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(54) **GLUCOSE SYRUP HAVING SPECIFIC PROPERTIES AND PROCESS FOR OBTAINING THE SAME**

GLUCOSESIRUP MIT SPEZIELLEN EIGENSCHAFTEN UND VERFAHREN ZU SEINER
HERSTELLUNG

SIROP DE GLUCOSE AYANT DES PROPRIETES SPECIFIQUES ET PROCEDE DE FABRICATION
DUDIT SIROP

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EP 0 929 690 B1

Description

[0001] The present invention relates to a new process for preparing enzymatically converted glucose syrups which can be used as countertypes for standard acid converted glucose syrups, i.e. glucose syrups with a DE varying between 30 and 50, and to the new syrups which can be thus obtained.

[0002] The standard acid converted glucose syrups are obtained by acidifying a starch slurry to a pH=2,0. This slurry is then pumped into a continuous reactor which operates at elevated temperature and pressure. After the proper time interval, the liquor is returned to atmospheric conditions and neutralised. This liquor is clarified, decolourised with activated carbon and concentrated to the final syrup. The acid process is generally used for syrups in the range of 30-50 DE (Dextrose Equivalent). The acid conversion always yields a product of specific composition because of the random hydrolysis of the starch. Major disadvantages of this process are the high salt content of the syrup, and the special equipment needed to perform the acid conversion reaction.

[0003] The acid converted glucose syrups are typically used in hard boiled candy. There they reduce the tendency of sucrose to crystallise, they slow down the tendency to shell-graining and they contribute to the body and "mouthfeel" of the confection on consumption. Glucose syrups are also used in toffees, fudge or fondant where they prevent, slow down or control granulation of sucrose. These acid converted glucose syrups represent a market of more than 400.000 ton dry substance Europe-wide.

[0004] The acid converted glucose syrups used today are further purified by extended demineralisation, which results in better colour stability and improved organoleptic properties. These additional purification steps, which are needed to produce refined products, require additional equipment and cause additional operating costs. For this reason, alternatives for acid converted glucose syrups have been developed, based on acid-enzyme and enzyme-enzyme converted syrups. These products are already used in a number of food applications. These syrups are characterised by a DE which is the same as the DE of the acid converted syrups, but they differ considerably in sugar spectrum and rheological properties. A comparison between acid converted, acid-enzyme and enzyme-enzyme converted syrups of the same DE is illustrated in table 1:

Table 1

Comparison of state of the art glucose syrups obtained by:			
	acid conversion	acid-enzyme conversion	enzyme-enzyme conversion
DE - value	42	42	42
Sugar Spectrum (weight percentages)			
dextrose	19	6	2,5
maltose	14	45	56
maltotriose	12	12	16
maltotetraose	10	3	0,7
maltopentaose	8	2	0,4
maltohexaose	7	2	0,7
higher sugars	30	30	23,7

[0005] Other types of syrups, having a sugar spectrum which is closer to that of an acid converted syrup, are commercialised. These syrups are obtained by blending acid or enzymatically converted syrups with high maltose and/or 95DE glucose syrup.

[0006] It is generally admitted that direct enzymatic conversion of starch into an acid converted-type of syrup would have a number of advantages, namely :

- starch conversion by a mild biochemical process
- reduction of the formation of the colour precursor hydroxymethyl furfural
- no formation of anhydroglucose as a by-product
- lowered ash content because of a reduction in acid requirements
- cheaper downstream processing and refining Notwithstanding the fact that these advantages are well known, no confectionery syrups are however known up till now which are prepared by a one-step enzymatic conversion of a liquified starch substrate, and which have a sugar spectrum comparable with that of acid converted syrups.

[0007] The publication "Labo-Pharma-Probl.Tech., Vol 29, no 310, 1981, p.443-447" gives an overview of various

processes for converting starch in sugar sirups, and of the sugar distribution (by Degree of Polymerization DP) of those processes, corresponding to the state of the art discussed hereabove.

[0008] DE 41 25 969 discloses a process in which a mixture of certain enzymes is used to convert native starch directly into a sirup with high glucose content (DE>80). This type of sirup is very different from the so called acid converted glucose syrups for which the present invention aims at providing a countertype product.

[0009] DE 30 12 143 discloses a continuous process for the conversion of starch into a glucos sirup by means of a mixture alpha-amylase and amyloglycosydase, also yielding sugar syrups with a DE value above 80.

[0010] Applicants have now found unexpectedly that such glucose syrups having a sugar spectrum and rheological behaviour comparable to that of an acid converted sirup can be obtained.

[0011] It is therefore one object of the present invention to provide as new product, starch based, enzymatically converted glucose syrups of specific properties.

[0012] The glucose syrups according to the invention, which are obtainable by the process according to the invention, consist of a starch based, enzymatically converted glucose syrups, having a DE value (Dextrose Equivalent) between 30 and 50 and a sugar spectrum in which

the fraction of DP1 - DP3 ranges from 30 to 60 %,
the fraction of DP4 - DP6 ranges from 25 to 16 %,
the fraction of DP7 - DP9 ranges from 14 to 4 %, and
the fraction above DP9 ranges from 38 to 18 %, on d.s. (dry substance).

Preferred glucose syrups according to the invention have a DE value between 36 and 45 and a sugar spectrum in which

the fraction of DP1 - DP3 ranges from 38 to 55 %,
the fraction of DP4 - DP6 ranges from 24 to 17 %,
the fraction of DP7 - DP9 ranges from 13 to 4,5 %, and
the fraction above DP9 ranges from 32 to 21 %, on d.s.,

whereas the most preferred glucose syrups according to the invention have a DE value between 38 and 42 and by a sugar spectrum in which

the fraction of DP1 - DP3 ranges from 40 to 52 %,
the fraction of DP4 - DP6 ranges from 24 to 18 %,
the fraction of DP7 - DP9 ranges from 13 to 5 %, and
the fraction above DP9 ranges from 30 to 22 %, on d.s..

[0013] Applicants have also developped well determined conditions of a double enzymatic process allowing the preparation of such new glucose syrups.

[0014] It is therefore also an object of the present invention to provide a new process for preparing glucose sirup by treating starch with enzymes.

[0015] The process according to the invention comprises treating a liquified starch substrate by means of an enzyme mixture in a single enzymatic conversion step, whereas said enzyme mixture comprises together a bacterial alpha amylase, a maltogenic amylase and a glucoamylase.

[0016] The starting substrate for the process according to the invention is a liquified starch, as may for instance be obtained by liquifaction of native starch with a thermostable alpha amylase to a DE of 10-12, deactivation of the thermostable alpha amylase, and cooling of the liquified starch to a temperature of about 60°C.

[0017] Although other starting liquified starch substrates may be contemplated in the process according to the invention, the specifically liquified starch mentionned by way of example is most preferred.

[0018] The enzymes used in the enzyme mixture according to the invention are widely available on the market.

[0019] The preferred glucoamylase, exo-1,4-alpha-D-glucosidase, can in particular be obtained from a selected strain of *Aspergillus niger* by submerged fermentation.

[0020] The recommended reaction conditions for this enzyme are pH=4,5 and T=60°C. The enzyme activity of the glucoamylase (AGU) is defined as the amount of enzyme which hydrolyses 1 micro-mol maltose per minute under standard conditions (T=25°C; pH=4,3; reaction time 30 minutes).

[0021] The bacterial alpha amylase is preferably an endo-amylase which hydrolyses 1,4-alpha-glucosidic bonds in gelatinised starch. The alpha amylase can be produced by fermentation of a selected strain of *Bacillus subtilis*.

[0022] Recommended operating conditions for this enzyme are pH=6-6,5 and T=70-90°C. The enzyme activity of

the alpha amylase (KNU) is defined as the amount of enzyme which breaks down 5,26g starch per hour at Novo's standard method for determination of alpha amylase under standard conditions (substrate=soluble starch; Ca-content in solvent=0,0043M; T=37°C; pH=5,6).

[0023] The preferred maltogenic amylase (EC3.2.1.133) hydrolyses 1,4-alpha-glucosidic linkages in starch, partially hydrolysed starch and low-molecular weight oligosaccharides, including maltotriose. Maltose units are removed in a stepwise manner from the non-reducing chain ends. The enzyme, which can come from *Bacillus stearothermophilus*, can be expressed in and produced by a genetically modified strain of *Bacillus subtilis*. For industrial applications the recommended operating conditions are 60°C and pH 5,0-5,5. The enzyme activity of this maltogenase is defined as the amount of enzyme which hydrolyses 1 micromole of maltotriose under standard conditions, (substrate concentration 10mg/ml; T=37°C; pH=5,0; incubation time=30 min.)

[0024] The single enzymatic conversion step - i.e. a saccharification step - applied to the starting substrate in accordance with the invention is preferably performed at a temperature in the range from 55 to 65° C for a period of 10 to 48 hours, at a pH between 4,9 and 5,1; most preferably at a temperature in the range from 60 to 62° C for a period of 18 to 24 hours, at a pH between 4,9 and 5,1.

[0025] Of course shorter or longer reaction times are not excluded, but this could result in too high enzyme costs or too high investments in storage or reaction vessel capacity.

[0026] During the enzymatic conversion step the dry substance content of reaction mixture is preferably between 30 and 40% , more preferably between 32 and 37% , and most preferably between 33 and 35%.

[0027] The process according to the invention is particularly suitable for preparing the new glucose syrups according to the invention as defined above.

[0028] The enzyme concentrations and the enzyme ratios during the enzymatic conversion step according to the invention entirely depend on the process conditions applied and on the specific properties of the glucose one wishes to obtain. These concentrations will readily be determined by the skilled art worker on the basis of the data provided by the supplier of the commercial enzymes used in the process and/or by using mathematical calculations on the basis of empirical models, as is already known in the art ("Development and field confirmation of a mathematical model for amyloglucosidase/pullulanase saccharification" by T.R. Swanson et al. - *Starch/Staerke* (1986), 38 (11), 382-387). An empirical model can be construed based on information obtained from a design set-up of experiments of saccharification tests. By selecting an appropriate model, equations are obtained by which the amount (%w/w) of the different DP fractions in function of the concentrations of the different enzymes and the time can be calculated. The empirical equations are then used to calculate those combinations of enzyme concentrations and reaction time which fit at best the sugar spectrum of the acid converted glucose syrup which has to be countertyped.

[0029] The invention will be further illustrated and explained by way of the following examples describing a number of specific embodiments of the invention. It should be observed that the specific features of these examples are only described as preferred embodiments of what is intended within the above general disclosure of the invention and should by no means be interpreted as limiting the scope of the invention as such and as set forth in the claims.

Example 1 :

[0030] Native starch was suspended in water at a concentration of 33-35% d.s. and at a slightly acidic pH (3,5-4,0). This slurry was then gelatinised at 160°C. After cooling to 95°C, pH was adjusted to 5,7-5,9 and thermostable alpha amylase was added (0,5-0,6ml comm./kg d.s.). This slurry was then further liquified during 2-3 hours at 90-95°C until a DE of 10-12 was reached. Then the alpha amylase was inactivated by adjusting the pH to 4 while heating the liquified starch for an additional 5 minutes at 95°C.

This substrate was then cooled to 60°C and pH was adjusted to 5,0. To this liquified starch a mixture of enzymes was added composed of a glucoamylase, a maltogenic amylase and a bacterial alpha amylase. The following enzyme quantities were used :

- AMG 300L : 10 AGU/kg d.s.
- maltogenase 4000L : 96 MANU/kg d.s.
- BAN 480L : 14 KNU/kg d.s.

After a reaction time of 20 hours, the reaction was stopped by adjusting the pH to 3,5 and heating the solution to 85°C via e.g. steam injection, to destroy as quickly as possible all the remaining enzyme activity. According to the reaction conditions used, an enzymatically converted 38DE syrup was obtained having a composition and properties comparable to those of an acid converted 38DE syrup. (cf table 2) :

Table 2

Comparison of glucose syrup obtained in example 1 with a conventional syrup of DE 38 obtained by acid conversion.		
	Acid DE38	Enzymatic DE38
Sugar Spectrum (weight percentages)		
DP1	15,9	13,0
DP2	12,9	15,0
DP3	9,9	14,9
DP4	9,5	7,8
DP5	7,9	7,2
DP6	6,6	7,6
DP7	5,4	3,7
DP8	4,3	1,4
DP9	4,0	2,2
>DP9	23,6	27,0
ERH (1)	32,25	32,47
Tg(97%d.s.)	103,7°C	104,1°C
Viscosity (mPas) (2)	8217	8177

(1) ERH of hard boiled candy : 48,5% syrup solids, 48,5% sucrose, 3% water

(2) viscosity at 80% d.s. and 50°C

Example 2 :

[0031] Native starch was suspended in water at a concentration of 33-35% d.s. and at a slightly acidic pH (3,5-4,0). This slurry was then gelatinised at 160°C. After cooling to 95°C, pH was adjusted to 5,7-5,9 and thermostable alpha amylase was added (0,5-0,6ml comm/kg d.s.). This slurry was then further liquified during 2-3 hours at 90-95°C until a DE of 10-12 is reached. Then the alpha amylase was inactivated by adjusting the pH to 4 while heating the liquified starch for an additional 5 minutes at 95°C. This substrate was then cooled to 60°C and pH is adjusted to 5,0. To this liquefied starch a mixture of enzymes was added composed of a glucoamylase, a maltogenic amylase and a bacterial alpha amylase. The following enzyme quantities were added :

- AMG 300 L : 16,5 AGU/kg d.s.
- maltogenase 4000L : 48 MANU/kg d.s.
- BAN 480L : 12 KNU/kg d.s.

After a reaction time of 20 hours, the reaction was stopped by adjusting the pH to 3,5 and heating the solution to 85°C via e.g. steam injection, to destroy as quick as possible all the remaining enzyme activity. According to the reaction conditions used, an enzymatically converted 42DE syrup was obtained having a composition and properties comparable to those of an acid converted 42DE syrup. (cf table 3)

Table 3

Comparison of glucose syrup obtained in example 2 with a conventional syrup of DE 42 obtained by acid conversion.		
	Acid DE42	Enzymatic DE42
Sugar Spectrum (weight percentages)		
DP1	19,7	19,1
DP2	16,4	14,5
DP3	9,5	17,0
DP4	7,9	6,9
DP5	6,7	6,8
DP6	5,5	5,5
DP7	4,7	2,6
DP8	3,9	1,3

Table 3 (continued)

Comparison of glucose syrup obtained in example 2 with a conventional syrup of DE 42 obtained by acid conversion.		
	Acid DE42	Enzymatic DE42
Sugar Spectrum (weight percentages)		
DP9	3,4	1,5
>DP9	22,3	24,6
ERH (1)	31,47	31,12
Tg(97%d.s.)	98°C	94°C
Viscosity (mPas) (2)	6300	5900

(1) ERH of hard boiled candy : 48,5% syrup solids, 48,5% sucrose, 3% water

(2) viscosity at 80% d.s. and 50°C

Claims

1. Starch based, enzymatically converted glucose syrup, **characterised by** a DE value (Dextrose Equivalent) between 30 and 50 and by a sugar "Degree of Polymerization" (DP) spectrum in which

the fraction of DP1 - DP3 ranges from 30 to 60%,
the fraction of DP4 - DP6 ranges from 25 to 16%,
the fraction of DP7 - DP9 ranges from 14 to 4%,
the fraction above DP9 ranges from 38 to 18 % on dry substance (d.s.), obtainable by the process claimed in claim 4.

2. Glucose syrup according to claim 1, **characterised by** a DE value between 36 and 45 and by a sugar spectrum in which

the fraction of DP1 - DP3 ranges from 38 to 55%,
the fraction of DP4 - DP6 ranges from 24 to 17%,
the fraction of DP7 - DP9 ranges from 13 to 4,5%,
the fraction above DP9 ranges from 32 to 21 % on d.s.

3. Glucose syrup according to claim 1, **characterised by** a DE value between 38 and 42 and by a sugar spectrum in which

the fraction of DP1 - DP3 ranges from 40 to 52%,
the fraction of DP4 - DP6 ranges from 24 to 18%,
the fraction of DP7 - DP9 ranges from 13 to 5 %,
the fraction above DP9 ranges from 30 to 22 % on d.s.

4. Process for preparing glucose syrup by treating starch with enzymes, **characterised in that** said process comprises treating a liquefied starch substrate by means of an enzyme mixture in a single enzymatic conversion step, whereas said enzyme mixture comprises together a bacterial alpha amylase, a maltogenic amylase and a glucoamylase.

5. Process according to claim 4, **characterised in that** the enzymatic conversion step is performed at a temperature in the range from 55 to 65° C for a period of 10 to 48 hours, at a pH between 4,9 and 5,1.

6. Process according to claim 4, **characterised in that** the enzymatic conversion step is performed at a temperature in the range from 60 to 62° C for a period of 18 to 24 hours, at a pH between 4,9 and 5,1.

7. Process according to claims 4-6, **characterised in that** during the enzymatic conversion step the dry substance content of the reaction mixture is between 30 and 40% on d.s..

8. Process according to claim 7, **characterised in that** during the enzymatic conversion step the dry substance

content of the reaction mixture is between 32 and 37% on d.s..

9. Process according to claim 7, **characterised in that** during the enzymatic conversion step the dry substance content of the reaction mixture is between 33 and 35% on d.s..

10. Process according to claims 4-9, **characterised in that** the liquefied starch substrate has a DE of 10 - 12.

11. Process according to claims 4-10, **characterised in that** the liquefied starch substrate results from a pre-treatment of native starch with thermostable alpha amylase, followed by deactivation of the thermostable alpha amylase.

12. Process according to claims 4-11, for preparing a glucose syrup **characterised by** a DE value between 30 and 50 and by a sugar spectrum in which

the fraction of DP1 - DP3 ranges from 30 to 60%,
the fraction of DP4 - DP6 ranges from 25 to 16%,
the fraction of DP7 - DP9 ranges from 14 to 4%,
the fraction above DP9 ranges from 38 to 18 % on d.s.

13. Process according to claims 4-12, for preparing a glucose syrup **characterised by** a DE value between 36 and 45 and by a sugar spectrum in which

the fraction of DP1 - DP3 ranges from 38 to 55%,
the fraction of DP4 - DP6 ranges from 24 to 17%,
the fraction of DP7 - DP9 ranges from 13 to 4,5%,
the fraction above DP9 ranges from 32 to 21 % on d.s.

14. Process according to claim 4-13, for preparing a glucose syrup **characterised by** a DE value between 38 and 42 and by a sugar spectrum in which

the fraction of DP1 - DP3 ranges from 40 to 52%,
the fraction of DP4 - DP6 ranges from 24 to 18%,
the fraction of DP7 - DP9 ranges from 13 to 5 %,
the fraction above DP9 ranges from 30 to 22 % on d.s.

Patentansprüche

1. Enzymatisch umgesetzter Glucosesirup aus Stärke, **gekennzeichnet durch** einen DE-Wert (Dextrose Equivalent) zwischen 30 und 50 und **durch** ein Zucker- "Polymerisierungsgrad" (DP)-Spektrum wobei:

die Fraktion von DP1 - DP3 zwischen 30 und 60% liegt,
die Fraktion von DP4 - DP6 zwischen 25 und 16% liegt,
die Fraktion von DP7 - DP9 zwischen 14 und 4% liegt und
die Fraktion über DP9 zwischen 38 und 18% liegt, auf trockene Substanz bezogen, mit Hilfe des erfindungs-
gemäßen Verfahrens in Anspruch 4 erhältlich.

2. Glucosesirup nach Anspruch 1, **gekennzeichnet durch** einen DE-Wert zwischen 36 und 45 und **durch** ein Zuckerspektrum in dem:

die Fraktion von DP1 - DP3 zwischen 38 und 55% liegt,
die Fraktion von DP4 - DP6 zwischen 24 und 17% liegt,
die Fraktion von DP7 - DP9 zwischen 13 und 4,5% liegt,
die Fraktion über DP9 zwischen 32 und 21% liegt auf trockene Substanz bezogen.

3. Glucosesirup nach Anspruch 1, **gekennzeichnet durch** einen DE-Wert zwischen 38 und 42 und **durch** ein Zuckerspektrum in dem:

die Fraktion von DP1 - DP3 zwischen 40 und 52% liegt,

die Fraktion von DP4 - DP6 zwischen 24 und 18% liegt,
 die Fraktion von DP7 - DP9 zwischen 13 und 5% liegt,
 die Fraktion über DP9 liegt zwischen 30 und 22% auf trockener Substanz bezogen.

- 5 **4.** Verfahren zur Herstellung von Glucosesirup durch Behandlung von Stärke mit Enzymen, **dadurch gekennzeichnet, dass** besagtes Verfahren die Behandlung eines verflüssigten Stärkesubstrats mittels eines Enzymgemisches in einer einzigen enzymatischen Umsetzungsphase umfasst, wobei besagtes Enzymgemisch eine bakterielle Alpha-Amylase, eine maltogene Amylase und eine Glucoamylase zusammen enthält.
- 10 **5.** Verfahren nach Anspruch 4, **dadurch gekennzeichnet, dass** die enzymatische Umsetzungsphase ausgeführt wird bei einer Temperatur im Bereich von 55 bis 65°C, während einer Periode von 10 bis 48 Stunden, bei einem pH-Wert zwischen 4,9 und 5,1.
- 15 **6.** Verfahren nach Anspruch 4, **dadurch gekennzeichnet, dass** die enzymatische Umsetzungsphase ausgeführt wird bei einer Temperatur im Bereich von 60 bis 62°C liegt, während einer Periode von 18 bis 24 Stunden, bei einem pH-Wert zwischen 4,9 und 5,1.
- 20 **7.** Verfahren nach den Ansprüchen 4 bis 6, **dadurch gekennzeichnet, dass** während der enzymatischen Umsetzungsphase, der Gehalt der trockenen Substanz des Reaktionsgemisches zwischen 30 und 40%, auf trockene Substanz bezogen, liegt.
- 25 **8.** Verfahren nach Anspruch 7, **dadurch gekennzeichnet, dass** während der enzymatischen Umsetzungsphase, der Gehalt der trockenen Substanz des Reaktionsgemisches zwischen 32 und 37%, auf trockene Substanz bezogen, liegt.
- 30 **9.** Verfahren nach Anspruch 7, **dadurch gekennzeichnet, dass** während der enzymatischen Umsetzungsphase, der Gehalt der trockenen Substanz des Reaktionsgemisches zwischen 33 und 35%, auf trockene Substanz bezogen, liegt.
- 35 **10.** Verfahren nach den Ansprüchen 4 bis 9, **dadurch gekennzeichnet, dass** das verflüssigte Stärkesubstrat einen DE-Wert von 10 - 12 hat.
- 11.** Verfahren nach den Ansprüchen 4 bis 10 **dadurch gekennzeichnet, dass** das verflüssigte Stärkesubstrat von einer Vorbehandlung der Naturstärke mit wärmebeständiger Alpha-Amylase, von einer Inaktivierung der wärmebeständigen Alpha-Amylase gefolgt, herrührt.
- 12.** Verfahren nach den Ansprüchen 4 bis 11 zur Herstellung eines Glucosesirups, **gekennzeichnet durch** einen DE-Wert zwischen 30 und 50 und ein Zuckerspektrum in dem:
40 die Fraktion von DP1 - DP3 zwischen 30 und 60% liegt,
 die Fraktion von DP4 - DP6 zwischen 25 und 16% liegt,
 die Fraktion von DP7 - DP9 zwischen 14 und 4% liegt und
 die Fraktion über DP9 zwischen 38 und 18% liegt, auf trockene Substanz bezogen.
- 45 **13.** Verfahren nach den Ansprüchen 4 bis 12 zur Herstellung eines Glucosesirups, **gekennzeichnet durch** einen DE-Wert zwischen 36 und 45 und **durch** ein Zuckerspektrum in dem:
50 die Fraktion von DP1 - DP3 zwischen 38 und 55% liegt,
 die Fraktion von DP4 - DP6 zwischen 24 und 17% liegt,
 die Fraktion von DP7 - DP9 zwischen 13 und 4,5% liegt,
 die Fraktion über DP9 zwischen 32 und 21% liegt auf trockene Substanz bezogen,
- 55 **14.** Verfahren nach den Ansprüchen 4 bis 13 zur Herstellung eines Glucosesirups, **gekennzeichnet durch** einen DE-Wert zwischen 38 und 42 und **durch** ein Zuckerspektrum in dem:
 die Fraktion von DP1 - DP3 zwischen 40 und 52% liegt,
 die Fraktion von DP4 - DP6 zwischen 24 und 18% liegt,
 die Fraktion von DP7 - DP9 zwischen 13 und 5% liegt,

die Fraktion über DP9 liegt zwischen 30 und 22% auf trockene Substanz bezogen.

Revendications

1. Sirop de glucose converti enzymatiquement, issu d'amidon, **caractérisé par** une valeur DE (Equivalent Dextrose) entre 30 et 50 et par une répartition de "degré de polymérisation" (DP) des sucres dans laquelle
 - la fraction de DP1 - DP3 varie de 30 à 60 %,
 - la fraction de DP4 - DP6 varie de 25 à 16 %,
 - la fraction de DP7 - DP9 varie de 14 à 4 %,
 - la fraction au delà de DP9 varie de 38 à 18 % sur matière sèche (d.s.), tel que pouvant être obtenu par le procédé selon la revendication 4.
2. Sirop de glucose selon la revendication 1, **caractérisé par** une valeur DE située entre 36 et 45 et par une répartition des sucres dans laquelle
 - la fraction de DP1 - DP3 varie de 38 à 55 %,
 - la fraction de DP4 - DP6 varie de 24 à 18 %,
 - la fraction de DP7 - DP9 varie de 13 à 4,5 %,
 - la fraction au delà de DP9 varie de 32 à 21 % sur d.s.
3. Sirop de glucose selon la revendication 1, **caractérisé par** une valeur DE située entre 36 et 45 et par une répartition des sucres dans laquelle
 - la fraction de DP1 - DP3 varie de 40 à 52 %,
 - la fraction de DP4 - DP6 varie de 24 à 18 %,
 - la fraction de DP7 - DP9 varie de 13 à 5 %,
 - la fraction au delà de DP9 varie de 30 à 22 % sur d.s.
4. Procédé de préparation de sirop de glucose par le traitement d'amidon au moyen d'enzymes, **caractérisé en ce que** le procédé comprend le traitement d'un substrat liquéfié d'amidon en une seule étape de conversion enzymatique au moyen d'un mélange d'enzymes, ce mélange d'enzymes comprenant, en même temps, une amylase alpha bactérienne, une amylase maltogénique et une glucoamylase.
5. Procédé selon la revendication 4, **caractérisé en ce que** l'étape de conversion enzymatique est réalisée à une température entre 55 et 65 °C pendant une durée de 10 à 48 heures, à un pH entre 4,9 et 5,1.
6. Procédé selon la revendication 4, **caractérisé en ce que** l'étape de conversion enzymatique est réalisée à une température entre 60 et 62 °C pendant une durée de 18 à 24 heures, à un pH entre 4,9 et 5,1.
7. Procédé selon les revendications 4 - 6, **caractérisé en ce que** lors de l'étape de conversion enzymatique la teneur en matière sèche du milieu réactionnel est entre 30 et 40 % sur d.s.
8. Procédé selon la revendication 7, **caractérisé en ce que** lors de l'étape de conversion enzymatique la teneur en matière sèche du milieu réactionnel est entre 32 et 37 % sur d.s.
9. Procédé selon la revendication 7, **caractérisé en ce que** lors de l'étape de conversion enzymatique la teneur en matière sèche du milieu réactionnel est entre 33 et 35 % sur d.s.
10. Procédé selon les revendications 4 - 9, **caractérisé en ce que** le substrat liquéfié d'amidon présente un DE de 10 - 12.
11. Procédé selon les revendications 4 - 10, **caractérisé en ce que** le substrat liquéfié d'amidon résulte d'un traitement préalable d'amidon native au moyen d'alpha amylase thermostable, suivie d'une désactivation de l'alpha amylase thermostable.
12. Procédé selon les revendications 4 - 11 pour la préparation d'un sirop de glucose, **caractérisé par** une valeur DE

entre 30 et 50 et par une répartition des sucres dans laquelle

la fraction de DP1 - DP3 varie de 30 à 60 %,
la fraction de DP4 - DP6 varie de 25 à 16 %,
la fraction de DP7 - DP9 varie de 14 à 4 %,
la fraction au delà de DP9 varie de 38 à 18 % sur d.s.

13. Procédé selon les revendications 4 - 12 pour la préparation d'un sirop de glucose, **caractérisé par** une valeur DE entre 36 et 40 et par une répartition des sucres dans laquelle

la fraction de DP1 - DP3 varie de 38 à 55 %,
la fraction de DP4 - DP6 varie de 24 à 17 %,
la fraction de DP7 - DP9 varie de 13 à 4,5 %,
la fraction au delà de DP9 varie de 32 à 21 % sur d.s.

14. Procédé selon les revendications 4 - 13 pour la préparation d'un sirop de glucose, **caractérisé par** une valeur DE entre 38 et 42 et par une répartition des sucres dans laquelle

la fraction de DP1 - DP3 varie de 40 à 52 %,
la fraction de DP4 - DP6 varie de 24 à 18 %,
la fraction de DP7 - DP9 varie de 13 à 5 %,
la fraction au delà de DP9 varie de 30 à 22 % sur d.s.