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COMPRESSIBLE ENZYME POWDER

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In the present context a directly compressible powder is a powder which may be directly tabletted without adding any excipients except possibly a lubricant. This means that no flow-aids and binders are added before tableting, but a lubricant such as stearic acid, hydrogenated vegetable oil or Mg stearate may be added, if necessary.

Claim

1. A directly compressible powder as hereinbefore defined, which is produced by wet granulation and comprises a carbohydrate and an enzyme.

8. A powder according to any one of the preceding claims, wherein the carbohydrate is a starch, or the carbohydrate is a sugar, or the carbohydrate is a sugar alcohol, or the carbohydrate is a mixture of a sugar and a sugar alcohol, or the carbohydrate is a mixture of a starch and a sugar and/or a sugar alcohol.

18. A powder according to claim 16 or 17, wherein the enzyme is an enzyme useful for the preparation of food and feed, a medicinal enzyme, an enzyme useful for digestive aids or an enzyme useful for technical applications.

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(54) Title: COMPRESSIBLE ENZYME POWDER

(57) Abstract

This invention relates to a directly compressible enzyme powder produced by mixing a liquid enzyme preparation with a suitable carrier, using the principle of wet granulation, whereby the step of freeze-drying and spray-drying is avoided. The resulting enzyme powder has extraordinary good compression qualities and may directly be tabletted.

COMPRESSIBLE ENZYME POWDER

FIELD OF INVENTION

This invention relates to a directly compressible enzyme powder useful for producing enzyme-containing tablets. It also relates to a process for the preparation of such a powder and to a tablet prepared from such a powder.

BACKGROUND OF THE INVENTION

In the art of tablet technology tablets are often made from a spray-dried powder containing an active component which after spray-drying and prior to tableting is mixed with one or more components (for example flow-aids) needed for tableting to take place. Flow-aids are added in order to make the powder for tableting free-flowing. Free-flowing means that the powder may be poured through a hopper without caking or sticking to the side walls. An example of a typical flow-aid is fumed silicon dioxide.

By using this traditional method the spray-dried powder is normally very dusty and difficult to handle, so there are safety problems by handling them if the active component has an allergy potential. Often this very dusty powder also has to be handled in more than one operation: First the spray-dried powder is mixed with flow-aids as described above, and then a granulation may be needed in order to give the powder the right strength for tableting.

To overcome these difficulties much effort has been put into developing directly compressible powders which are non-dusting and free-flowing, for instance by spray-drying an emulsion containing a vitamin, a carbohydrate and a gelatin (see US 4,892,889).

Tablets containing enzymes such as amylases, proteases, lipases, invertases, papain, trypsin, pepsin, pancreatin, etc. have been described long ago (see for instance US

3 515 642). They are made by the conventional methods of
converting a freeze-dried or spray-dried powder into tablets.

SUMMARY OF THE INVENTION

In accordance with this invention, it has
5 surprisingly been found that a directly compressible enzyme
powder may be produced by mixing a liquid enzyme preparation
with a suitable carrier, using the principle of wet
granulation, whereby the step of freeze-drying and spray-drying
is avoided. The resulting enzyme powder has extraordinary good
10 compression qualities and may directly be tabletted.

Accordingly, in a first aspect the present invention
relates to a directly compressible powder, which comprises a
carbohydrate and an enzyme. In a second aspect the invention
relates to a process for the preparation of such a powder and
15 to a tablet prepared from such a powder.

DETAILED DISCLOSURE OF THE INVENTION

Directly Compressible Powders

According to this invention the directly compressible
powder comprises a carrier of carbohydrate(s) and one or more
20 enzymes.

In the present context a directly compressible powder
is a powder which may be directly tabletted without adding any
excipients except possibly a lubricant. This means that no
flow-aids and binders are added before tableting, but a
25 lubricant such as stearic acid, hydrogenated vegetable oil or
Mg stearate may be added, if necessary.

In order to make the powder directly compressible the
demands made on the carrier are quite large: It has to be a
material with plastic properties (so that the resulting tablet
30 does not fall apart before use), on the other hand, when the
tablet is used the carrier must be able to absorb liquid and
make the tablet disintegrate. Moreover, as the powder is
directly compressible, the powder should be free-flowing, which

means that no flow-aids need to be added before tableting. Lastly, as the resulting tablet may be ingested by humans, the carrier should preferably be non-toxic.

In order to make the powder directly compressible the water content of the powder may be of at the most 10%(w/w), preferably in the range of 3-5%(w/w), and the particles of the powder may be in the range from 50 to 1500 μm , preferably in the range from 125 to 1000 μm , more preferably in the range from 150 to 700 μm .

Some carbohydrates or mixtures of carbohydrates possess the above mentioned properties of workable carriers. It has especially been found that starch, sugar and sugar alcohols or any mixtures thereof may give very good carriers. For instance, the starch may be maize starch, potato starch, rice starch, wheat starch, in fact any starch of vegetable origin. The sugar may be any mono-, di- or oligosaccharide, e.g. sucrose, maltose, lactose, galactose, fructose or glucose. The sugar alcohol may be any alcohol of a mono-, di- or trisaccharide, e.g. sorbitol, mannitol or xylitol. All these carbohydrates are available from normal commercial sources.

It has been found that a superior carrier consists of a mixture of maize starch and sorbitol. The maize starch is preferably present in an amount of 65-90%(w/w), while the sorbitol is preferably present in an amount of 10-35%(w/w), more preferably the maize starch is present in an amount of 75%(w/w) and the sorbitol in an amount of 25%(w/w).

Enzymes

According to the invention, the enzyme could be any enzyme, e.g. one which may be used in the preparation of food and feed, a medicinal enzyme, an enzyme used for digestive aids, an enzyme useful for technical applications or any application where a precise and safe dosage of an enzyme is needed or desirable. The enzyme may be chosen from oxidoreductases such as peroxidases and glucoseoxidases, hydrolases such as carbohydrases (e.g. amylases, hemicellulases, cellulases, inulinases, lactases and galactosidases), proteases

(e.g. serin proteases and aspartic proteases), lipases and phytases, isomerases such as glucose isomerases or any mixture thereof. The enzyme may be of microbial, plant or animal origin. The enzyme may be a recombinant enzyme or an enzyme recovered from its natural source.

The enzyme is added to the carrier as a liquid enzyme preparation. The liquid enzyme preparation may be an enzyme concentrate. An enzyme concentrate is produced by removing the production strain from the fermentation broth, for example by filtration or centrifugation, whereafter the liquid is concentrated to the desired enzyme strength, for example by ultrafiltration or by evaporation. The enzyme concentrate may be stabilized by preservatives such as sorbate or benzoate and/or by stabilizers such as polyols (e.g. propylene glycol), boric acid, salts, sugar (e.g. glucose and sucrose) or sugar alcohols (e.g. sorbitol) or carbohydrates of low molecular weight. pH may be adjusted and stabilized, for instance with buffer salts such as salts from organic acids, e.g. sodium citrate and sodium lactate.

It has been found that α -galactosidase concentrate derivable from Aspergillus, in particular from A. niger or A. aculeatus (having an enzyme activity of 250-100000 GALU/g, preferably an activity of 1000-25000 GALU/g, more preferably an activity of 2000-5000 GALU/g) is a very suitable enzyme concentrate.

1 GALU is the unit of α -galactosidase strength. It is defined as the amount of α -galactosidase required to form 1 μ mole of p-nitro phenol + galactose from p-nitrophenyl α -D-galactopyranoside in one minute under standard conditions of pH 5.5 at 37°C. The procedure is further described below.

It has also been found that lactase concentrate (having an enzyme activity of 250-100000 LAU/g, preferably 1000-25000 LAU/g, more preferably an activity of 2000-8000 LAU/g) is a very suitable enzyme concentrate.

1 LAU is the unit of lactase strength. It is defined as the amount of lactase required to release 1 μ mole of glucose per minute from a solution of 4.75% w/v lactose in M-buffer pH

6.5 at 37°C. M-buffer is a special buffer designed to give the same major mineral concentrations as found naturally in cow's milk. M-buffer contains:

Na ₃ citrate X 2H ₂ O:	2.70 mMoles/litre
5 Citric acid X 2H ₂ O:	7.91 mMoles/litre
K ₂ SO ₄ :	1.03 mMoles/litre
K ₂ HPO ₄ :	2.99 mMoles/litre
KH ₂ PO ₄ :	10.80 mMoles/litre
KOH:	19.43 mMoles/litre
10 MgCl ₂ X 6H ₂ O:	4.08 mMoles/litre
CaCl ₂ X 2H ₂ O:	5.10 mMoles/litre
4 N NaOH solution:	10.00 mMoles/litre
NaHCO ₃ :	3.33 mMoles/litre.

Granulation

15 In the process of the invention the powder may be made in accordance with well-known procedures of making wet granulation, for instance by using a convective mixer, preferably a high shear mixer, more preferably a high shear, high speed mixer, followed by fluid bed drying, optionally followed
20 by a sieving. According to the invention it is preferred to use a high shear, high speed mixer of the trade mark "Fielder", "Lödige", "Diosna" or "Rowenta". High shear, high speed mixers from "Fielder", "Lödige" and "Diosna" are well known. A "Rowenta" consists of a sphere-shaped granulation chamber in which
25 the carrier is mixed by means of a fast rotating knife, and the liquid enzyme preparation is poured into the unit from the top. The mixing is continued until the carrier is evenly wetted and a proper granulate has been formed. Accordingly, it will be understood that the term "powder" is also intended to include
30 granulates. In accordance with this invention the directly compressible powder may contain no lubricants, or a lubricant may be added to the carbohydrate(s) before granulation (preferred), or a lubricant may be added during the granulation, or a lubricant may be added at a separate mixing after the
35 granulation and before the tableting. The lubricant may be

added in an amount of at the most 20%(w/w), preferably in an amount of 0.25-10%(w/w).

According to the invention it is preferred to make a wet granulation consisting of a liquid enzyme preparation and a carrier, but the wet granulation may also consist of a carrier mixed with a spray-dried or freeze-dried enzyme powder whereto a liquid is added. The great disadvantage by using a spray-dried or freeze-dried enzyme powder is the dust problem described above.

10 In order to make a non-dusty powder the size of the particles is preferably at least 50 μm . On the other hand, they may also be too large to be directly compressible. It has been found that the particles of the powder may be in the range from 50-1500 μm , preferably in the range from 125-1000 μm , more
15 preferably in the range from 150-700 μm .

It is important that the powder has the right water content in order to make it directly compressible. The water content is measured by loss on drying. A water content of at the most 10%(w/w), preferably a water content of 3-5%(w/w), may
20 be accomplished by using any method known in the art, an example of which is conventional fluid-bed drying. The temperature of the fluid-bed should be adjusted to a level which does not deactivate the enzyme(s).

After fluid-bed drying the powder may be sieved,
25 whereafter it is ready for tabletting.

Potential Applications

The directly compressible enzyme powder described in this invention may be used in all circumstances where a precise and safe dosage of an enzyme is needed or desired, for instance
30 in dairies where a milk clotting enzyme may be added as tablets, or in the digestive aid industry for various digestive enzyme tablets, or in technical applications, for instance for washing, dish-washing and denim-washing purposes.

In particular for use as digestive aids, the tablets
35 may be provided with an enteric coating to protect the enzyme(s) from degradation by gastric fluid. Examples of suitable

enteric coating agents are cellulose acetate phthalate (CAP, Cellacephate®), vinyl acetate crotonic acid copolymer (Luviset®), methacrylic acid, (meth)acrylic acid ester copolymer (Eudragit®) or hydroxypropyl methylcellulose phthalate. For a further description of enteric coatings and coating processes, reference is made to WO 87/07292.

Manual Method For Determination of α -Galactosidase Activity

Reagents:

1. BUFFER: Acetate buffer 0.05 M, pH 5.5

10 A: 11.55 ml of glacial acetic acid p.a. are dissolved in demineralized water. Make up to 1000 ml.

 B: Dissolve 16.4 g of sodium acetate, p.a. in demineralized water and make up to 1000 ml.

 Buffer: Mix 7.5 ml of A and 42.5 ml of B and make up
15 to 200 ml with demineralized water.

 Max. advisable storage time: 1 month at 25°C.

2. SUBSTRATE: 1.2 mM p-Nitrophenyl- α -D-galactopyranoside

 Dissolve 0.0383 g of p-Nitrophenyl- α -D-galactopyranoside $\cdot$ 1 H₂O (Pierce N-0877) in acetate buffer 0.05 M and
20 make up to 100 ml.

 Max. advisable storage time: 1 week at 4°C.

3. STOP REAGENT: Borax - NaOH buffer 0.0625 M, pH 9.7

 Dissolve 47.63 g of Na₂B₄O₇ $\cdot$ 10 H₂O in 500 ml of slightly heated demineralized water. Cool and transfer to a
25 2000 ml volumetric flask. Add demineralized water to approximate 1500 ml. Add 20 ml of 4 N NaOH. Adjust pH to 9.7 with 4 N NaOH and make up to the 200 ml mark with demineralized water.

 Max. advisable storage time: 2 months at 25°C.

4. COLOUR STANDARD: 4-Nitrophenol, 240 μ M

A: Dissolve 0.0334 g of 4-Nitrophenol (Merck 820896) in demineralized water. Make up to 1000 ml. 4 Nitrophenol should be handled in a well-ventilated room.

5 Make a standard curve as follows:

- I 240 μ M: A used undiluted
- II 160 μ M: 100 ml of A + 50 ml of demineralized water
- III 80 μ M: 50 ml of A + 100 ml of demineralized water
- IV 40 μ M: 25 ml of A + 125 ml of demineralized water

10 Max. advisable storage time: 1 month at 25°C.

Procedure:Colour Standard

Make the colour standard values by mixing 2 ml of substrate and 1 ml of colour standard. Add 5 ml stop reagent.

15 When making the colour standard blank use demineralized water instead of colour standard. Measure OD₄₀₅.

Make standard and standard blank at room temperature.

Sample

Weigh and dilute the enzyme to a concentration
20 corresponding to an activity of about 0.0015 GALU/ml.

	Sample	Sample blank
	1 ml	1 ml
	37°C	
5	Add substrate (stop watch) and mix	
	37°C	room temp.
10	Add stop reagent and mix	5 ml
		2 ml
	Measure OD ₄₀₅ within 30 minutes*	

15 *OD measurements should be finished within 30 minutes due to the risk of OD-change.

Calculation of Activity:

Make the colour standard curve (ΔOD against concentration). The activity is calculated according to the
20 following formula:

$$\text{Act} = \frac{(A_s - A_b) \cdot F_s \cdot 10^{-3}}{T \cdot M}$$

where

- 25 A_s = The reading on the standard curve in μM 4-NP, corresponding to OD₄₀₅ for the sample.
- A_b = The reading on the standard curve in μM 4-NP, corresponding to OD₄₀₅ for the sample blank.
- F_s = Dilution factor for the sample.
- 30 T = Reaction time in minutes (= 15).
- M = Amount of sample weighed out.
- 10^{-3} = Conversion factor 1/ml.

The invention is further illustrated in the following examples which are not intended to be in any way limiting to the scope of the invention as claimed.

EXAMPLE 1

5 α -Galactosidase Powder(1)

α -Galactosidase Concentrate

α -galactosidase 1550 GALU/g

20%(w/w) sorbitol

2%(w/w) NaCl

10 3%(w/w) sodium citrate

0.2%(w/w) potassium sorbate

pH of the α -galactosidase concentrate was 6.0. The portion of dry matter was approximately 50%.

Wet Granulation

15 A powder consisting of

45 g of α -galactosidase concentrate (see above)

133 g of maize starch (CERESTAR, GLOBE 03302)

43 g of sorbitol (ROQUETTE FRERES, NEOSORB 60)

was made in a Rowenta-mixer (MULTIMIXER KA-70). This powder was
20 dried in a fluid-bed for 20 min. at 60°C. (the temperature of the product was max. 40°C).

The dried granulate was sieved through a sieve with a mesh size of 0.7 mm.

The dried and sieved granulate was tabletted without
25 adding any other components. The tablets had a hardness of 11-12 kp. The disintegration time of the tablets was measured to approximately 5 min. in water at 37°C (Ph. Eur.). Tablet weight was 430 mg. The punches used were 10.5 mm diameter), normal concave.

30 EXAMPLE 2

α -Galactosidase Powder (2)

α -Galactosidase Concentrate

The same as described in Example 1.

Wet Granulation

A powder consisting of

- 5 45 g of α -galactosidase concentrate (see Ex. 1)
 125 g of maize starch (see Ex. 1)
 60 g of sorbitol (see Ex. 1)
was made in a Rowenta-mixer (see Ex. 1)

This powder was dried in a fluid-bed for 20 min. at
10 60°C (the temperature of the product was max. 40°C).

The dried granulate was sieved through a sieve with
a mesh size of 0.7 mm.

1% Mg stearate was added to the dried and sieved
granulate before tableting. The resulting tablets had a
15 hardness of 9-10 kp. The disintegration time of the tablets was
measured to approximately 6 min. in water at 37°C (Ph.Eur.).
Tablet weight was 430 mg. The punches were 10.5 mm (diameter),
normal concave.

EXAMPLE 3**20 α -Galactosidase Powder (3)** α -Galactosidase Concentrate

α -galactosidase 3000 GALU/g
pH. of the α -galactosidase-concentrate was 5.0. The portion of
dry matter was approximately 48%.

25 Wet Granulation

A powder consisting of

- 45 g of α -galactosidase (described above)
 133 g of maize starch (see ex.1)
 43 g of sorbitol (see Ex. 1)
30 was made in a Rowenta-mixer (see Ex. 1).

This powder was dried in a fluid-bed for 20 min. at
60°C (the temperature of the product was max. 40°C).

The dried granulate was sieved through a sieve with a mesh size of 0.7 mm.

0.5% Mg stearate was added to the dried and sieved granulate before tabletting. The resulting tablets had a hardness of 3.5 kp. The disintegration time of the tablets was measured to < 10 min. in water at 37°C (Ph.Eur.). Tablet weight was 251 mg. The punches used were 8.0 mm (diameter), normal concave.

EXAMPLE 4

10 α -Galactosidase Powder (4)

α -Galactosidase Concentrate

α -Galactosidase 3930 GALU/g

pH of the concentrate was 5.0. The dry matter content approximately 48%.

15 Wet Granulation

A powder consisting of

24.7 g of α -Galactosidase (described above)

126.0 g of maize starch (see Ex. 1)

50.0 g of sucrose powder (DDS, Flor)

20 10.0 g of hydrogenated vegetable oil

(Edward Mendell, Lubritab)

was made in a Rowenta-mixer (see Ex. 1).

The powder was dried in a fluid-bed for 20 min. at 60°C (the temperature of the product was max. 40°C). The dried granulate was sieved through a sieve with a mesh size of 0.7 mm.

The sieved granulate was compressed into tablets in an excenter tabletting machine. The resulting tablets had a hardness of approx. 6 kp and the disintegration time was measured to less than 10 min. in water at 37°C (Ph.Eur.). Tablet weight was 333 mg. The punches used were 9.5 mm (diameter), normal concave.

EXAMPLE 5 **α -Galactosidase Powder (5)** α -Galactosidase Concentrate

α -Galactosidase 3930 GALU/g

5 pH of the concentrate was 5.0. The dry matter content approximately 48%.

Wet Granulation

A powder consisting of

- 24.7 g of α -Galactosidase (described above)
- 10 126.0 g of maize starch (see Ex. 1)
- 50.0 g of sorbitol (see Ex. 1)
- 10.0 g of hydrogenated vegetable oil
- (Edward Mendell, Lubritab)

was made in a Rowenta-mixer (see Ex. 1)

- 15 The powder was dried in a fluid-bed for 20 min. at 60°C (the temperature of the product was max. 40°C). The dried granulate was sieved through a sieve with a mesh size of 0.7 mm.

The sieved granulate was compressed into tablets in
20 an excenter tabletting machine. The resulting tablets had a hardness of approx. 6 kp, and the disintegration time was measured to less than 10 min. in water at 37°C (Ph.Eur.). Tablet weight was 333 mg. The punches used were 9.5 mm (diameter), normal concave.

25 EXAMPLE 6 **α -Galactosidase Powder (6)** α -Galactosidase Concentrate

α -Galactosidase 3930 GALU/g

pH of the concentrate was 5.0. The dry matter content approximately 48%.

30

Wet Granulation

A powder consisting of

- 24.7 g of α -Galactosidase (described above)
- 126.0 g of maize starch (see Ex. 1)
- 5 50.0 g of mannitol (Roquette Freres, Standard)
- 10.0 g of hydrogenated vegetable oil
(Edward Mendell, Lubritab)

was made in a Rowenta-mixer (see Ex. 1).

The powder was dried in a fluid-bed for 20 min. at
10 60°C (the temperature of the product was max. 40°C). The dried
granulate was sieved through a sieve with a mesh size of 0.7
mm.

The sieved granulate was compressed into tablets in
an excenter tableting machine. The resulting tablets had a
15 hardness of approx. 2 kp, and the disintegration time was
measured to less than 10 min. in water at 37°C (Ph.Eur.).
Tablet weight was 333 mg. The punches used were 9.5 mm (diam-
eter), normal concave.

EXAMPLE 7**20 α -Galactosidase Powder (7)** α -Galactosidase Concentrate

α -Galactosidase 3930 GALU/kg

pH of the concentrate was 5.0. The dry matter content approxi-
mately 48%.

25 Wet Granulation

A powder consisting of

- 24.7 g of α -Galactosidase (described above)
- 108.0 g of maize starch (see Ex. 1)
- 25.0 g of mannitol (see Ex. 6)
- 30 43.0 g of sorbitol (see Ex. 1)
- 10.0 g of hydrogenated vegetable oil
(Edward Mendell, Lubritab)

was made in a Rowenta-mixer (see Ex. 1).

The powder was dried in a fluid-bed for 20 min. at 60°C (the temperature of the product was max 40°C). The dried granulate was sieved through a sieve with a mesh size of 0.7 mm.

5 The sieved granulate was compressed into tablets in an excenter tableting machine. The resulting tablets had a hardness of approx. 5 kp, and the disintegration time was measured to less than 10 min. in water at 37°C (Ph.Eur.). Tablet weight was 333 mg. The punches used were 9.5 mm (diam-

10 eter), normal concave.

EXAMPLE 8

Lactase Powder (1)

Lactase Concentrate

15 Lactase 6400 LAU/g
 32% (w/w) sorbitol
 0.2% (w/w) Potassium sorbate

pH of the concentrate was 5.4. The portion of dry matter was approximately 50%.

Wet Granulation

20 A powder consisting of

50.0 g of Lactase Concentrate (described above)
126.0 g maize starch (see Ex. 1)
50.0 g of sucrose powder (see Ex. 4)
10.0 g of hydrogenated vegetable oil

25 (Edward Mendell, Lubritab)

was made in a Rowenta-mixer (see Ex. 1).

The powder was dried in a fluid-bed for 20 min. at 60°C (the temperature of the product was max. 40°C). The dried granulate was sieved through a sieve with a mesh size of 0.75 mm.

The sieved granulate was compressed into tablets in an excenter tabletting machine. The resulting tablets had a hardness of approx. 6-8 kp, and the disintegration time was

measured to less than 10 min. in water at 37°C (Ph.Eur.). Tablet weight was 333 mg. The punches used were 9.5 mm (diameter), normal concave.

EXAMPLE 9

5 Lactase Powder (2)

Lactase Concentrate

Lactase 4500 LAU/g

The dry matter was approximately 52%.

Wet Granulation

10 A powder consisting of

50.0 g of Lactase Concentrate (described above)

126.0 g of maize starch (see Ex. 1)

50.0 g of sucrose powder (see Ex. 4)

10.0 g of hydrogenated vegetable oil

15 (Edward Mendell, Lubritab)

was made in a Rowenta-mixer (see Ex. 1)

The powder was dried in a fluid-bed for 20 min. at 60°C (the temperature of the product was max. 40°C). The dried granulate was sieved through a sieve with a mesh size of 0.7
20 mm.

The sieved granulate was compressed into tablets in an excenter tableting machine. The resulting tablets had a hardness of approx. 6-8 kp, and the disintegration time was measured to less than 10 min. in water at 37°C (Ph.Eur.).
25 Tablet weight was 400 mg. The punches used were 9.5 mm (diameter), normal concave.

The claims defining the invention are as follows:

1. A directly compressible powder as hereinbefore defined, which is produced by wet granulation and comprises a carbohydrate and an enzyme.
2. A powder according to claim 1, wherein the powder is free-flowing.
- 5 3. A powder according to claims 1 or 2, in which the particles of the powder are in the range of from 50 to 1500 μ m.
4. A powder according to claim 3, in which the particles of powder are in the range of from 125 to 1000 μ m.
5. A powder according to claim 4, in which the particles of powder are in the
10 range of from 150 to 700 μ m.
6. A powder according to any one of claims 1 to 5, characterised by having a water content of at the most 10% (w/w) measured by loss on drying.
7. A powder according to claim 6, characterised by having a water content in the range of 3-5% (w/w).
- 15 8. A powder according to any one of the preceding claims, wherein the carbohydrate is a starch, or the carbohydrate is a sugar, or the carbohydrate is a sugar alcohol, or the carbohydrate is a mixture of a sugar and a sugar alcohol, or the carbohydrate is a mixture of a starch and a sugar and/or a sugar alcohol.
9. A powder according to claim 8, wherein the starch is of vegetable origin.
- 20 10. A powder according to claim 8 or claim 9, wherein the starch is maize starch, potato starch, rice starch or wheat starch.
11. A powder according to claim 10, wherein the starch is maize starch.
12. A powder according to any one of claims 8 to 11, wherein the sugar is a mono-, di- or oligosaccharide, and the sugar alcohol is an alcohol of a mono-, di- or
25 trisaccharide.
13. A powder according to claim 12, wherein the sugar is sucrose, maltose, lactose, galactose, fructose or glucose, and the sugar alcohol is sorbitol, mannitol or xylitol.
14. A powder according to claim 13, wherein the sugar alcohol is sorbitol.
- 30 15. A powder according to any one of claims 8 to 14, wherein the carbohydrate is a mixture of 65-90% (w/w) maize starch and 10-35% (w/w) sorbitol.
16. A powder according to any one of claims 1 to 15, wherein the enzyme is a microbial enzyme or an enzyme of animal or plant origin.
17. A powder according to claim 16, wherein the enzyme is a mixture of two or
35 more enzymes.
18. A powder according to claim 16 or 17, wherein the enzyme is an enzyme useful for the preparation of food and feed, a medicinal enzyme, an enzyme useful for digestive aids or an enzyme useful for technical applications.
19. A powder according to any one of claims 16 to 18, wherein the enzyme is an
40 oxido-reductase, a hydrolase, an isomerase or any mixture thereof.



20. A powder according to any one of claims 16 to 19, wherein the enzyme is an α -galactosidase.

21. A powder according to claim 20, wherein the enzyme is an α -galactosidase derivable from *Aspergillus*, in particular from *A. niger* or *A. aculeatus*.

5 22. A powder according to claim 20 or 21, wherein the α -galactosidase has an activity of 50-20000 GALU/g, preferably an activity of 200-5000 GALU/g, more preferably an activity of 400-1000 GALU/g.

23. A process for producing a powder according to any one of claims 1 to 22, comprising mixing a liquid enzyme preparation with a carbohydrate in a convective
10 mixer, subjecting the resulting mixture to drying and optional sieving so as to obtain a powder having a particle size in the range of from 50 to 1500 μ m.

24. A process according to claim 23, wherein the particle size of the powder obtained is in the range of from 125 to 1000 μ m.

25. A process according to claim 23 wherein the particle size of the powder
15 obtained is in the range of from 150 to 700 μ m.

26. A process according to claim 23, wherein the convective mixer is a high shear mixer.

27. A process according to claim 26, wherein the mixer is a high shear, high speed mixer.

20 28. A process according to any one of claims 23 to 27, wherein the carbohydrate is a starch, or the carbohydrate is a sugar, or the carbohydrate is a sugar alcohol, or the carbohydrate is a mixture of a sugar and a sugar alcohol, or the carbohydrate is a mixture of a starch and a sugar and/or a sugar alcohol.

29. A process according to claim 28, wherein the starch is of vegetable origin.

25 30. A process according to claim 28 or claim 29, wherein the starch is maize starch, potato starch, rice starch or wheat starch.

31. A process according to claim 30, wherein the starch is maize starch.

32. A process according to any one of claims 28 to 31, wherein the said sugar is a mono-, di- or oligosaccharide, and the said sugar alcohol is an alcohol of a mono-, di- or
30 trisaccharide.

33. A powder according to claim 32, wherein the sugar is sucrose, maltose, lactose, galactose, fructose or glucose, and the sugar alcohol is sorbitol, mannitol or xylitol.

34. A process according to claim 33, wherein the sugar alcohol is sorbitol.

35 35. A process according to any one of claims 23 to 34, wherein the carbohydrate is a mixture of 65-90% (w/w) maize starch and 10-35% (w/w) sorbitol.

36. A process according to any one of claims 23 to 35, wherein the enzyme is a microbial enzyme or an enzyme of animal or plant origin.

37. A process according to claim 36, wherein the enzyme is a mixture of two or
40 more enzymes.



38. A process according to claim 36 or claim 37, wherein the enzyme is an enzyme useful for the preparation of food and feed, a medicinal enzyme, an enzyme useful for digestive aids or an enzyme useful for technical applications.

39. A process according to any one of claims 36 to 38, wherein the enzyme is an
5 oxidoreductase, a hydrolase, an isomerase or any mixture thereof.

40. A process according to any one of claims 36 to 38, wherein the enzyme is an α -galactosidase.

41. A process according to claim 40, wherein the enzyme is an α -galactosidase derivable from *Aspergillus*, in particular from *A. niger* or *A. aculeatus*.

10 42. A process according to claim 40 or 41, wherein the liquid α -galactosidase preparation has an activity of 250-100000 GALU/g.

43. A process according to claim 41, wherein the α -galactosidase preparation has an activity of from 1000 to 2500 GALU/g.

44. A process according to claim 41, wherein the α -galactosidase preparation has
15 an activity of from 2000 to 5000 GALU/g.

45. A process according to any one of claims 23 to 44, wherein the carbohydrate is a mixture of maize starch and sorbitol, and the enzyme is a liquid α -galactosidase preparation.

46. A directly compressible powder as hereinbefore defined, substantially as
20 hereinbefore described with reference to any one of the Examples.

47. A tablet prepared from the powder according to any one of claims 1 to 22 or
46.

48. A process of preparing an enzyme-containing tablet comprising mixing a liquid enzyme preparation with one or more carbohydrate(s), subjecting the resulting
25 mixture to drying and optional sieving so as to obtain a powder having a particle size in the range from 50 to 1500 μ m and subjecting the resulting powder directly to tableting.

49. The process of claim 48, wherein the particle size of the powder obtained is in the range of from 125 to 1000 μ m.

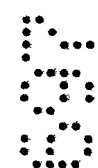
50. The process of claim 48, wherein the particle size of the powder obtained is
30 in the range of from 150 to 700 μ m.

51. A process according to any one of claims 48 to 50, wherein a lubricant in an amount of at the most 20% (w/w) is added to the carbohydrate(s) before mixing with the liquid enzyme preparation.

52. The process according to claim 51, wherein the amount of lubricant added to
35 the carbohydrate(s) is 0.25-10% (w/w).

53. A process according to any one of claims 48 to 52, wherein a lubricant in an amount of at the most 20% (w/w) is added during mixing.

54. The process according to claim 53, wherein the amount of lubricant adding during mixing is from 0.25 to 10% (w/w).



55. A process according to any one of claims 48 to 54, wherein a lubricant in an amount of at the most 20% (w/w) is added after mixing, drying and sieving.

56. The process according to claim 55, wherein the amount of lubricant added after mixing, drying and sieving is 0.25 to 10% (w/w).

5 57. A directly compressible powder, substantially as hereinbefore described with reference to any one of the Examples.

58. A process of preparing an enzyme-containing tablet, substantially as hereinbefore described with reference to any one of the Examples.

59. A process for producing a powder, substantially as hereinbefore described
10 with reference to any one of the Examples.

60. Powder produced by the process of any one of claims 23 to 45 or 59.

61. An enzyme-containing tablet prepared by the process according to any one of claims 48 to 57.

Dated 6 June, 1997

Novo Nordisk A/S

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 94/00237

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: A61K 9/16, C11D 3/386, A23K 1/165, A23L 1/30
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: C12N, A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, WPIL CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Dialog Information Services, file 351, DERWENT WPI, Dialog accession no. 008934442/7, WPI accession no. 92-061711/08, (AMAN) AMANO PHARM KK: "Easily breakable tablet prepn. useful as detergent - by adding water-sol. binder and wetting agent to enzyme, mixed and then incor- porating breaking agent and lubricant to granule", & JP 4008288 A 920113 9208 (Basic)	1-42
	--	
X	DE, A, 2140747 (E.I. DU PONT DE NEMOURS AND CO.), 17 February 1972 (17.02.72)	1-42
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *B* earlier document but published on or after the international filing date
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T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Z document member of the same patent family

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 94/00237

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Dialog Information Services, file 351, DERWENT WPI, Dialog accession no. 003941331/7, WPI accession no. 84-086875/14, (ANTI=) ANTIBIOTICS RES: "Prepn. of enzyme tablets by pressing uses casein, starch, lactose or soluble starch as stabiliser and drying by lyophilic or spray method", & SU 1024087 A 830623 8414 (Basic) --	1-16,38-42
X	Patent Abstracts of Japan, Vol 12, No 155, C-494, abstract of JP, A, 62-269685 (SHOWA DENKO K.K.), 24 November 1987 (24.11.87) -- -----	1-37

INTERNATIONAL SEARCH REPORT

Information on patent family members

27/08/94

International application No.

PCT/DK 94/00237

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		FR-A- 2104349	14/04/72
		GB-A- 1316522	09/05/73
		NL-A- 7111106	16/02/72
		SE-B, C- 395221	08/08/77
		US-A- 3721725	20/03/73
		US-A- 3928566	23/12/75
		US-A- 3932943	20/01/76