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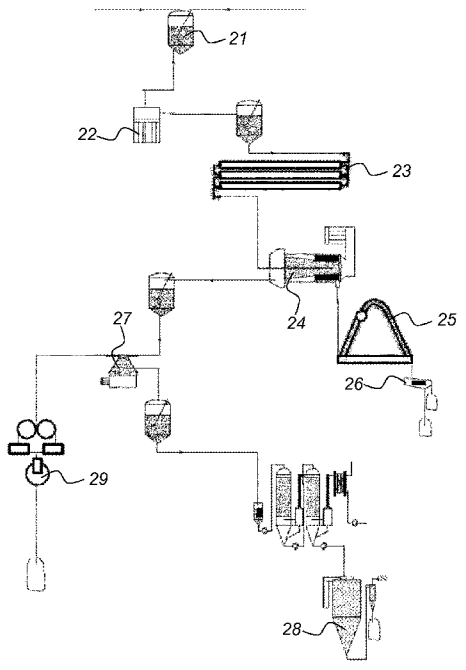

Fig. 2

(57) Abstract: A process for preparation of cereal fractions. The process comprises wet milling of oat bran, endosperm or starch, or barley bran, endosperm or starch, in the presence of an enzyme composition derived from malt; and when oat bran or barley bran is wet milled, optionally isolating, from the wet milled bran, a beta-glucan enriched fraction. Liquid food products obtainable by the process.

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A PROCESS FOR PREPARATION OF OAT OR BARLEY FRACTIONS

Technical field

The present invention relates to a process for preparation of cereal fractions, the process comprising wet milling. The present invention also relates to liquid food products.

Background art

There are acknowledged health and nutritional benefits for humans in increasing the daily intake of soluble dietary fibres from oat and barley grains. In particular, the beta-glucan component of these cereals has been related and directly linked to a number of beneficial effects, for example a demonstrated reduction of serum cholesterol levels, alongside improvements in HDL/LDL ratios in the blood, an effect strongly correlated with improved cardiovascular health in humans (Bell et al, Critical Reviews in Food Science and Nutrition, Vol 39,2, 1999). Additionally, highly viscous (and usually high molecular weight) non-starch polysaccharides present in whole cereal grains may be implicated in mechanisms regulating blood glucose, with an implied beneficial effect in long term prevention of type 2 diabetes (Foster-Powell and Brand Miller, Am J. Clin. Nutr., 62, 871S-893S, 1995).

Of further significance, the soluble dietary fibres present in oat and barley are not digested in the human intestine and therefore pass through to the colon where they are available for microbial fermentation and as such are effective prebiotic materials. Additionally, barley and oats comprise several other nutritional components of great value. Thus, native proteins, non-gelatinized starch and fat are important components.

Furthermore, the soluble beta-glucans from oats and barley are very interesting as functional ingredients in foods as they exhibit gelling behaviour, stabilizing properties, water binding and impart good mouth feel to products. High molecular weight beta-glucans have potential as viscosity modifiers, colloidal stabilizers, texturizers etc. in foodstuffs.

Most processes claiming to produce compositions containing high concentrations of soluble dietary fibers from oat and barley grain are based on alkaline extraction either from milled whole grain or a sieved fraction (Fisher et al, US 6,323,338) or even on hot water extraction, which yields lower molecular weight soluble beta-glucans (Morgan, WO 02/02645).

Inglett (US 4,996,063 and WO 92/10106) describes methods to produce water-soluble dietary fibre compositions from milled, heat treated oat flours and milled barley flours, via treatment with alpha-amylase enzymes to degrade starch components and subsequent centrifugation to remove insoluble materials from the hydrolysate mixture.

Lindahl et al (US 5,686,123) inform on methods to produce soluble cereal suspensions from oat. The basis of the invention is treatment of previously heat-treated ground oat, with alpha-amylase class of enzyme, whilst slurred in water.

Triantafyllou (WO 00/24270) describes a method to produce beta-glucan soluble dietary fibre from heat-treated oat flour, using alpha-amylase enzyme to hydrolyze starch to lower molecular weight fragments.

EP 1 706 001 discloses a method for preparing beta-glucans from oat were non-heated oat grains were dry milled and 50 % by weight of the grain was retained as a coarser fraction. This coarser material was suspended in water at a temperature of 95 °C and alpha-amylase enzyme was added to the suspension.

For many of the nutraceutical and functional applications, it is crucial to maintain high molecular weights in the beta-glucan component of the soluble fibre and to isolate the soluble dietary fibre cost-effectively with a reasonably high concentration of beta-glucan in the isolate. This “double challenge” is addressed in the present invention

Summary of the invention

It is an object of the present invention to provide cereal fractions of high nutritional value. It is another object of the present invention to provide cereal fractions of high health value. It is an additional object of the present invention to provide cereal fractions of high technological value. It is thus an

object of the invention to provide cereal fractions that are suitable for further processing and/or that may be used for modifying the rheological properties of products such as food or cosmetics. It is a further object of the present invention to provide cereal fractions of high sensorical quality. It is thus an object of the invention to provide cereal fractions having a good taste and mouth-feel.

A particular object also accomplished by the invention is to facilitate wet milling of oat bran, endosperm or starch, or barley bran, endosperm or starch.

These objects as well as other objects of the invention, which should become apparent to a person skilled in the art after having studied the description below, are accomplished by a process for preparation of cereal fractions, comprising the following step:

d) wet milling of oat bran, endosperm or starch, or barley bran, endosperm or starch, in the presence of an enzyme composition derived from malt; and when oat bran or barley bran is wet milled, isolating, from the wet milled bran, a beta-glucan enriched fraction.

The wet milling of the bran, endosperm or starch is performed in the presence of an enzyme composition derived from malt. The term “enzyme composition derived from malt” designates herein a combination of enzymes derived from malt, wherein the enzymes may be isolated from malted grain or may be present in or together with malted grain. Enzymes present in malt are several. Starch degrading enzymes are alpha-amylase, beta-amylase, limit dextrinase, and alpha-glucosidase. Beta-glucan degrading enzymes are endo-1,4-glucanase and endo-1,3-glucanase. A protein degrading enzyme is exapeptidase. Presence of the enzyme composition derived from malt facilitates the wet milling, in particular the separation of bran components from each other, by lowering the viscosity of the slurry being wet milled and by shortening the process time necessary for the separation. The wet milling, in presence of the enzyme composition derived from malt, may occur, continuously or intermittently, for 30 minutes or less, preferably 20 minutes or less. Presence of the enzyme composition derived from malt may not substantially affect the molecular weight of the beta-glucans. The present

invention may thus provide a soluble fibre rich fraction wherein the native molecular weight of the separated beta-glucans is substantially maintained or wherein more than 50 %, preferably more than 75 %, of the weight average molecular weight is maintained. The molecular weight of beta-glucans separated from other bran components may, for different enzyme sources and as a function of process time, be studied by HPLC (high pressure liquid chromatography).

The wet milling in presence of the enzyme composition derived from malt may be followed, typically before isolation of sub fraction(s) from the wet-milled bran enriched fraction, by inactivation of said enzyme composition, such as by heat treatment of the wet-milled bran enriched fraction, preferably at 100 °C or above.

By the wet milling of step d) a mechanical processing of the slurry is obtained, wherein the bran tissue, the endosperm tissue or the starch granule is torn apart and large surfaces are created that allow for the different molecules in the system to find each other. The wet milling may be performed by a toothed colloid mill (available, e.g., from Fryma).

The wet milling of step d) may be performed at a ratio of bran to water in the range of 1:1 to 1:12, preferably below 1:10, below 1:8 or below 1:4. The viscosity or the consistency of a resulting product may thus be adjusted already during step d). Alternatively, drying of a resulting product may be facilitated by a low water content during step d).

The product of subjecting bran to the wet milling of step d) may be used as or for a fibre rich and beta-glucan rich liquid food product, typically of high consistency. The product of subjecting endosperm to the wet milling of step d) may be used as or for a dextrin rich and protein rich liquid food product, typically of low consistency. The product of subjecting starch to the wet milling of step d) may be used as or for a dextrin rich liquid food product, typically of low consistency. Each of these liquid food products may be a drink or a soup. Each of these liquid food products can easily be modified by adding taste enhancers or by adding probiotics.

In step d) the malt may be selected from the group consisting of oat malt, barley malt or a combination thereof. It is preferred that oat malt is used for the wet milling of oat bran, endosperm or starch. It is preferred that barley malt is used for the wet milling of barley bran, endosperm or starch. By such preferred uses contamination of an oat based or barley based product, respectively, with another cereal is avoided.

The activity of one or more of beta-glucanase, beta-amylase, limit dextrinase and alpha-glucosidase present in said enzyme composition derived from malt may be reduced or eliminated, preferably while essentially maintaining the activity of alpha-amylases present in said enzyme composition derived from malt, before the enzyme composition is provided to the wet milling of step d). The viscosity of the slurry being wet milled is lowered under influence of alpha-amylase.

The enzyme composition may be heat treated, preferably at a temperature in the range of 78 to 80 °C, before being provided to the wet milling of step d). Such heat treatment activates the alpha-amylase enzymes of the malt and reduces the activity of other malt enzymes present. The enzyme composition may be heat treated for 1 to 15 minutes, preferably for 3 to 12 minutes.

The enzyme composition may be a malt extract or comminute malt grains, preferably a malt extract. The malt extract can be used in an amount of 2 to 4 wt% of the weight of the bran, endosperm or starch. The malt extract may be obtained by crushing malt grains and extracting enzymes into a water phase. Malt grains need not be removed from the enzyme composition if it will be satisfactorily milled in the wet milling of step d).

Step d) may further comprise isolating, from the wet milled bran enriched fraction, a beta-glucan enriched sub fraction. The beta-glucan enriched sub fraction may be isolated by removing, from the wet milled bran enriched fraction, a fibre enriched sub fraction. The isolation of the beta-glucan enriched sub fraction or the removal of the bran enriched fraction is typically performed by decanting. The viscosity of the beta-glucan enriched sub fraction can be modified by changing the proportions of water and bran in the bran enriched fraction to be wet milled or in the wet milled bran enriched

fraction. The beta-glucan enriched sub fraction can be used as or for a liquid food product, such as a drink or soup. The liquid food product can easily be modified by adding taste enhancers or by adding probiotics. The viscosity of the liquid food product can be increased by adding a more concentrated beta-glucan product, wet or dry. The fibre enriched sub fraction may optionally be dried, typically in a ring dryer. The fibre enriched sub fraction can be used for production of an extruded food product, such as a meat substitute.

The process may further comprise isolating, from the fibre enriched sub fraction, a component enriched in protein and fat. It is preferred to dry the fibre enriched sub fraction before isolating the component enriched in protein and fat. The isolation may typically be performed by sieving. Thus, protein and fat can be collected as one fraction.

The process may further comprise isolating, from the beta-glucan enriched sub fraction, a component further enriched in beta-glucan and a component enriched in dextrins, and optionally drying, the component further enriched in beta-glucan and/or the component enriched in dextrins. Such isolation is typically performed in a centrifugal separator. The component further enriched in dextrins is typically dried in a spray drier, preferably after evaporation. The component further enriched in beta-glucan is typically dried in a drum drier. The component further enriched in beta-glucan may be added to the beta-glucan enriched sub fraction in order to raise its viscosity.

It is possible to perform the isolation of step d) by use of a three-phase decanter. One obtains three phases, a solid phase comprising fibre, protein and fat, and two individual liquid phases comprising dextrins and beta-glucans, respectively. Isolation is thus performed in one step, which means that the process is shortened and that beta-glucans come out of the process faster and can be pumped to the dryer. One thus obtains a high molecular weight of the beta-glucans due to the short processing time.

An alternative to the use of the three-phase decanter is the use of a two-phase decanter and a centrifugal separator. One obtains from the two-phase decanter a solid phase comprising fibre, protein and fat and a liquid phase comprising dextrines and beta-glucans. The liquid phase may be

passed through a centrifugal sepatator. One obtains from the separator a phase comprising dextrins and one phase comprising beta-glucans.

The wet milled bran may alternatively be decanted to form a sub fraction enriched in beta-glucan and dextrin, a sub fraction enriched in protein and fat and a sub fraction enriched in fibre.

The process may further comprise a step b) of providing oat bran or endosperm, or barley bran or endosperm, for use in step d) by subjecting oat grains or barley grains to milling substantially separating endosperm from bran, and isolating an endosperm enriched fraction from a bran enriched fraction.

The process may further comprise steps of providing oat starch or barley starch for use in step d) by

b) subjecting oat grains or barley grains to milling substantially separating endosperm from bran, and isolating an endosperm enriched fraction from a bran enriched fraction; and

c) subjecting the endosperm enriched fraction from step b) to wet fractionation substantially separating starch from protein, and isolating a starch enriched fraction.

The milling of step b) may be performed by methods as such known in the art of milling. The isolation of step b) may be performed by methods as such known in the art of milling, such as by sieving. Heat treated oat grains or barley grains are thus milled, the resulting comminute grains preferably being sieved into two fractions. The endosperm enriched fraction may be considered a flour fraction, such as oat flour or barley flour. The bran enriched fraction may be considered a bran fraction, such as oat bran or barley bran. The isolation may be carried out to retain 55–60 % of the grain weight as the endosperm enriched fraction and 40–45 % of the grain weight as the bran enriched fraction.

The flour fraction obtained from step b) is stable towards oxidation and development of rancidity. Starch may remain ungelatinized when subjected to the dry heat treatment of step a), thereby facilitating further separation of endosperm components of the flour fraction from each other. Protein may remain partially or substantially non-denatured when subjected to the dry heat

treatment of step a), the flour fraction thus being of particular nutritional value. The oat flour is as such a unique debranned oat flour.

The bran fraction obtained from step b) is stable towards oxidation and development of rancidity. Removal of endosperm components, such as starch and protein, from the bran facilitates further separation, in step d), of bran components from each other.

The wet fractionation of step c) is preferably performed by mixing of the endosperm enriched fraction with water and homogenizing of the resulting mixture. Homogenization may be perfomed by wet-milling. It has turned out that a dry heat treatment of the grains in step a), maintaining the starch in an ungelatinized state, reduces the need for dilution of the endosperm enriched fraction during wet fractionation. The aqueous phase may then be more concentrated, thereby reducing the amount of energy needed for preparing dry products during subsequent processing.

Step c) may further comprise isolating, and optionally drying, a starch enriched fraction and/or isolating, and optionally drying, a protein enriched fraction. Starch and/or proteins may be isolated by methods as such known in the art, such as by centrifugation or decanting. The starch can be distributed on the consumer market or become further processed as wanted. The protein is highly nutritionally valuable and can be used as a food additive.

Step c) may further comprise withdrawing, from the wet fractionated endosperm enriched fraction, a liquid and providing at least a portion or fraction of the withdrawn liquid to the wet milling of step d). The liquid fraction may be withdrawn by methods as such known in the art, such as by centrifugation or decanting. Accordingly, water consumption is reduced and soluble substances, such as B starch and beta-glucans, can be recovered.

The process may further comprise a step a) of providing oat grains or barley grains for use in step b) by subjecting oat grains or barley grains to a dry heat treatment reducing lipase activity.

The oat grains or barley grains are preferably of a variety with high content of beta-glucans. The oat grains or barley grains may be traditional or organic. The reception of grains is preferably of high quality, good hygienic condition and/or substantially dust-free. The grains may be stored in silos.

Before entering step a), the oat grains or barley grains are preferably cleansed. Cleansing may comprise removal of stones and dirt and/or sorting out seeds of another species, such as non-oat grains and/or non-barley grains. Before entering step a), the oat grains are preferably dehulled and separated from the hulls.

Grains may contain a high content of fat. Oat grains may contain > 5 % fat. The heat treatment of step a) may reduce enzyme activity, in particular it reduces lipase activity, in the oat grains or barley grains. Due to the reduced enzyme activity, in particular the reduced lipase activity, the oat grains or barley grains, or any product or fraction derived thereof, become stable towards oxidation and development of rancidity. In the present process any dry heat treatment reducing lipase activity may be used. The term “dry” is used herein to designate a heat treatment wherein heat is transferred to the grains without contacting the grains with water or steam. A number of dry heat treatments suitable for grains are conceivable, such as heat treatments wherein heat is transferred to the grains by contacting the grains with hot air or by irradiation of a suitable wavelength. By applying a dry heat treatment there is no influence of water or steam on the starch content or the proteins, so the starch may remain substantially non-gelatinized and the proteins may remain partially or substantially non-denatured.

In the heat treatment of step a) the core of the grains may be heated to a temperature of at least 60 °C, preferably to a temperature in the range of 60 to 80 °C. At this temperature range lipase activity will be reduced, while sensorical and functional properties of the grains are maintained.

The heat treatment of step a) may be performed by micro-wave technology. Heating of the grains by micro-wave technology, typically at their native water content, causes inactivation of the enzymes without gelatinization of the starch in the oat or barley kernel. Because starch is not gelatinized, a very useful oatmeal or barley flour will result when the kernels are milled. The heat treatment of step a) may thus maintain starch in a substantially non-gelatinized condition and/or maintain proteins in a partially or substantially non-denatured condition.

The present description thus provides a novel method for the preparation of cereal grain fractions, such as producing a beta-glucan enriched fraction starting from a heat-treated oat or barley grain, which is milled and the bran fraction is made subject to malt, such as barley and/or oat malt in an aqueous phase. The heat treatment is carried out under non-aqueous conditions, thereby leaving a substantially non-gelatinized starch and a partially or substantially non-denaturated protein content. The oat or barley flour retained has a high quality and will not become rancid as the lipases of the grain have been inactivated by the heat treatment. The described process thus facilities the retaining of high-molecular beta-glucans, non-gelatinized starch, non-denaturated protein, fat and/or fibres in different fractions due to the requested final use of the different fractions. Isolation of a reasonably clean fraction of soluble dietary fibre containing high molecular weight beta-glucan at appreciable concentrations facilitates the cost-effective further processing of the material to yield preparations of very high beta-glucan concentrations at high molecular weight, and to adjust molecular weight of the materials in a controlled manner to “tailor” final product properties.

Brief description of the drawings

The invention will be described in the following with reference to the appended drawings.

Figure 1 shows schematically dry processing of grains.

Figure 2 shows schematically one embodiment of wet processing of a bran enriched fraction.

Figure 3 shows schematically another embodiment of wet processing of a bran enriched fraction.

Figure 4 shows schematically wet processing of an endosperm enriched fraction.

Figure 5 shows schematically preparation of a malt extract.

Detailed description

Figure 1 shows that oat grains are received into a silo 11 and are cleansed from dirt and gravel in a separator 12, whereupon the oat grains are transferred to a dehulling/dehusking apparatus 13. Dehulling/dehusking is only necessary for oats as being the only grain comprising a hull. The hull content is separated off on a shaking table 14, whereupon the grains are transferred to a heat treatment apparatus 15. The heat treatment apparatus 15 is, in this embodiment, a micro-wave apparatus tube, wherein the grains are made subject to a micro-wave heat treatment as described in WO 01/54519 A1. The grains are heated to a temperature at which lipases present are deactivated, said temperature being about 60 °C in the centre or core of the grain, the grain core temperature, whereby an oat kernel is obtained that has a non-gelatinized starch content and may have a non-denaturated protein content. The oat grains are transferred to a mill 16 wherein oat flour, i.e. an endosperm fraction, is obtained as one fraction 17, and an oat bran fraction is obtained as a second fraction 18. Flour and bran are milled out in a ratio of 60:40 (flour:bran w/w).

Figure 2 shows that the oat bran fraction is transferred into a wet process, wherein water, oat bran and a malt extract are mixed in a reaction vessel 21, the mixture then being made subject to a homogenization in a wet mill 22. Subsequently, the wet milled slurry is transferred to a heat exchanger 23 for heat treatment at high temperature in order to deactivate enzymes present. The slurry is then passed over to a decanter 24, wherein the slurry is separated into a fraction of fibres, also containing protein and fat, and a fraction of beta-glucans and dextrins (which are present as a result of hydrolysis of starch remaining in the bran starting material). The fibres/protein/fat fraction is dried in a ring dryer 25, whereupon the fibres are sieved off by a sieve 26. The beta-glucan/dextrin fraction is separated in a separator 27, whereby the aqueous dextrin fraction is transferred to an evaporator for drying to increase the dry substance content from 10 to 30 %. The aqueous dextrins are spray dried in a spray dryer 28. The beta-glucan fraction obtained in the separator 27 is drum dried in a drum drier 29 and retrieved.

Figure 3 shows an alternative, in which the bran fraction from the milling step is mixed with water in a reaction vessel 31 together with malt extract. After hydrolysis the slurry is made subject to a wet milling stage in a wet mill 32 and is further reacted with an additional amount of malt extract. Subsequently, the slurry is made subject to a heat treatment in a heat exchanger 33 at high temperature to deactivate any enzymes left. The slurry is then transferred to a decanter 34 to eliminate fibres, whereas the aqueous phase is transferred via a tank 35 to a filling machine 36 for filling of bottles or other packages for distribution to the market.

Figure 4 shows that the oat flour, i.e. endosperm fraction, obtained from the milling step is added together with water to a dough mixer 41 from a container 42. The dough obtained is passed through a homogenizer 43. The homogenized dough is decanted in a decanter 44, whereby process water, containing i.a. beta-glucans, as well as a starch phase and a protein phase are obtained. Thus three phases are collected individually. The process water is returned into the process as a starting liquid to vessel 21 or 31 in the wet processing of Figure 2 or 3, respectively. The starch phase is dried in a ring drier 45 and packed in packages for the consumer market. The protein phase is dried in a spray drier 46 and packed in packages for the consumer market.

Figure 5 shows a process suitable to obtain a malt extract to be used in the wet processing described in connection with Figures 2 and 3. Malt is milled in a mill 51 and then mixed in a mixer with water at an elevated temperature of 78 °C to 80 °C for 10 minutes. The malt is then homogenized in a wet mill 52, is sieved in a wet sieve 53, whereby a solid phase as well as an aqueous phase comprising enzymes are obtained. The aqueous phase, i.e. the malt extract, is transferred to a holding tank 54 held at 78 °C. The malt extract is then added to the process, to vessel 21 or 31 of the wet processing of Figure 2 or 3, respectively, via a malt pipe line 55 when needed.

<u>Example 1. Wet processing of bran. Fractionation of beta-glucans, fibre, protein/fat and dextrin.</u>

A bran fraction, obtained by heat treatment of oat grains in a microwave equipment and subsequent milling of the oat grains, was mixed

with water in a ratio of 1:6 by adding 3 kilograms of the bran fraction to 18 liters of water in a boiling pan (a 100 liters Getinge cooking vessel) as follows.

The water was heated to 78 °C, whereupon 1.5 %, based on the weight of the bran fraction, of barley malt extract (45 grams) was added to the water in the boiling pan and the extract was mixed in the water with stirring for 5 minutes. The bran was added under vigorous stirring to obtain an oat bran slurry, which was stirred vigorously for 5 minutes. The slurry was then wet-milled in a colloid mill (Fryma MZ) in a first step. After the first wet milling step, the slurry was further stirred in the boiling pan for 5 minutes at 78 °C after having added an additional 1.5 % of malt extract (45 grams) to the slurry. The slurry was then made subject to a second wet-milling step in the colloid mill (Fryma MZ).

After the second wet milling step, the slurry was stirred in the boiling pan for another 5 minutes. The slurry was then made subject to a third wet-milling step in the colloid mill (Fryma MZ). After the third wet-milling step, the slurry was stirred in the boiling pan for 5 minutes, whereupon the slurry was heated to 100 °C with stirring.

The oat slurry was subsequently autoclaved at 1.5 bar overpressure, temperature 115 °C for 15 minutes to pasteurize the slurry. The slurry was then wet-milled in a fourth step in a colloid mill (Fryma MZ).

The resulting oat slurry was decanted, whereby a solid fibre phase was removed. The remaining liquid was centrifuged (Beckman centrifuge J-6B) at 4100 rev/min for 10 minutes. Centrifugation resulted in three phases: one of beta-glucans, one of dextrins and one of protein/fat.

All four phases of beta-glucans, dextrins, proteins/fat and fibre, respectively, were dried in a drying cabinet at 105 °C for 8 hours and then milled into powders. Weighing of the dried phases confirmed that 720 grams of fibre, 690 grams of protein/fat, 870 grams of dextrines and 510 grams of beta-glucans were obtained.

Example 2. Wet processing of bran. Liquid oat product.

A bran fraction, obtained by heat treatment of oat grains in a microwave equipment and subsequent milling of the oat grains, was mixed with water in a ratio of 1:9 by adding 2 kilograms of the bran fraction to 18 liters of water in a boiling pan (a 100 liters Getinge cooking vessel) as follows.

The water was heated to 78 °C, whereupon 1.5 %, based on the weight of the bran fraction, of barley malt extract (30 grams) was added to the water in the boiling pan and the extract was mixed in the water with stirring for 5 minutes. The bran was added under vigorous stirring to obtain an oat bran slurry, which was stirred vigorously for 5 minutes. The slurry was then wet-milled in a colloid mill (Fryma MZ) in a first step.

After the first wet milling step, the slurry was further stirred in the boiling pan for 5 minutes at 78 °C after having added an additional 1.5 % of malt extract (30 grams) to the slurry. The slurry was then made subject to a second wet-milling step in the colloid mill (Fryma MZ).

After the second wet milling step, the slurry was stirred in the boiling pan for another 5 minutes. The slurry was then made subject to a third wet-milling step in the colloid mill (Fryma MZ). After the third wet-milling step, the slurry was stirred in the boiling pan for 5 minutes, whereupon the slurry was heated to 100 °C with stirring.

The oat slurry was subsequently autoclaved at 1.5 bar overpressure, temperature 115 °C for 15 minutes to pasteurize the slurry. The slurry was then wet-milled in a fourth step in a colloid mill (Fryma MZ).

The resulting oat slurry was decanted, whereby a solid fibre phase was removed. The remaining liquid was a liquid drinkable oat product. About 16 kilograms of liquid oat product at a dry substance of about 9 % was obtained. The drinkable oat product was bottled in autoclaved bottles. The fibre phase was dried in drying cabinet at 105 °C for 8 hours and then milled into a powder.

Example 3. Wet processing of flour (endosperm).

1.2 liters of water were added into a dough mixer (Electrolux household assistant) together with 1 kg of oat flour derived from milling of microwave

treated oat grains during stirring. The dough was mixed until the dough was completely smooth, approximately for 10 minutes. The dough obtained was homogenized in a colloid mill (Fryma MZ). 0.8 liters of water were added to the homogenized dough, whereupon the dough was mixed in the dough mixer, until the dough became completely smooth, it took about 10 minutes. The dough was centrifuged (Beckman centrifuge J-6B) at 4100 rev/min for 10 minutes. The centrifugation provided three phases: one of starch, one of protein/fat as well as an aqueous phase.

The starch and protein/fat phases were placed in drying cabinet, dried at 105 °C for 8 hours and milled into powder. The aqueous phase had a dry matter content of approximately 3 % and consisteds of soluble substances such as B starch and beta-glucans.

1 kg of oat flour provided 685 g of dried starch, 110 g of dried protein/fat and 1,2 kg of an aqueous solution containing B starch and beta-glucans.

Itemized list of embodiments

Item 1. A process for preparation of cereal fractions, comprising the following step:

d) wet milling of oat bran or barley bran in the presence of an enzyme composition derived from malt; and

isolating, from the wet milled bran, a beta-glucan enriched fraction.

Item 2. The process according to item 1, wherein in step d) the malt is selected from the group consisting of oat malt, barley malt or a combination thereof.

Item 3. The process according to item 1 or 2, wherein the activity of one or more of beta-glucanase, beta-amylase, limit dextrinase and alpha-glucosidase present in said enzyme composition derived from malt is reduced or eliminated, preferably while essentially maintaining the activity of alpha-amylases present in said enzyme composition derived from malt, before the enzyme composition is provided to the wet milling of step d).

Item 4. The process according to any one of the preceding items, wherein the enzyme composition is heat treated, preferably at a temperature in the range of 78 to 80 °C, before being provided to the wet milling of step d).

Item 5. The process according to any one of the preceding items, wherein the enzyme composition is a malt extract or comminute malt grains, preferably a malt extract.

Item 6. The process according to any one of the preceding items, wherein the beta-glucan enriched fraction is isolated by removing, from the wet milled bran, a fibre enriched fraction, wherein the fibre enriched fraction is optionally dried.

Item 7. The process according to any one of the preceding items, further comprising isolating, from the beta-glucan enriched fraction, a component further enriched in beta-glucan and a component enriched in dextrins, and optionally drying the component further enriched in beta-glucan and/or the component enriched in dextrins.

Item 8. The process according to any one of items 6 to 7, further comprising isolating, from the fibre enriched fraction, a component enriched in protein and fat, and optionally drying the component enriched in protein and fat.

Item 9. The process according to any one of the preceding items, wherein the wet milled bran is decanted to form a fraction enriched in beta-glucan and dextrin, a fraction enriched in protein and fat and a fraction enriched in fibre.

Item 10. The process according to any one of the preceding items, further comprising the following step:

b) providing oat bran or barley bran for use in step d) by subjecting oat grains or barley grains to milling substantially separating endosperm from bran, and isolating an endosperm enriched fraction from a bran enriched fraction.

Item 11. The process according to item 10, further comprising the following step:

a) providing oat grains or barley grains for use in step b) by subjecting oat grains or barley grains to a dry heat treatment reducing lipase activity.

Item 12. The process according to item 11, wherein in the heat treatment of step a) the core of the grains is heated to a temperature of at least 60 °C, preferably to a temperature in the range of 60 to 80 °C.

Item 13. The process according to item 11 or 12, wherein the heat treatment of step a) is performed by micro-wave technology.

Item 14. The process according to any one of item 11 to 13, wherein the heat treatment of step a) maintains starch in a substantially non-gelatinized condition and/or maintains proteins in a partially or substantially non-denatured condition.

Item 15. The process according to any one of items 10 or 14, further comprising the following step:

c) subjecting the endosperm enriched fraction from step b) to wet fractionation substantially separating starch from protein, withdrawing, from the wet fractionated endosperm enriched fraction, a liquid and providing at least a portion or fraction of the withdrawn liquid to the wet milling of step d).

CLAIMS

1. A process for preparation of cereal fractions, comprising the following step:
d) wet milling of oat bran, endosperm or starch, or barley bran, endosperm or starch, in the presence of an enzyme composition derived from malt; and when oat bran or barley bran is wet milled, optionally isolating, from the wet milled bran, a beta-glucan enriched fraction.

2. The process according to claim 1, wherein in step d) the malt is selected from the group consisting of oat malt, barley malt or a combination thereof.

3. The process according to claim 1 or 2, wherein the activity of one or more of beta-glucanase, beta-amylase, limit dextrinase and alpha-glucosidase present in said enzyme composition derived from malt is reduced or eliminated, preferably while essentially maintaining the activity of alpha-amylases present in said enzyme composition derived from malt, before the enzyme composition is provided to the wet milling of step d).

4. The process according to any one of the preceding claims, wherein the enzyme composition is heat treated, preferably at a temperature in the range of 78 to 80 °C, before being provided to the wet milling of step d).

5. The process according to any one of the preceding claims, wherein the enzyme composition is a malt extract or comminute malt grains, preferably a malt extract.

6. The process according to any one of the preceding claims, wherein the beta-glucan enriched fraction is isolated by removing, from the wet milled bran, a fibre enriched fraction, wherein the fibre enriched fraction is optionally dried.

7. The process according to claim 6, further comprising isolating, from the fibre enriched fraction, a component enriched in protein and fat, and optionally drying the component enriched in protein and fat.

8. The process according to any one of the preceding claims, further comprising isolating, from the beta-glucan enriched fraction, a component further enriched in beta-glucan and a component enriched in dextrins, and optionally drying the component further enriched in beta-glucan and/or the component enriched in dextrins.

9. The process according to any one of the preceding claims, wherein the wet milled bran is decanted to form a fraction enriched in beta-glucan and dextrin, a fraction enriched in protein and fat and a fraction enriched in fibre.

10. The process according to any one of the preceding claims, further comprising the following step:
b) providing oat bran or endosperm, or barley bran or endosperm, for use in step d) by subjecting oat grains or barley grains to milling substantially separating endosperm from bran, and isolating an endosperm enriched fraction from a bran enriched fraction.

11. The process according to claim 10, further comprising the following step:
a) providing oat grains or barley grains for use in step b) by subjecting oat grains or barley grains to a dry heat treatment reducing lipase activity.

12. The process according to claim 11, wherein in the heat treatment of step a) the core of the grains is heated to a temperature of at least 60 °C, preferably to a temperature in the range of 60 to 80 °C.

13. The process according to claim 11 or 12, wherein the heat treatment of step a) is performed by micro-wave technology.

14. The process according to any one of claim 11 to 13, wherein the heat treatment of step a) maintains starch in a substantially non-gelatinized condition and/or maintains proteins in a partially or substantially non-denatured condition.

15. The process according to any one of the preceding claims, further comprising the following steps:
providing oat starch or barley starch for use in step d) by
b) subjecting oat grains or barley grains to milling substantially separating endosperm from bran, and isolating an endosperm enriched fraction from a bran enriched fraction; and
c) subjecting the endosperm enriched fraction from step b) to wet fractionation substantially separating starch from protein, and isolating a starch enriched fraction.

16. A liquid food product, such as a drink or soup, comprising oat or barley fibre and oat or barley beta-glucan, said food product being obtainable by processing of oat or barley bran according to the process of any of claims 1 to 15.

17 A liquid food product, such as a drink or soup, comprising oat or barley protein and dextrin derived from oat or barley, said food product being obtainable by processing of oat or barley endosperm according to the process of any of claims 1 to 15.

18. A liquid food product, such as a drink or soup, comprising dextrin derived from oat or barley, said food product being obtainable by processing of oat or barley starch according to the process of any of claims 1 to 15.

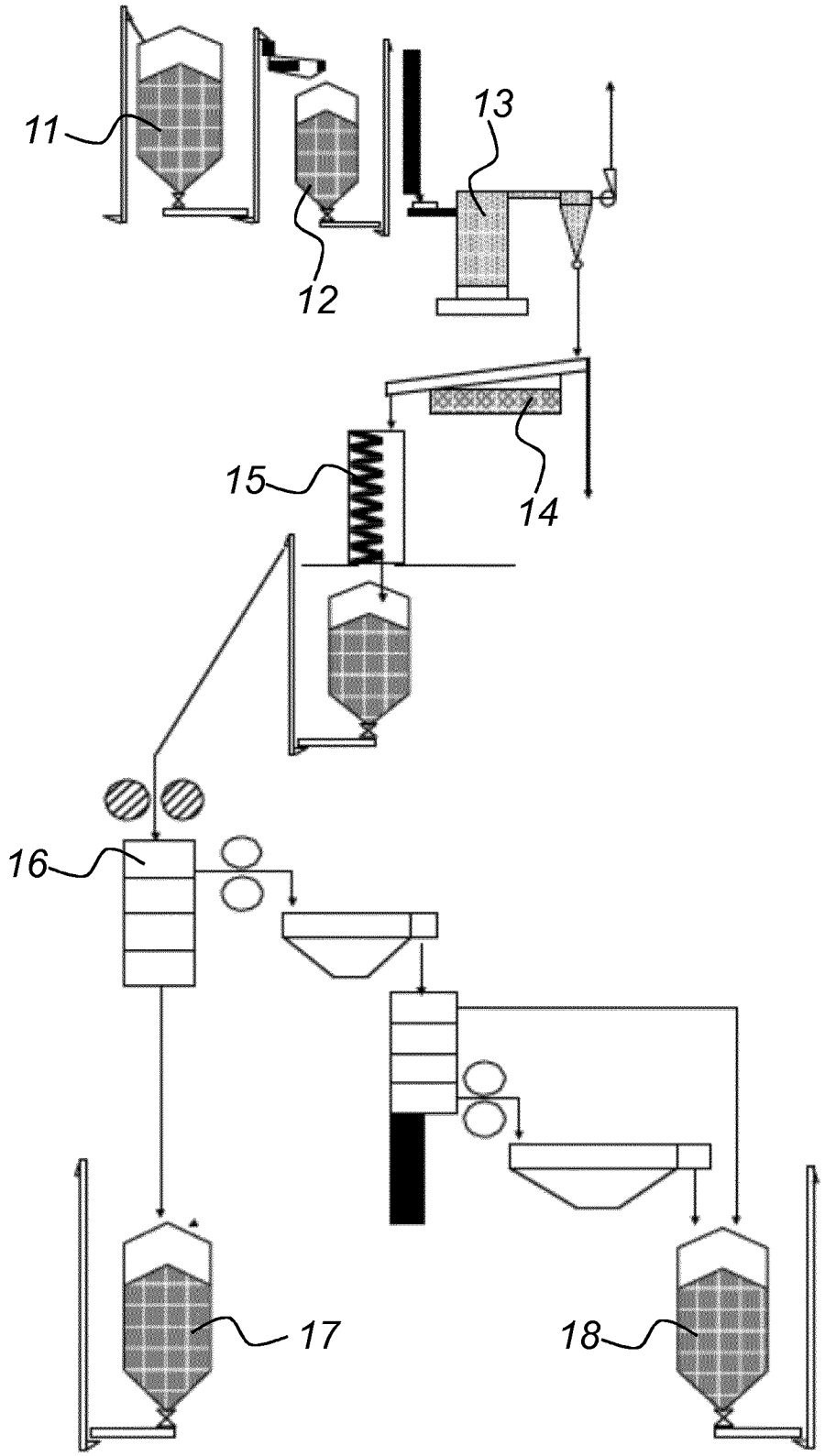

Fig. 1

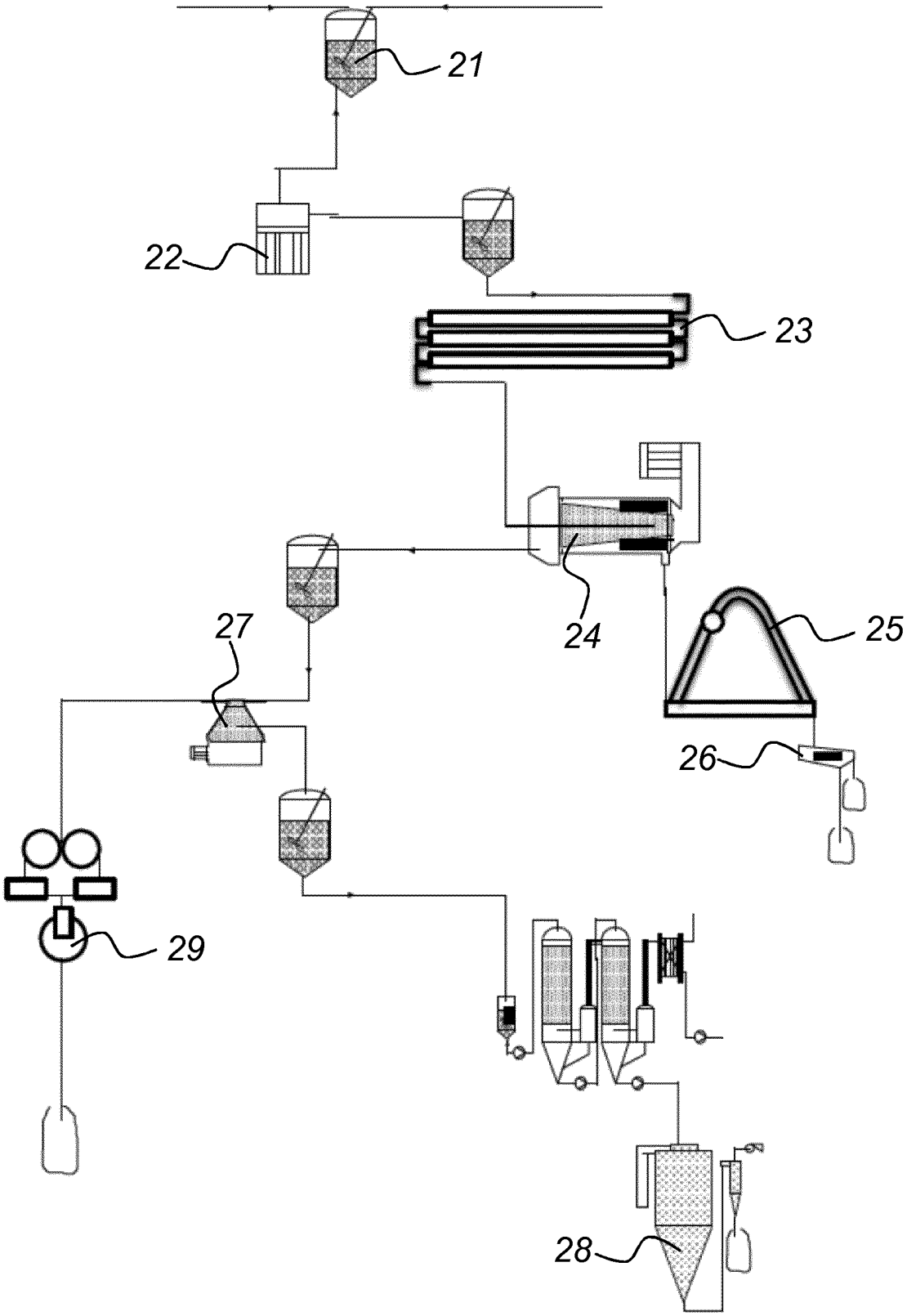

Fig. 2

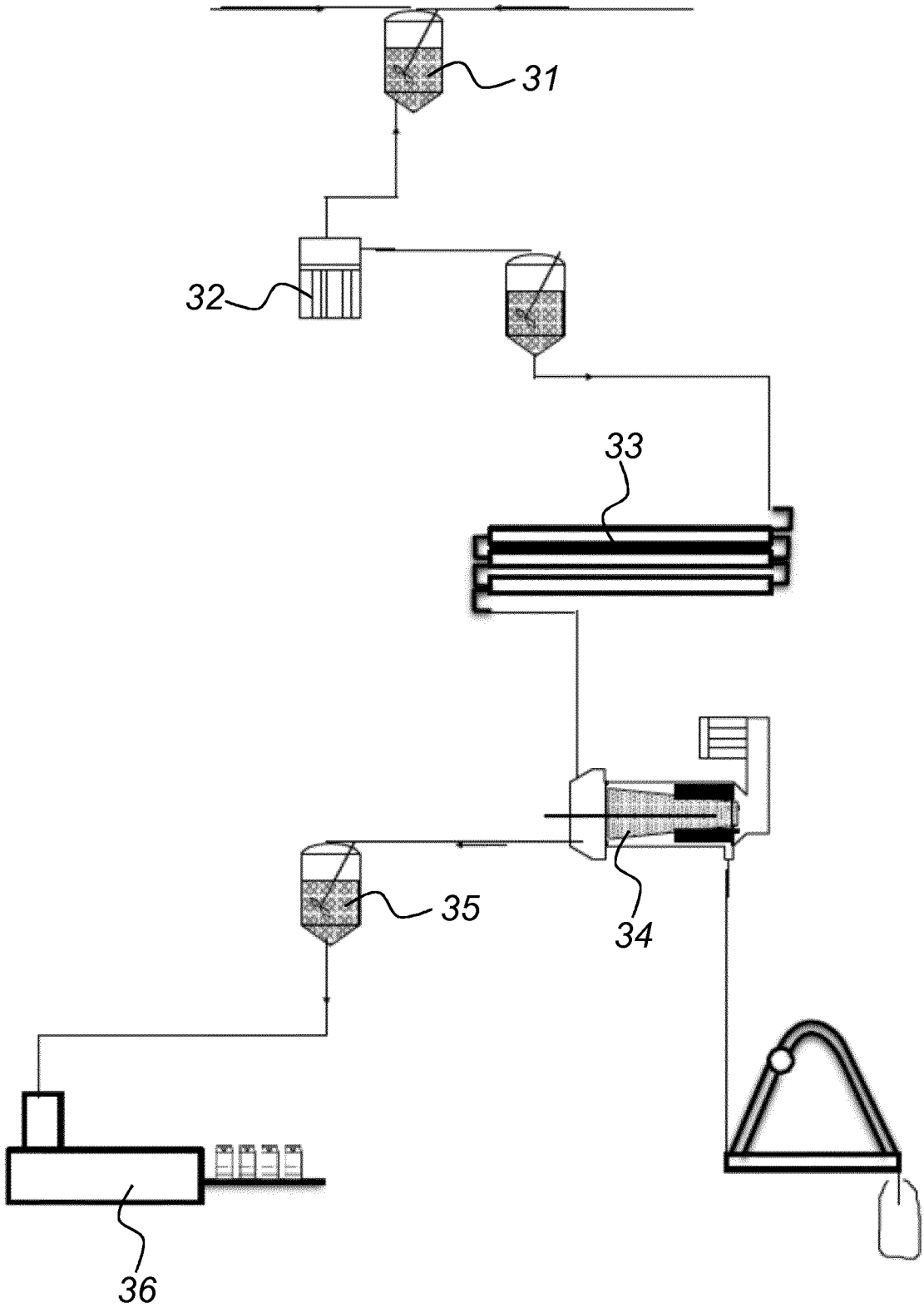

Fig. 3

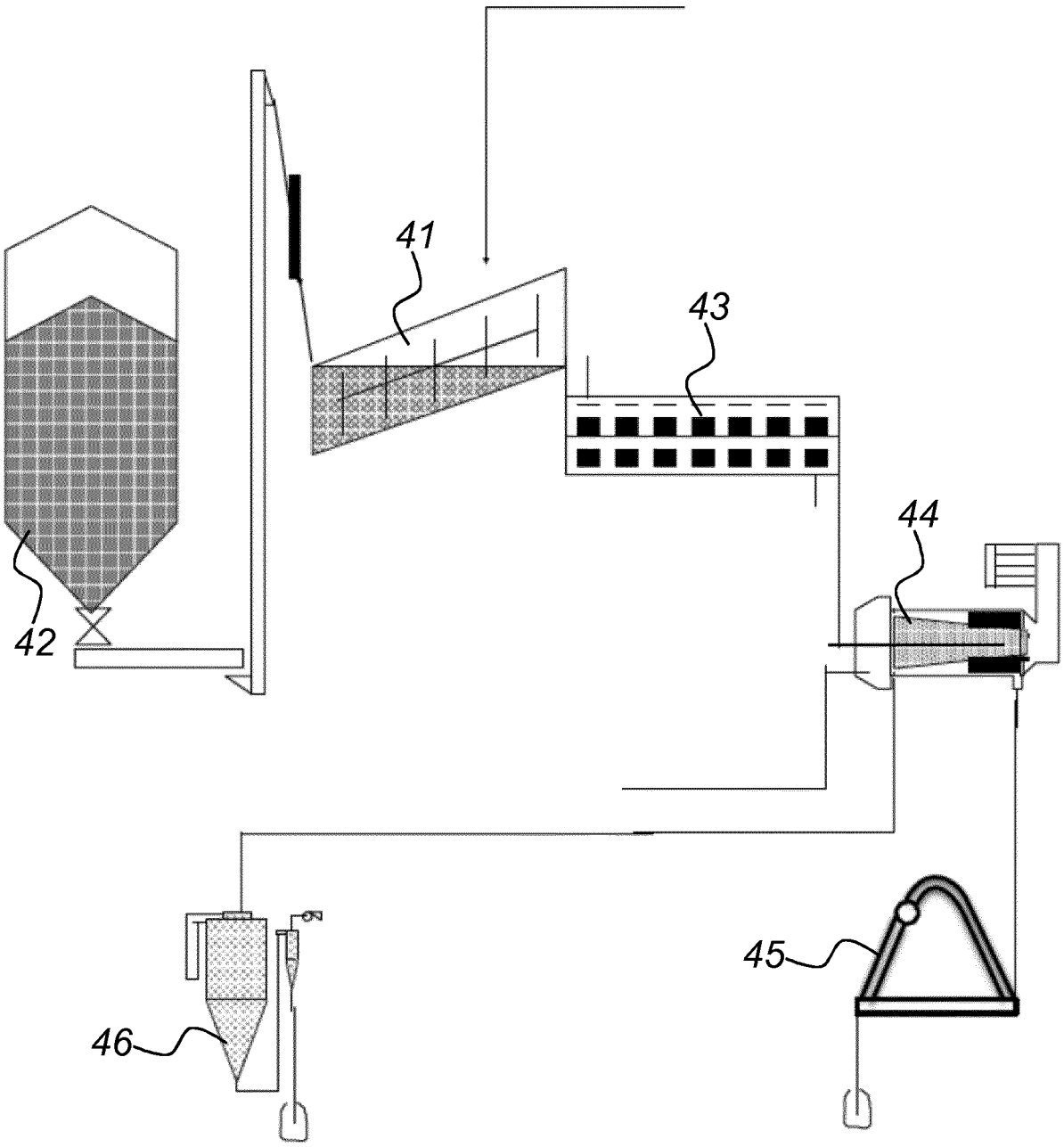

Fig. 4

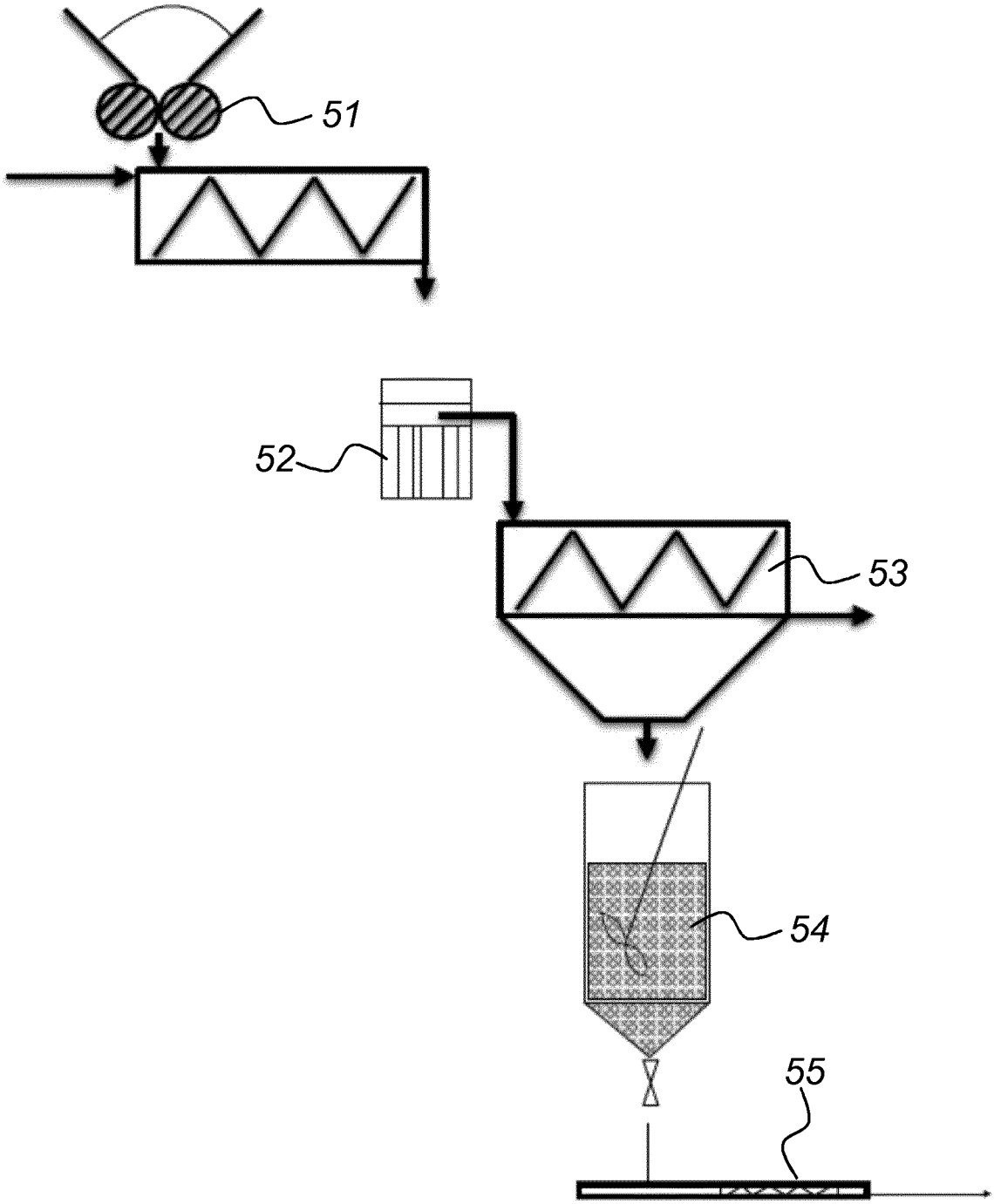

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/063937

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23L7/104
ADD.

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)
A23L

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/089602 A1 (KVIST STEN [SE] ET AL) 28 April 2005 (2005-04-28) paragraphs [0026], [0033], [0044], [0050]	1-18
X	JP 2009 207359 A (MARUSAN I KK) 17 September 2009 (2009-09-17) machine translation para. 0009 and claim 1	1-3,5, 10,15,16
X	US 5 686 123 A (LINDAHL LENNART [SE] ET AL) 11 November 1997 (1997-11-11)	16-18
Y	column 1, line 63 - column 2, line 15	1-15
X	WO 2014/123466 A1 (OATLY AB [SE]) 14 August 2014 (2014-08-14)	16-18
Y	page 4, line 20 - page 5, line 4 page 3, line 9 - line 10	1-15

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 September 2018	02/10/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Graham, Judith

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/063937

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 03/075683 A1 (RAISIO GROUP PLC [FI]; NILSSON JAN [SE]; FUNETEG BO [SE]; LINGERUD CEC) 18 September 2003 (2003-09-18) page 1, line 5 - line 10 page 2, line 37 - page 3, line 6 page 4, line 28 - page 8, line 11 examples 1-3	1-18
X	WO 2010/023351 A1 (RAISIO NUTRITION LTD [FI]; ALHO-LEHTO PIRJO [FI]; KUUSISTO PAEIVI [FI]) 4 March 2010 (2010-03-04)	16-18
Y	page 9, line 35 - page 10, line 10	1-15
Y	KEYING Q ET AL: "An investigation on pretreatments for inactivation of lipase in naked oat kernels using microwave heating", JOURNAL OF FOOD ENGINEERING, BARKING, ESSEX, GB, vol. 95, no. 2, 1 November 2009 (2009-11-01), pages 280-284, XP026419541, ISSN: 0260-8774 [retrieved on 2009-05-08] the whole document	11-14

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2018/063937

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005089602 A1	28-04-2005	NONE	
JP 2009207359 A	17-09-2009	JP 5074238 B2	14-11-2012
		JP 2009207359 A	17-09-2009
US 5686123 A	11-11-1997	AT 199486 T	15-03-2001
		AU 7713594 A	03-04-1995
		CA 2170988 A1	23-03-1995
		DE 69426834 D1	12-04-2001
		DE 69426834 T2	02-08-2001
		DK 0731646 T3	17-04-2001
		EP 0731646 A1	18-09-1996
		ES 2154684 T3	16-04-2001
		FI 961162 A	13-03-1996
		GR 3035983 T3	31-08-2001
		JP 3657003 B2	08-06-2005
		JP H09505204 A	27-05-1997
		PL 313475 A1	08-07-1996
		PT 731646 E	29-06-2001
		US 5686123 A	11-11-1997
		WO 9507628 A1	23-03-1995
WO 2014123466 A1	14-08-2014	AU 2014215729 A1	09-07-2015
		CA 2899717 A1	14-08-2014
		CN 105007757 A	28-10-2015
		EP 2953482 A1	16-12-2015
		HK 1212562 A1	17-06-2016
		JP 2016506732 A	07-03-2016
		JP 2018075029 A	17-05-2018
		KR 20150113200 A	07-10-2015
		RU 2015125371 A	13-03-2017
		SG 11201504862Q A	28-08-2015
		US 2015351432 A1	10-12-2015
		US 2017318841 A1	09-11-2017
		WO 2014123466 A1	14-08-2014
WO 03075683 A1	18-09-2003	AT 556603 T	15-05-2012
		AU 2003210100 A1	22-09-2003
		DK 1482813 T3	06-08-2012
		EP 1482813 A1	08-12-2004
		ES 2387671 T3	28-09-2012
		NO 327618 B1	31-08-2009
		PL 204435 B1	29-01-2010
		RU 2323590 C2	10-05-2008
		WO 03075683 A1	18-09-2003
WO 2010023351 A1	04-03-2010	BR PI0912907 A2	04-08-2015
		CA 2734386 A1	04-02-2010
		CN 102137596 A	27-07-2011
		EP 2343990 A1	20-07-2011
		FI 20080492 A	02-03-2010
		RU 2011108027 A	10-10-2012
		US 2011159145 A1	30-06-2011
		WO 2010023351 A1	04-03-2010