentration of dextran sucrose reaches its maximum
value just after the *Leuconostoc mesenteroides ssp.*
cremoris bacteria enter the stationary phase.

**Purification of the enzyme dextran sucrase and
determination of its specific activity**

5 A culture medium containing 0.2% of sucrose, 0.5% of yeast
extract, 0.5% of peptone, 2% of K_2HPO_4 , 0.02% of $MgSO_4$,
0.001% of $MnSO_4$, 0.001% of $FeSO_4$ and 0.001% of NaCl is
inoculated with 1% of a preculture of *Leuconostoc*
10 *mesenteroides ssp. cremoris* CNCM I-1692 and allowed to
ferment at room temperature for 12 h with the pH being
maintained at a value of 6.7.

The culture prepared in this way is then centrifuged at
18,000 g for 20 min at 4°C.

15

The supernatant containing the dextran sucrase is then
isolated and its pH is adjusted to a value of 5.2 prior to
incubation for 4 h at 4°C.

20 The supernatant is then mixed with an equal volume of 33%
polyethylene glycol 400 and the mixture is allowed to
incubate at 4°C for 5 h, with stirring, so as to
precipitate the proteins contained in the supernatant.

25 The mixture is centrifuged at 18,000 g for 20 min at 4°C so
as to isolate the residue containing the precipitated
proteins.

This residue containing the precipitated proteins is then
30 suspended in 70 ml of 20 mM ammonium acetate, pH 5.2.

600 µg of dextranase are then added to this suspension and
the whole is allowed to incubate at 25°C for 1 h so that
the dextran contained in the suspension is digested by the
35 dextranase.

The suspension is dialyzed in the presence of 70 ml of
20 mM ammonium acetate, pH 5.2, so as to eliminate the
glucose molecules obtained after digestion of the dextran
40 with the dextranase. The proteins are then isolated on an
anion exchange column (Fast Q, Pharmacia Biotech AB,

Uppsala, SU) which has been equilibrated beforehand with a 20 mM ammonium acetate buffer, pH 5.2.

The proteins are eluted over a linear gradient of 0-0.5 M NaCl.

The activity of the dextran sucrose in the different protein fractions eluted in this way is analyzed and these protein fractions are subjected to electrophoresis on an SDS-polyacrylamide gel.

The protein fractions containing the dextran sucrose are isolated and the activity of the purified dextran sucrose is measured and found to be 105 u/mg.

15

Texturing capacity of the dextrans as a function of the incubation temperature of the enzyme

The activity of the dextran sucrose from the strain *Leuconostoc mesenteroides ssp. cremoris* CNCM I-1692 is demonstrated, on the one hand at 30°C and on the other hand at 4°C, thereby verifying the texturing capacity of the dextrans at these different temperatures.

This is done by preparing an additive containing active dextran sucrose from a culture of the strain *Leuconostoc mesenteroides ssp. cremoris* CNCM I-1692.

A synthetic medium containing 2% of sucrose, 2% of K_2HPO_4 , 0.5% of yeast extract, 0.5% of peptone, 0.02% of $MgSO_4$, 0.001% of $MnSO_4$, 0.001% of $FeSO_4$ and 0.001% of NaCl is inoculated with 1% of a preculture of the strain *Leuconostoc mesenteroides ssp. cremoris* CNCM I-1692. It is allowed to ferment at 30°C for 12 h with the pH being maintained at 6.7.

The culture is then separated by centrifugation at 18,000 g for 20 min at 4°C so as to isolate the supernatant containing the dextran sucrose.

40

The pH of the supernatant is lowered to 5.2 and this supernatant is incubated for 12 h at 4°C.

The macromolecules in the supernatant are then
5 precipitated twice with polyethylene glycol at 4°C so as to purify the dextran sucrase.

The texturing capacity of the dextrans synthesized by the dextran sucrase isolated in this way is then verified by
10 incubating the latter, on the one hand at 30°C and on the other hand at 4°C, in a buffer-substrate containing 20 mM acetate, pH 5.2, 200 mM sucrose and 20 mM CaCl₂.

Table IV below shows the results of texturing with the
15 active dextran sucrase from the strain *Leuconostoc mesenteroides ssp. cremoris* CNCM I-1692, on the one hand at 30°C and on the other hand at 4°C.

Table IV

20

medium	incubation conditions	texturing
a	30°C for 12 h	-
	4°C for 12 h	+++++

a: buffer-substrate medium of pH 5.2

-: absence of texture

+++++: good texture, very thick

25 The results shown in Table IV demonstrate the fact that the dextran sucrase from the strain *Leuconostoc mesenteroides ssp. cremoris* CNCM I-1692 makes it possible at 4°C to synthesize a dextran with a thick and pleasant texture, whereas at 30°C a turbid solution devoid of
30 texture is obtained. This difference in texturing is without doubt due to the fact that at 4°C the dextran is in the form of molecules with short branches and thus makes it possible to obtain a thick and pleasant texture, whereas at 30°C the dextran is in the form of molecules
35 with long branches aligned parallel with the main chain. These molecules do not afford a good texture.

Texturing of a dairy product with the dextran sucrose

The dextran sucrose is incubated under conditions (medium, temperature and pH) identical to those which prevail
5 during the preparation of a yoghurt.

This is done by preparing an additive containing active dextran sucrose from a culture of the strain *Leuconostoc mesenteroides ssp. cremoris* CNCM I-1692.

10

A synthetic medium containing 2% of sucrose, 2% of K_2HPO_4 , 0.5% of yeast extract, 0.5% of peptone, 0.02% of $MgSO_4$, 0.001% of $MnSO_4$, 0.001% of $FeSO_4$ and 0.001% of NaCl is inoculated with 1% of a preculture of the strain

15

Leuconostoc mesenteroides ssp. cremoris CNCM I-1692. It is allowed to ferment at 30°C overnight with the pH being maintained at 6.7.

The culture is then separated by centrifugation at
20 18,000 g for 20 min at 4°C so as to isolate the supernatant containing the dextran sucrose.

The pH of the supernatant is then lowered to 5.2 and this supernatant is incubated for 12 h at 4°C.

25

The macromolecules in the supernatant are then precipitated twice with polyethylene glycol at 4°C so as to purify the dextran sucrose.

30 The synthesis of dextran by the dextran sucrose is then verified. This is done by incubating the dextran sucrose on the one hand in a buffer-substrate of pH 6.4 containing 20 mM acetate, 200 mM sucrose and 20 mM $CaCl_2$, and on the other hand in a milk drink containing 6% of sucrose.

35

Table V below shows the results obtained for texturing with the dextran sucrose from the strain *Leuconostoc mesenteroides ssp. cremoris* CNCM I-1692.

Table V

medium	simulation conditions	texture
a	c	-
	d	+++++
b	c	+
	d	+++++

a: buffer-substrate of pH 6.4

b: milk drink containing 6% of sucrose

5 c: 5 h at 37°C followed by adjustment of the pH to 4.7, lowering of the temperature to 4°C and incubation for 24 h at 4°C

d: 5 h at 20°C followed by adjustment of the pH to 4.7, lowering of the temperature to 4°C and incubation for 24 h
10 at 4°C

-: absence of texture

+: small amount of texture

+++++: good texture

15 The results shown in Table V make it possible to demonstrate the fact that the dextran sucrose also textures a milk-based medium, but no longer produces thickening dextran after 5 h at 37°C. Yoghurts can be textured by adding the dextran sucrose after fermentation
20 and before storage at 4°C.

The Examples below are given in order to illustrate the use of the dextran, the dextran sucrose and/or a strain producing this dextran and this dextran sucrose in the
25 manufacture of a food product or cosmetic composition according to the present invention. The percentages given are by weight, unless indicated otherwise.

30 Example 1

The strain *Leuconostoc mesenteroides* ssp. *cremoris* CNCM I-1692 according to the present invention is used for the manufacture of yoghurts.

To do this, 1 l of a milk product containing 2.8% of fats and supplemented with 2% of skimmed milk powder and 6% of sucrose is prepared, it is pasteurized at 96°C for 30 min and its temperature is then lowered to 42°C.

5

In a parallel operation, a frozen preculture of a non-thickening strain of *Streptococcus thermophilus* and a frozen preculture of a non-viscous strain *Lactobacillus bulgaricus* are reactivated in a sterile MSK culture medium containing 10% of reconstituted milk powder and 0.1% of commercial yeast extract.

A frozen preculture of the strain of *Leuconostoc mesenteroides ssp. cremoris* is also reactivated in an MRS culture medium (MRS lactobacilli - Detroit - USA) and then in a sterile MSK culture medium containing 10% of reconstituted milk powder and 0.1% of commercial yeast extract and supplemented with 1% of sucrose.

The pasteurized milk product is then inoculated with 1% of each of these reactivated precultures and this milk product is then allowed to ferment at 37°C until the pH reaches a value of 4.5.

Yoghurts are produced in this way and stored at 4°C.

These yoghurts, prepared with a strain of *Leuconostoc mesenteroides ssp. cremoris*, have an unctuous texture with a pleasant taste, especially after storage for 10 days at 4°C.

Example 2

The additive containing active dextran sucrose according to the present invention is used for the manufacture of yoghurts.

To do this, a synthetic medium containing 2% of sucrose, 2% of K_2HPO_4 , 0.5% of yeast extract, 0.5% of peptone, 0.02% of $MgSO_4$, 0.001% of $MnSO_4$, 0.001% of $FeSO_4$ and 0.001% of

NaCl is inoculated with 1% of a preculture of the strain *Leuconostoc mesenteroides* ssp. *cremoris* CNCM I-1692. It is allowed to ferment at 30°C for 12 h with the pH being maintained at 6.7. The culture is then separated by
5 centrifugation at 18,000 g for 20 min at 4°C so as to isolate the supernatant containing the active dextran sucrase. The pH of the supernatant is lowered to 5.2 and the macromolecules in the supernatant are then precipitated at 4°C with ammonium sulphate so as to isolate
10 a precipitate containing the dextran sucrase. This precipitate is then dialyzed to remove the ammonium sulphate.

1 l of a milk product containing 2.8% of fats and
15 supplemented with 2% of skimmed milk powder and 6% of sucrose is also prepared, it is pasteurized at 96°C for 30 min and its temperature is then lowered to 42°C.

In a parallel operation, a frozen preculture of a non-thickening strain of *Streptococcus thermophilus* and a frozen preculture of a non-viscous strain of *Lactobacillus bulgaricus* are reactivated in a sterile MSK culture medium containing 10% of reconstituted milk powder and 0.1% of commercial yeast extract.

25 The pasteurized milk product is inoculated with 1% of each of the cultures of the two strains and the milk product is then incubated at 37°C until the pH reaches a value of 4.5.

30 1% of purified dextran sucrase is then added, with stirring.

Yoghurts are produced in this way and stored at 4°C.

35 These yoghurts, prepared with the purified dextran sucrase synthesized by *Leuconostoc mesenteroides* ssp. *cremoris*, have an unctuous texture with a pleasant taste, especially after storage for 10 days at 4°C.

Example 3

The additive containing active dextran sucrase according to the present invention is used in powder form for the manufacture of yoghurts.

To do this, a culture medium containing 9% of skimmed milk powder, 0.1% of yeast extract and 2% of sucrose is inoculated with 1% of a preculture of the strain of *Leuconostoc mesenteroides ssp. cremoris*. It is allowed to ferment at 30°C for 20 h with the pH being maintained at 6.7. The culture is mixed with an equal volume of 20% MSK solution. The pH of the resulting culture is then lowered to 5.2 by the addition of lactic acid before the culture is spray-dried to give the additive containing active dextran sucrase in powder form.

1 l of a milk product containing 2.8% of fats and supplemented with 2% of skimmed milk powder and 6% of sucrose is also prepared, it is pasteurized at 96°C for 30 min and its temperature is then lowered to 42°C.

In a parallel operation, a frozen preculture of a non-thickening strain of *Streptococcus thermophilus* and a frozen preculture of a non-viscous strain of *Lactobacillus bulgaricus* are reactivated in a sterile MSK culture medium containing 10% of reconstituted milk powder and 0.1% of commercial yeast extract.

The pasteurized milk product is inoculated with 1% of each of the cultures of the two strains and the milk product is then incubated at 40°C until the pH reaches a value of 4.5. 1% of the additive containing the active dextran sucrase is then added in powder form, with stirring.

Yoghurts are produced in this way and stored at 4°C.

These yoghurts, prepared with the additive containing active dextran sucrase in powder form, have an unctuous texture with a pleasant taste, especially after storage for 10 days at 4°C.

Example 4

The additive containing active dextran sucrase according
5 to the present invention is used in powder form for the
manufacture of ice creams.

To do this, a culture medium containing 0.5% of yeast
extract and at least 2% of sucrose is inoculated with 1%
10 of a preculture of the strain of *Leuconostoc mesenteroides*
ssp. cremoris. It is allowed to ferment at 23°C for 20 h
with the pH being maintained at 6.7. The pH of the
resulting culture is lowered to 5.2 by the addition of
lactic acid. The culture is mixed with an equal volume of
15 20% MSK solution before being spray-dried to give the
additive containing active dextran sucrase in powder form.

In another operation, 100 l of an ice cream mixture
containing 8% of fats, 10% of non-fat solids, 14% of
20 sucrose, 3% of glucose syrup DE 36-40, 0.3% of emulsifier,
monoglyceride and diglyceride are prepared. This mixture
has a total dry extract of 35.28%. The mixture prepared
in this way is stirred at 60-65°C for 20 min, homogenized
at 210 bar and at 72°C (rising homogenization - 2 stages),
25 pasteurized at 86°C for 22 sec and then cooled to +4°C.
The output of the homo-pasteurization line is 200 l/h.

The mixture is acidified to pH 5.5 with lactic acid. 1%
of the additive containing the active dextran sucrase is
30 then added in powder form, with stirring.

The mixture is then matured at +4°C. When mature, the ice
cream mixture prepared with the additive containing active
dextran sucrase in powder form has an unctuous texture.
35 It is frozen on a freezer at -5°C, with a 95%
volume increase, at a counterpressure of 3 bar and with an
output of 80 l/h. The ice cream is then stored at -35°C in
a hardening chamber and subsequently at -30°C or -20°C.

40 The ice cream prepared with the additive containing active
dextran sucrase in powder form has a good textural quality

and a pleasant taste. The ice cream obtained in this way gives a good sensation in the mouth. The ice cream is smooth and unctuous. After accelerated ageing the ice cream preserves a good level of textural quality and of
5 creamy sensation in the mouth. The smooth character of the ice cream is preserved well; this can be explained by the cryoprotective property of the dextrans, which then limits excessive growth of the ice crystals.

10 Example 5

The additive containing active dextran sucrose according to the present invention is used in powder form for the manufacture of ice creams.

15

To do this, a culture medium containing 0.5% of yeast extract and at least 2% of sucrose is inoculated with 1% of a preculture of the strain of *Leuconostoc mesenteroides*
20 *ssp. cremoris*. It is allowed to ferment at 23°C for 20 h with the pH being maintained at 6.7. The pH of the resulting culture is lowered to 5.2 by the addition of lactic acid. The culture is mixed with an equal volume of 20% MSK solution before being spray-dried to give the additive containing active dextran sucrose in powder form.

25

In another operation, 100 l of a premix containing 18% of sucrose are prepared. 1% of the additive containing the active dextran sucrose is then added in powder form, with stirring. The premix is then incubated at +4°C.

30

After incubation, the viscosity of the premix has increased. The premix is made up to give a final ice cream mixture containing 8% of fats, 10% of non-fat solids, 14% of sucrose, 3% of glucose syrup DE 36-40, 0.3%
35 of emulsifier, monoglyceride and diglyceride. This mixture has a total dry extract of 35.28%. The mixture prepared in this way is stirred at 60-65°C for 20 min, homogenized at 210 bar and at 72°C (rising homogenization - 2 stages), pasteurized at 86°C for 22 sec and then cooled
40 to +4°C. At this point the enzyme is totally inactivated. The output of the homo-pasteurization line is 200 l/h.

The mixture is matured at +4°C and then frozen on a freezer at -5°C, with a 95% volume increase, at a counterpressure of 3 bar and with an output of 80 l/h.

- 5 The ice cream is then stored at -35°C in a hardening chamber and subsequently at -30°C or -20°C.

- The ice cream prepared from a premix incubated with the additive containing active dextran sucrose in powder form
- 10 has a good textural quality and a pleasant taste. The ice cream obtained in this way gives a good sensation in the mouth. The ice cream is smooth and unctuous. After accelerated ageing the ice cream preserves a good level of textural quality and of creamy sensation in the mouth.
- 15 The smooth character of the ice cream is preserved well; this can be explained by the cryoprotective property of the dextrans, which then limits excessive growth of the ice crystals.

Claims

1. Strain of *Leuconostoc mesenteroides* ssp. *cremoris*
5 which produces dextran.
2. Strain according to Claim 1 deposited in the CNCM
under the number I-1692.
- 10 3. Strain according to Claim 1 deposited in the CNCM
under the number I-1693.
4. Strain according to Claim 1 which produces the same
dextran as the strain CNCM I-1692 or the strain CNCM I-
15 1693.
5. Strain according to one of Claims 1, 3 and 4 which
does not ferment lactose.
- 20 6. Process for the production of dextran, wherein:
 - a culture medium containing sucrose is inoculated with a
preculture of a strain according to one of Claims 1-5,
 - it is allowed to ferment at 25-35°C for 10-20 h, and
 - the pH of the resulting culture is then lowered to 5-5.5
- 25 prior to storage at 0-10°C for 16-48 h.
7. Process according to Claim 6 wherein the culture
medium contains at least 2% of sucrose.
- 30 8. Process according to Claim 6 wherein the culture is
mixed with a milk-based medium just after the fermentation
step.
9. Process according to Claim 6 wherein the culture is
35 dried after the storage step.
10. Food product or cosmetic composition comprising
dextran from *Leuconostoc mesenteroides* ssp. *cremoris*
obtainable by carrying out the process according to one of
40 Claims 6-9.

11. Process for the production of an additive containing active dextran sucrase, wherein a medium containing sucrose is inoculated with a preculture of a strain according to one of Claims 1-5 and is then allowed to ferment at 25-35°C for 10-20 h.

12. Process according to Claim 11 wherein the culture medium contains at least 2% of sucrose.

13. Process according to Claim 11 wherein the pH of the culture is adjusted to 5-5.5 after fermentation and this culture is then dried.

14. Process according to Claim 11 wherein the culture is separated after fermentation so as to isolate the supernatant containing the dextran sucrase.

15. Process according to Claim 14 wherein the pH of the supernatant is adjusted to 4.9-5.7, the supernatant is stored at 0-10°C for 15-30 h and the macromolecules contained in the supernatant are then precipitated so as to isolate a precipitate containing the dextran sucrase.

16. Process according to Claim 15 wherein the precipitate containing the dextran sucrase is dialyzed.

17. Process according to one of Claims 15-16 wherein the precipitate containing the dextran sucrase is stored at a temperature below -4°C.

18. Food product or cosmetic composition comprising an additive containing active dextran sucrase from *Leuconostoc mesenteroides ssp. cremoris* obtainable by carrying out the process according to one of Claims 10 to 16.

19. Method of using a strain according to one of Claims 1-5 for the manufacture of a food product or cosmetic composition.