(19) DANMARK

(10) DK/EP 2830436 T3

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: *C 08 B 30/02 (2006.01)* *A 23 L 7/10 (2016.01)* *A 23 L 19/10 (2016.01)*
C 08 B 30/04 (2006.01)

(45) Oversættelsen bekendtgjort den: **2016-12-05**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2016-08-24**

(86) Europæisk ansøgning nr.: **13711885.7**

(86) Europæisk indleveringsdag: **2013-03-22**

(87) Den europæiske ansøgnings publiceringsdag: **2015-02-04**

(86) International ansøgning nr.: **EP2013056016**

(87) Internationalt publikationsnr.: **WO2013143986**

(30) Prioritet: **2012-03-26 DE 102012102588** **2012-07-06 DE 102012106074**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

(73) Patenthaver: **GEA Mechanical Equipment GmbH, Werner-Habig-Strasse 1, 59302 Oelde, Tyskland**

(72) Opfinder: **GOLDAU, Hans-Peter, Stettinerstrasse 6, 59329 Wadersloh, Tyskland**
TIMMER, Wim, Orionweg 2, NL-9641 MN Veendam, Holland

(74) Fuldmægtig i Danmark: **PATRADE A/S, Fredens Torv 3A, 8000 Århus C, Danmark**

(54) Benævnelse: **Fremgangsmåde til genvinding af stivelse fra stivelsesholdige planter, især fra kartoffelknolde eller kassavarødder eller bælgplanter**

(56) Fremdragne publikationer:
US-A- 4 416 701
F. MEUSER ET AL: "Einsatz der Hochdruckhomogenisierung zur Auflösung der Zellstruktur von Stärkekartoffeln", STARCH - STÄRKE, Bd. 36, Nr. 3, 1. Januar 1984 (1984-01-01) , Seiten 73-77, XP55080046, ISSN: 0038-9056, DOI: 10.1002/star.19840360302
JUSCELINO TOVAR ET AL: "Analytical and nutritional implications of limited enzymic availability of starch in cooked red kidney beans", JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY, Bd. 38, Nr. 2, 1. Februar 1990 (1990-02-01), Seiten 488-493, XP055080118, ISSN: 0021-8561, DOI: 10.1021/jf00092a034
MEUSER F ET AL: "YIELD OF STARCH AND BY-PRODUCTS IN THE PROCESSING OF DIFFERENT VARIETIES OF WRINKLED PEAS ON A PILOT SCALE", CEREAL CHEMISTRY, AACC INTERNATIONAL INC, US, Bd. 74, Nr. 4, 1. Januar 1997 (1997-01-01) , Seiten 364-370, XP001149013, ISSN: 0009-0352

The invention relates to a method for recovering starch from starchy plants, in particular from potato tuber or cassava roots or legumes.

Figure 2 discloses a method known per se for recovering starch, here from potatoes. It may be employed in a similar manner with cassava roots. The plant "cassava" is also known under the name "Manioc". The starch yield of this method is 95 - 97% by weight, based on the total amount of starch in a potato tuber. The residual fraction of starch remains bound to the plant components of the potato tubers or of the cassava roots and is not utilizable to date.

It is also known, for cell disruption, to place the cells, before a comminution, e.g. by grating, in a suitable apparatus for high-pressure generation under a high pressure such that disruption of a substantial part of the cells is effected (in particular of more than 50% of the cells). Such a procedure and/or such a "placing under high pressure" is termed subsequently in the context of this application also "high-pressure cell disruption". To date however, using such a high-pressure cell disruption before grating does not achieve a substantial increase in starch yield. Regarding prior art it is referred to the following article: F. Meuser et al: „Einsatz der Hochdruckhomogenisierung zur Auflösung der Zellstruktur von Stärkekartoffeln", STARCH – STÄRKE, Volume 36, No. 3, 1st January 1984 (1984-01-01), Pages 73-77, XP55080046, ISBN: 0038-9056, DOI: 10.1002/star. 19840360302.

It is therefore the object of the present invention to provide a method which effects an improvement in the starch yield, in particular also the recovery of starch from plant components which have only a low starch content.

The invention achieves this object by the features of claim 1.

The method according to the invention for recovering starch from starchy plants, in particular from potato tubers or cassava roots or legumes, has, according to the subject matter of claim 1, the following successive steps A) to D):

A) disruption, in particular by comminution, of the starchy plants with release of starch;

B) separation of the comminuted plants into a first starch-rich fraction (1) and, a relatively thereto, low-starch fiber fraction (2);

C) high-pressure treatment of the low-starch fiber fraction (2) for the high-pressure cell disruption with release of further starch;

D) separation of the low-starch fiber fraction treated by high pressure into a second starch-rich fraction and a second low-starch fiber fraction.

On account of the intermediate step "C" of the high-pressure cell disruption of the low-starch fiber fraction, further starch still bound to the plant components can be recovered. This leads to an improvement in the total starch yield of the process. Thus, in the experiment, a by 2 – 4% by weight compared with the conventional method was achieved using the steps A) and B). In comparison to a high-pressure cell disruption of the plants and/or plant parts directly before the first grating, it is surprisingly advantageous if the high-pressure cell disruption is first carried out with the fiber fraction which is already low-starch or lower-starch in comparison with the starting material (or with the low-starch fibrous fraction) and if this fraction is further separated into a second starch-rich fraction and a second low-starch fiber fraction.

It is advantageous if the high-pressure cell disruption is performed at a pressure of at least 10 bar, in particular at least 20 bar, particularly preferably at least 50 bar. The result generally continues to improve in each case with increasing pressure up to 200 bar.

As apparatuses for generating high pressure, homogenizers are particularly highly suitable.

However, other high-pressure generators are also suitable in principle such as, in particular, extruders with which a sufficiently high pressure can be generated for the high-pressure cell disruption.

Preferably, in a step E) following step D), further processing of the first or second starch-rich fraction to starch proceeds via measures which are known per se.

The first disruption by comminution of the starch-containing plants can be performed by grating with a grater. Via the grating, the cells of the plant are broken up and the starch is released. The separation of the comminuted plants in step A and/or of the first low-starch fiber fraction in step D, can be performed by separation, in particular sieving, for example by fixed sieves or by rotating sieves.

The first starch-rich fiber fraction can consist of starch milk or of starch milk and fine fibers.

According to one variant of the method according to the invention, the first low-starch fiber fraction is further or once more divided into low-starch and starch-rich fibers. Only the starch-rich fibers in this variant are subjected to the high-pressure disruption for releasing the starch. The advantage of this variant is that the capital costs are decreased and energy savings are achieved.

For separation of the fractions in step A and/or in step D, a multiple or multi-stage separation is advisable, in particular a multiple sieving. As a result, the required purity, depending on the dimension of the sieve and intensity of the separation, in particular sieving, can be set.

The further processing of the first and/or second starch-rich fiber fraction to starch can comprise one of the following steps – in particular in the following sequence:

D.1 starch washing;
D.2 starch dewatering; and/or
D.3 drying.

In this case it is particularly advantageous if the two starch-rich fiber fractions are combined for further processing, in order to minimize the expenditure on labor.

The subject matter of the invention will be described in more detail hereinafter with reference to drawings. In the drawings:

figure 1 shows a section of a method diagram;

figure 2 shows a method diagram of a previously known method for recovering starch from starch-rich plants;

figures 3, 4 diagrams relating to an experiment.

Figure 2 shows a diagram which describes a known method for recovering starch 11a. In this case, hereinafter the starch recovery from potato tubers will

be described in more detail. The method, however, is not restricted to potatoes, but may also be applied to starch recovery from other starchy plants, in particular to cassava roots, and to legumes (peas or beans, recovery of pea starch or bean starch).

Starting from an amount of harvested potatoes or cassava roots 1, first destoning and washing 2 proceeds in a washing and destoning facility, for example in a drum washing machine.

Subsequently thereto, the comminution of the potatoes or cassava roots proceeds. This can proceed via disintegration 3, using a comminutor or a grater, in particular an ultragrater. Depending on the amount of potatoes or cassava roots to be processed, ultragraters of the applicant with the name HRD, for example HRD 300, 400, 500 or 600 can be used. During the grating, the majority of cells are opened by the mechanical processing and the starch released into the water. During the grating 3, therefore, starch milk is formed and plant fibers.

In a grating of cassava roots, generally processed water is added.

In this manner, currently, via the ultragrating of the applicant, 95 – 97% by weight of the total content of starch in a potato tuber can be recovered. 3 – 5% by weight of starch correspondingly remains in the plant fibers.

After the grating of the potatoes or cassava roots, an optional desanding 4 can take place.

Subsequently – optionally after a centrifugal separation of fruit water, preferably in a decanter 16 – the plant fibers are separated by separation, in particular sieving, 5, from the starch milk. This corresponds to a separation of the comminuted plants into a first starch-rich fiber fraction and a low-starch fiber fraction, wherein the starch-rich fiber fraction in this case is the starch milk and the low-starch fiber fraction is the plant fibers.

Thereupon follows a dewatering 12 of the plant fibers which are subsequently discharged from the process as fiber pulp 13.

The starch milk, in contrast, is further processed after the step 5 to starch. This proceeds first by starch washing 6, wherein the starch milk is further puri-

fied. For this purpose, in addition, washing water 7 is supplied. After the washing of the starch milk, from the washing water, starch is recovered in a starch recovery 8, starch is returned to the unwashed starch milk before the starch washing 6. The washing water is subsequently removed from the process as process water 9.

The starch fraction of the starch recovery 8 can, however, also still contain finely distributed fibers. This fraction is removed by a fine fiber sieving.

The washed starch milk, subsequently to a starch dewatering 10, is freed from the predominant part of water. The water removed in this procedure is fed to the washing water 7 of the starch washing operation 6.

The dewatered starch is finally removed from residual water in a drying 11 and optionally packaged.

The method modification according to the invention depicted in figure 1 may be integrated into such a method.

Proceeding from the starting amount of potatoes or cassava roots, in a similar manner to the method in figure 1, destoning and washing 2 proceed, and also a comminution subsequently thereto, preferably by grating 3.

Subsequently to the grating, an optional desanding 4 can still proceed.

Preferably, again at 16 a fruit water separation can also proceed, in particular in the processing of potatoes.

Thereafter a separation, in particular by sieving, 5, proceeds, in which the grated potatoes or cassava roots are separated into a first starch-rich fiber fraction of starch milk A, and a first low-starch fiber fraction of plant fibers B.

This first low-starch fiber fraction of plant fibers B is then subjected to a high-pressure cell disruption 14. In this procedure, the plant fibers are fed to a high-pressure cell disruption.

It has been found that by this additional treatment step, the majority of the starch remaining in the plant fibers can be separated off. The yield can be increased thereby by an additional 2 – 4% by weight of the total content of

starch in a potato tuber or in cassava roots, in such a manner that starch can be up to 99% by weight recovered from the potato tuber.

The starch additionally recovered via the high-pressure cell disruption 14 can be further processed separately from the first starch-rich fiber fraction of starch milk A already separated off in the sieving operation. However, it is particularly advantageous if the starch recovered in the high-pressure cell disruption 14 is fed to the starch milk formed in the separation, in particular sieving, 5, in such a manner that no additional energy costs due to the separate processing of the additionally recovered starch can arise.

For this purpose, the starch can be separated from the second low-starch fiber fraction of plant fibers by separation – which is not shown here in more detail – in particular sieving, first as a second starch-rich fiber fraction.

Before the feed of the second starch-rich fiber fractions to the first starch-rich fiber fraction of starch milk A, a second separation, in particular sieving, 15, of the second starch-rich fiber fraction can proceed.

Optionally, the first starch-rich fiber fraction of starch milk A and the second starch-rich fiber fraction can also be combined as early as before or during the second separation, in particular sieving, in such a manner that the first fraction of starch milk is also subjected to the second separation, in particular sieving. In this manner, an improved purity of the first fraction of starch milk A can also be achieved, as a result of which the subsequent stage of the starch washing 6 can be operated with lower expenditure, in particular with a lower amount of washing water 7.

Preferably, the other process stages of the further process, as they are depicted in figure 1, follow the stage of starch washing 7.

Via the additional step of the high-pressure cell disruption 14, the method steps of figure 1 which are known per se can also be further optimized and modified in an advantageous manner. This is described in more detail hereinafter.

After the grating 3, the grated potatoes or cassava roots or the potato pulp or cassava pulp can be divided into a coarse fraction and a fine fraction by separation, in particular sieving 5. In this case the separation can proceed by sepa-

rating, in particular sieving by means of a stationary sieve, for example by a sieve belt or a rotary sieve. The separation, in particular sieving, 5, serves in particular, as already described above, for separating the fibers from the starch or starch milk.

It is also conceivable that by the separation, in particular sieving, 5, a low-starch first fraction of relatively coarse fibers is separated off from a starch-rich first fraction of relatively fine fibers and starch. The advantage of this procedure compared with the abovementioned complete separation of starch and fibers is that only the substantially smaller fraction of relatively coarse fibers is subjected to the subsequent high-pressure cell disruption 14, as a result of which it is possible to use a relatively small apparatus generating the high pressure.

In the high-pressure cell disruption 14, therefore, either the complete fiber fraction or the fraction of relatively coarse fibers is fed to the homogenizer.

Within the apparatus generating high pressure, in particular the homogenizer, the fiber material is preferably fed to a narrow gap at a pressure of preferably at least 20, in particular at least 50 to 150, preferably up to 150 bar. As a result of the high shear forces, at high pressure a cell disruption is achieved and starch is released from the fibers.

Subsequently the disrupted starch, after the high-pressure cell disruption, is separated from the pulp fraction by separation, in particular sieving, and combines in countercurrent with the remaining starch milk.

Hereinafter an experiment will be explained.

Fiber material from a European potato starch factory after the fourth stage of a multistage centrifugal sieve extraction (steps A and B) was further processed as low-starch fraction, in order to test the efficiency of steps C and D.

A sample of 1000 kg was used which contained 5% fiber material based on dry matter (dry solids).

The sample was diluted with tap water to 2% dry matter content concentration which is possibly advantageous before the homogenization.

The starch concentration in the fibers was approximately 22% (dry starch content of the total dry matter) and was present substantially as bound starch (17% and 5% free starch).

The diluted fiber material was pumped into a high-pressure homogenizer (GEA Niro Soavi type S3006 H-a). The pressure in the homogenizer was changed between 50 and 150 bar. The output/discharge of the homogenizer was passed into a container. The homogenized material was then pumped from the container through a vibratory sieve (Sweco type L 524), in order to separate off the coarse fibers from the starch by sieving.

Samples were taken which were studied using the microscope. The starch content was further studied using the ICCI168 method (method using enzymatic degradation).

The microscopic examination showed that the predominant fraction of starch had been dissolved from the fiber pulp. It was also found that the fibers retained a significant size of greater than 200 μm.

The results are shown in the table hereinafter: result: with the method described, in particular by using a homogenizer, the predominant fraction of starch grains in the fibers can be released and separated off.

It was also observed that the quality of the fibers remaining during starch recovery is very good and that they are usable as fiber addition for food, in particular food having a relatively low carbohydrate fraction (termed “low carbs”). The suitability of the starch-reduced fibers for water absorption is very good.

Homogenizer pressure (bar)	**Starch content (dry starch to dry fibers)**	
	Bound	**Free**
0	17%	6%
50	10%	12%
100	10%	13%
150	8%	14%

Finally, a further experiment may be explained with reference to figs. 3 and 4.

In this experiment, fiber material from a Polish potato starch factory was taken off after the third stage of a multistage centrifugal sieve extraction (steps A

and B) and was further processed as low-starch fraction in order to test the efficiency of steps C and D.

The fiber material mixed and diluted with water was first pumped into a high-pressure homogenizer (GEA Niro Soavi). The pressure in the homogenizer was set in the experiment to values between 50 and 250 bar (figs. 3, 4).

The aqueous starch pulp free from fibers (a sample of 20 g) was then diluted with 10 l of water and placed into a laboratory centrifuge (rpm: 1000) in order to separate off the starch in the centrifugal field, in order to be able to determine the fraction of free starch. The starch content was determined using the Evans method (fig. 3, bottom line “free starch”).

Material at the output/discharge of the homogenizer (100 g) was additionally diluted with 15 l of water and pumped through a sieve (100 μm sieve) in order to separate off the fibers. The material on the sieve was collected and dried for 24 h in an oven. In this manner the weight of the dry matter having a size of greater than 100 μm will be determined for 100 g (fig. 3, top line “material” > 100 μm).

Conjointly, before and after the homogenizer, samples were taken which were studied using the microscope.

Up to a pressure of 100 bar, the free starch fraction increases virtually linearly with the pressure. With further increasing pressure, the fraction of releasable starch generally no longer increases significantly.

The accompanying microscopic investigation showed that the predominant fraction of starch from the fiber pulp was dissolved, particularly advantageously at 100 bar pressure, in the homogenizer. It was found that the fibers substantially retained their size up to 100 bar, and that the size of the fibers decreased somewhat at still higher pressures. The fraction of releasable starch in the fibers was a maximum of 26% (fig. 4).

This experiment also shows that, using the method described, by high pressure, in particular by applying a homogenizer, the predominant fraction of starch grains in the fibers are released and separated off. In the starch factory, the yield and the fraction of recoverable starch from the plants that are to be processed can be increased in this manner.

Reference signs

1	Potatoes
2	Destoning and washing
3	Grating
4	Desanding
4a	Sand
5	Separation, in particular sieving
6	Starch washing
7	Washing water
8	Starch recovery
8a	Sieving
9	Process water
10	Starch dewatering
11	Drying
11a	Starch
12	Dewatering
13	Fiber pulp
14	High-pressure cell disruption
15	Separation, in particular sieving
16	Decanter
A	Starch milk
B	Plant fibers

Patentkrav

1. Fremgangsmåde til genvinding af stivelse (11a) fra stivelsesholdige planter, især fra kartoffelknolde eller kassavarødder eller bælgplanter, **kendetegnet ved** følgende trin:

A) opbrydning, især ved findeling, af de stivelsesholdige planter og frigørelse af stivelse,

B) separering af de findelte planter i en første stivelsesrig fraktion (1) og en i forhold dertil stivelsesfattig fiberfraktion (2),

C) højtryksbehandling af den stivelsesfattige fraktion (2) for højtrykscelle-opbrydning under frigørelse af yderligere stivelse,

D) separering af den stivelsesfattige fraktion ved højtryksbehandling i en anden stivelsesrig fraktion og en anden stivelsesfattig fraktion.

2. Fremgangsmåde ifølge krav 1, **kendetegnet ved, at** før findelingen af de stivelsesholdige planter under frigivelse af stivelse vaskes og udstenes (2) planterne.

3. Fremgangsmåde ifølge krav 1 eller 2, **kendetegnet ved, at** findelingen af de stivelsesholdige planter udføres ved rivning (3).

4. Fremgangsmåde ifølge ethvert af de foregående krav, **kendetegnet ved, at** separering af de findelte planter i trin A og/eller den første stivelsesfattige fiberfraktion i trin D udføres ved udskillelse, især sining (5).

5. Fremgangsmåde ifølge ethvert af de foregående krav, **kendetegnet ved, at** højtrykscelleopbrydningen udføres ved et tryk på mindst 10 bar, især mindst 20 bar, især fortrinsvis mindst 50 bar.

6. Fremgangsmåde ifølge ethvert af de foregående krav, **kendetegnet ved, at** højtrykscelleopbrydningen (14) udføres ved et tryk på maksimalt 150 bar, især maksimalt 250 bar.

7. Fremgangsmåde ifølge ethvert af de foregående krav, **kendetegnet ved, at** den første stivelsesrige fiberfraktion består af stivelsesmælk (A).

8. Fremgangsmåde ifølge ethvert af de foregående krav, **kendetegnet ved, at** den første stivelsesrige fiberfraktion består af stivelsesmælk (A) og fine fibre.

9. Fremgangsmåde ifølge ethvert af de foregående krav, **kendetegnet ved, at** separering af de findelte planter i trin A og/eller den første stivelsesfattige fiberfraktion i trin D udføres ved flerfoldig separation, især sining (5, 15).

10. Fremgangsmåde ifølge ethvert af de foregående krav, **kendetegnet ved, at** viderebehandling af den første og/eller anden stivelsesrige fiberfraktion til stivelse omfatter et eller flere følgende trin i denne rækkefølge:

D.1 stivelsesvask (6),

D.2 stivelsesafvanding (10), og/eller

D.3 tørring (11).

11. Fremgangsmåde ifølge krav 10, **kendetegnet ved, at** vaskevand (7) anvendes ved stivelsesvaskning (6), hvor vaskevandet (7) derefter underkastes stivelsesgenvinding (8).

12. Fremgangsmåde ifølge krav 10 eller 11, **kendetegnet ved, at** stivelsen, som er genvundet fra vaskevandet (7) underkastes sining (8a) på plantefibre.

13. Fremgangsmåde ifølge ethvert af de foregående krav, **kendetegnet ved, at** stivelsesudbyttet af fremgangsmåden er mindst 98 vægt-%, fortrinsvis 99 vægt-%, af det samlede stivelsesindhold i en kartoffelknold.

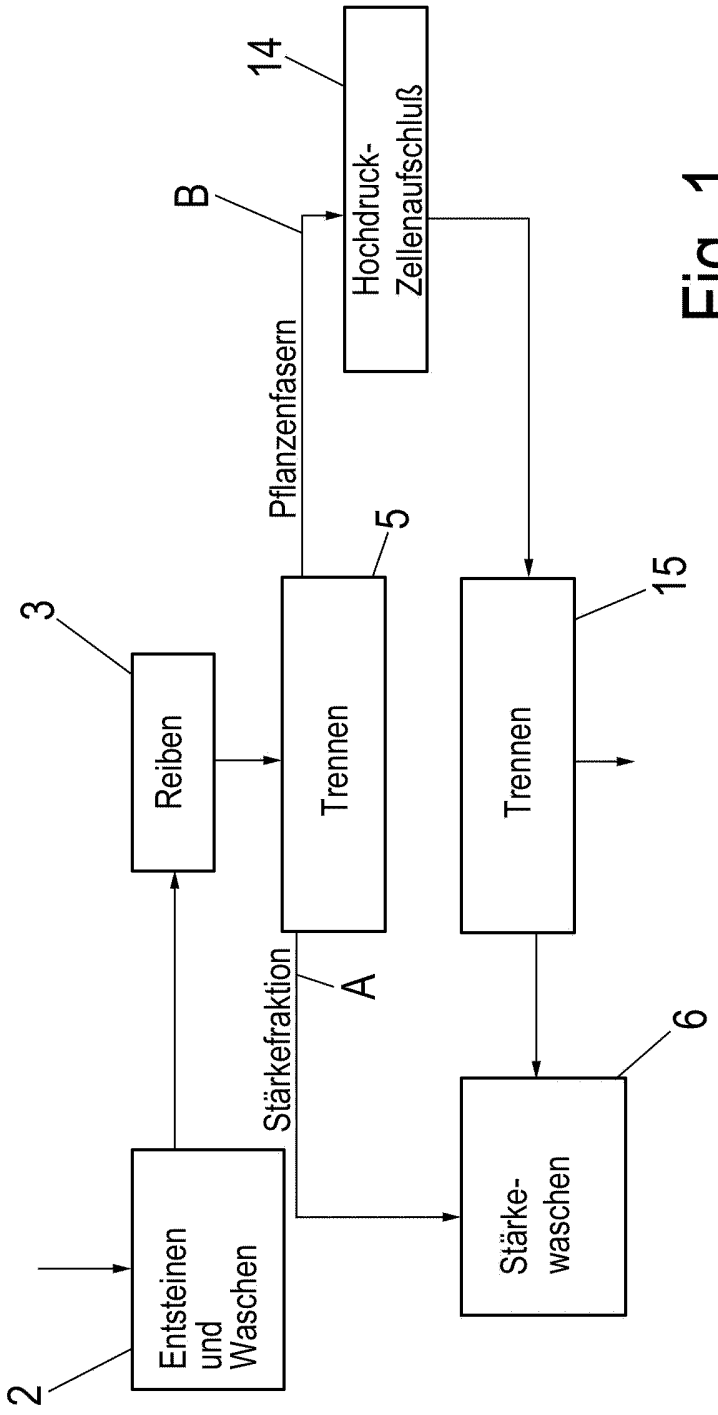

2
Entsteinen und Waschen
3
Reiben
5
Trennen
14
Hochdruck-Zellenaufschluß
B
Pflanzenfasern
15
Trennen
A
Stärkefraktion
6
Stärke-waschen

Fig. 1

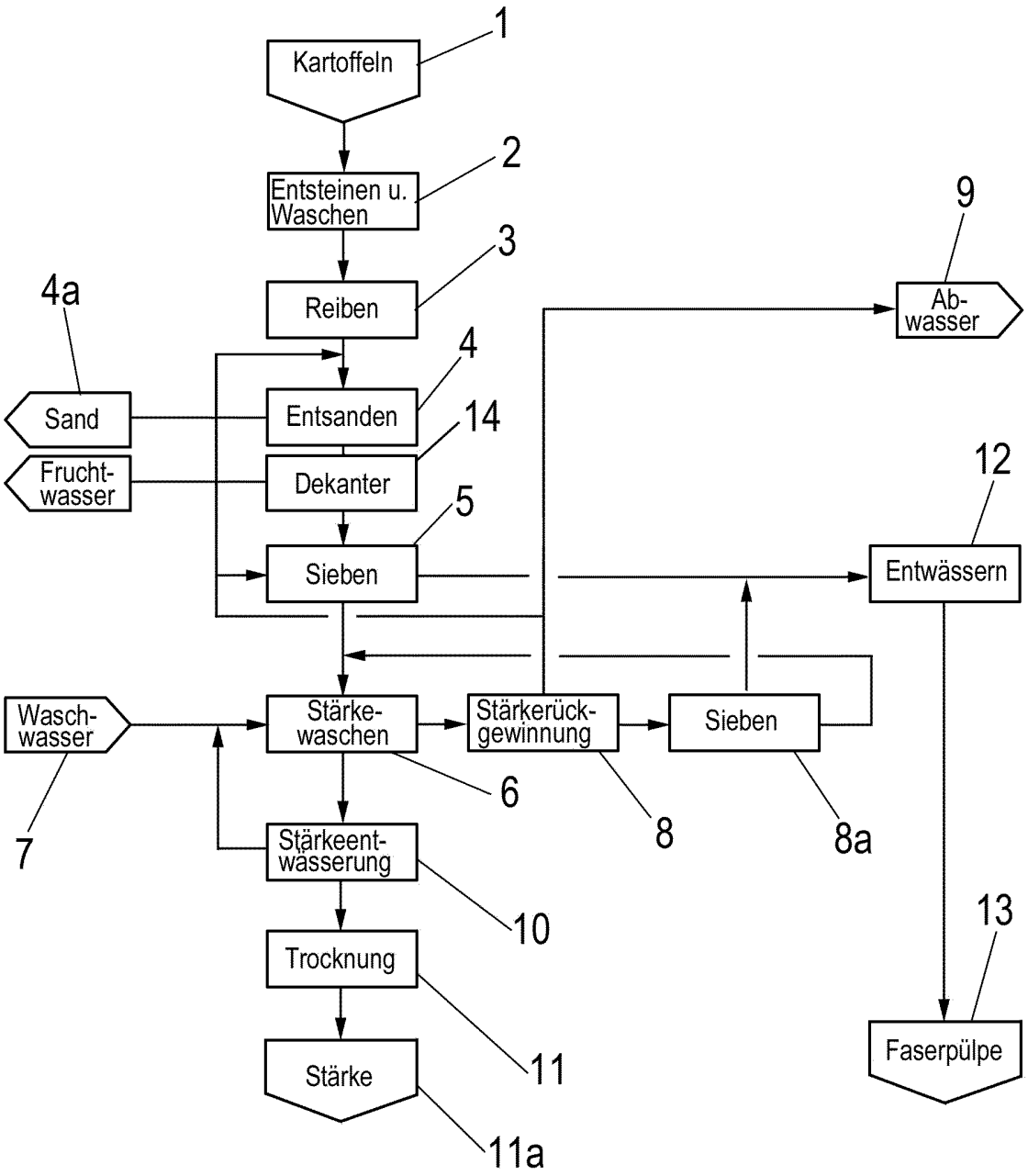

1
Kartoffeln
2
Entsteinen u. Waschen
3
Reiben
4a
Sand
4
Entsanden
14
Frucht-wasser
Dekanter
5
Sieben
9
Ab-wasser
12
Entwässern
Wasch-wasser
Stärke-waschen
Stärkerück-gewinnung
Sieben
7
6
8
8a
Stärkeent-wasserung
10
Trocknung
11
Stärke
11a
13
Faserpülpe

Fig. 2

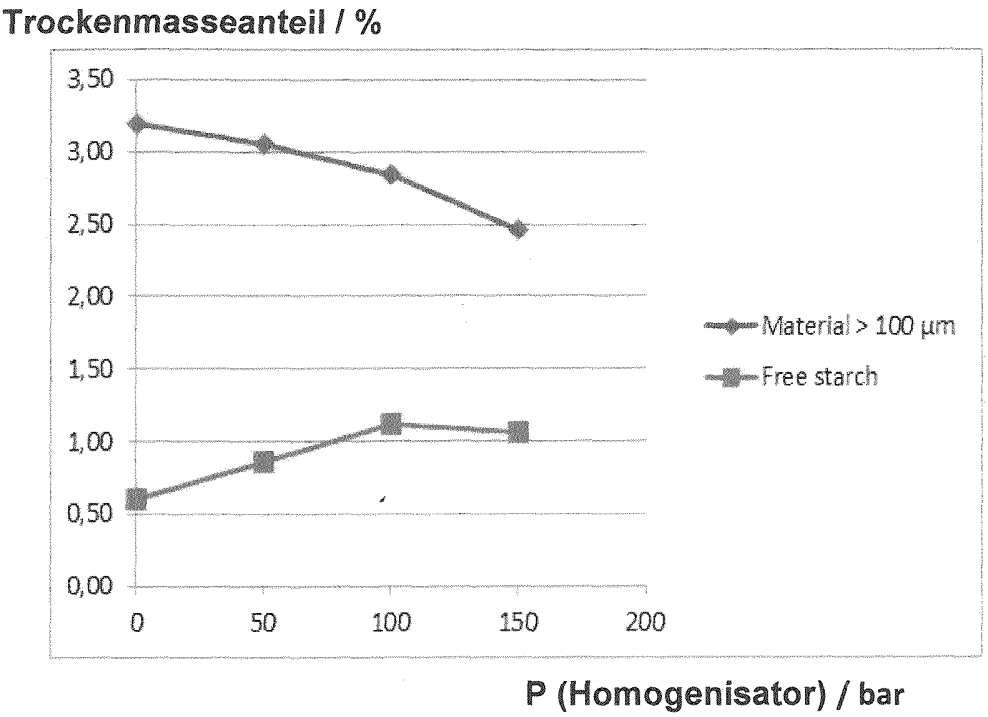

Trockenmasseanteil / %
3,50
3,00
2,50
2,00
1,50
1,00
0,50
0,00
0
50
100
150
200
Material > 100 µm
Free starch
P (Homogenisator) / bar

Fig. 3

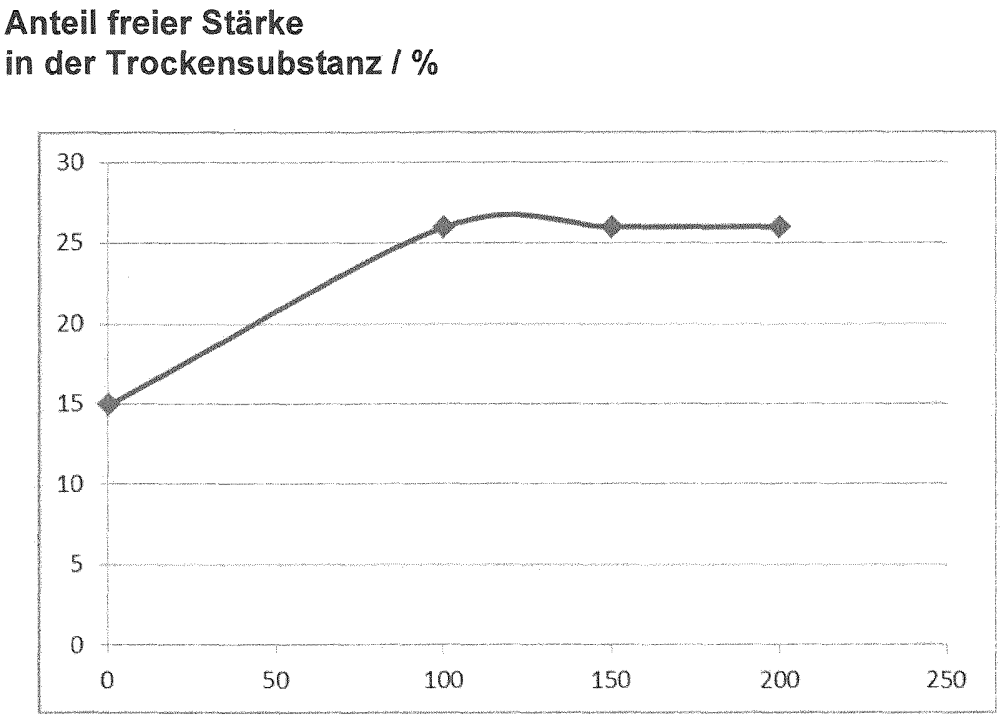

Anteil freier Stärke
in der Trockensubstanz / %
30
25
20
15
10
5
0
0
50
100
150
200
250
P (Homogenisator) / bar

Fig. 4