

Nutritional products comprising hydrolyzed whole grain

Technical field of the invention

The present invention relates to nutritional products being supplemented with
5 whole grain. In particular the present invention relates to nutritional products
which are supplemented with hydrolysed whole grain, where neither taste or
viscosity nor organoleptic properties of the nutritional product have been
compromised.

10 Background of the invention

There is now extensive evidence emerging mainly from epidemiological studies
that a daily intake of three servings of whole grain products, i.e. 48 g of whole
grain, is positively associated with decreased risk of cardiovascular diseases,
increased insulin sensitivity and decreased risk of type 2 diabetes onset, obesity
15 (mainly visceral obesity) and digestive system cancers. These health benefits of
the whole grains are reported to be due to the synergistic role of the dietary fibers
and other components, such as vitamins, minerals and bioactive phytochemicals.

The regulatory authorities in Sweden, the US and the UK have already approved
20 specific heart health claims based on the available scientific substantiation.
Food products comprising dietary fibers are also growing in popularity with
consumers, not just because whole grain consumption is now included in some
national dietary recommendations but also because whole grain products are
considered wholesome and natural. Recommendations for whole grain
25 consumption have been set up by government authorities and expert groups to
encourage consumers to eat whole grains. For instance, in the U.S.A,
recommendations are to consume 45-80 g of whole grain per day. However, data
provided by national dietary surveys in the United Kingdom, the U.S.A. and China
show that whole grain consumption varies between 0 and 30 g whole grains per
30 day.

The lack of whole grain products offered on the shelves and the poor organoleptic
properties of the available whole grain products are generally identified as barriers

for whole grain consumption and restrict the amount of whole grain to be added to e.g. a nutritional product, because, when increased amounts of whole grain are added the physical and organoleptic properties of the nutritional product changes dramatically.

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Whole grains are also a recognised source of dietary fibers, phytonutrients, antioxidants, vitamins and minerals. According to the definition given by the American Association of Cereal Chemists (AACC), whole grains, and food made from whole grains, consist of the entire grain seed. The entire grain seed
10 comprises the germ, the endosperm and the bran. It is usually referred to as the kernel.

Moreover, in recent years, consumers have increased attention to the label of food products, e.g. nutritional products, and they expect manufactured food products
15 to be as natural and healthy as possible. Therefore, it is desirable to develop food and drink processing technologies and food and drink products that limit the use of non-natural food additives, even when such non-natural food additives have been fully cleared by health or food safety authorities.

20 Given the health benefits of whole grain cereal, it is desirable to provide a whole grain ingredient having as much intact dietary fibers as possible. Nutritional products are a good vehicle for delivering whole grain and to increase the whole grain content of a product or a serving, it is of course possible to increase the serving size. But this is not desirable as it results in a greater calorie intake.
25 Another difficulty in just increasing the whole grain content of the product is that it usually impacts on physical properties such as the taste, texture and the overall appearance of the nutritional product (organoleptic parameters), as well as its processability.

30 The consumer is not willing to compromise on nutritional products organoleptic properties, in order to increase his daily whole grain intake. Taste, texture and overall appearance are such organoleptic properties.

Obviously, industrial line efficiency is a mandatory requirement in the food
35 industry. This includes handling and processing of raw materials, forming of the

nutritional products, packaging and later storing, in warehouses, on the shelf or at home.

US 4,282,319 relates to a process for the preparation of hydrolyzed products from whole grain, and such derived products. The process includes an enzymatic treatment in an aqueous medium with a protease and an amylase. The obtained product may be added to different types of products. US 4,282,319 describe a complete degradation of the proteins present in the whole grain.

US 5,686,123 discloses a cereal suspension generated by treatment with both an alpha-amylase and a beta-amylase both specifically generating maltose units and have no glucanase effect.

Thus, it is an object of the present invention to provide nutritional products that are rich in whole grains and in dietary fibers, while maintaining a low calorie intake, that provide an excellent consumption experience to the consumer, and that may be easily industrialised at a reasonable cost without compromising the organoleptic parameters.

Summary of the invention

Accordingly, in a first aspect the invention relates to a nutritional product comprising

- a hydrolyzed whole grain composition; and
- an alpha-amylase or fragment thereof, which alpha-amylase or fragment thereof shows no hydrolytic activity towards dietary fibers when in the active state;

wherein said nutritional product is fortified with at least 2 essential minerals and at least 4 essential vitamins.

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Another aspect of the present invention relates to a process for preparing a nutritional product, said process comprising:

- 1) preparing a hydrolyzed whole grain composition, comprising the steps of:

- a) contacting a whole grain component with an enzyme composition in water, the enzyme composition comprising at least one alpha-amylase, said enzyme composition showing no hydrolytic activity towards dietary fibers,
- 5 b) allowing the enzyme composition to react with the whole grain component, to provide a whole grain hydrolysate,
- c) providing the hydrolyzed whole grain composition by inactivating said enzymes when said hydrolysate has reached a viscosity comprised between 50 and 5000 mPa.s measured at 65°C;
- 10 2) providing the nutritional product by mixing the hydrolyzed whole grain composition with at least 2 essential minerals and at least 4 essential vitamins.

Brief description of the drawings

Figure 1 shows a thin layer chromatography analysis of various enzymes put in
15 contact with dietary fibres. The legend for the different tracks is the following:

- A0: pure arabinoxylan spot (blank)
- β0: pure beta-glucan spot (blank)
- A: arabinoxylan spot after incubation with the enzyme noted below the track (BAN, Validase HT 425L and Alcalase AF 2.4L)
- 20 β: beta-glucan spot after incubation with the enzyme noted below the track (BAN, Validase HT 425L and Alcalase AF 2.4L)
- E0: enzyme spot (blank)

Figure 2 shows size exclusion chromatography (SEC) of β-Glucan and
25 arabinoxylan molecular weight profile without enzyme addition (plain line) and after incubation with Alcalase 2.4L (dotted line). A) Oat β-glucan; B) Wheat arabinoxylan.

Figure 3 shows size exclusion chromatography (SEC) of β-Glucan and
30 arabinoxylan molecular weight profile without enzyme addition (plain line) and after incubation with Validase HT 425L (dotted line). A) Oat β-glucan; B) Wheat arabinoxylan.

Figure 4 shows size exclusion chromatography (SEC) of β -Glucan and arabinoxylan molecular weight profiles without enzyme addition (plain line) and after incubation with MATS L (dotted line). A) Oat β -glucan; B) Wheat arabinoxylan.

5 Detailed description of the invention

The inventors of the present invention have surprisingly found that by treating the whole grain component with an alpha-amylase and optionally with a protease the whole grain will become less viscous and the following mixing into the nutritional product may be easier. This results in the possibility to increase the amount of whole grains in the product. Furthermore, the alpha-amylase treatment also results in a reduced need for adding sweetener such as sucrose to the nutritional products.

- Thus in a first aspect the invention relates to a nutritional product comprising
- a hydrolyzed whole grain composition; and
 - an alpha-amylase or fragment thereof, which alpha-amylase or fragment thereof shows no hydrolytic activity towards dietary fibers when in the active state;
- wherein said nutritional product is fortified with at least 2 essential minerals and at least 4 essential vitamins.

Several advantages of having a nutritional product comprising a hydrolyzed whole grain composition according to the invention may exist:

- I. An increase in whole grain and fiber content may be provided in the final product, while the organoleptic parameters of the product are substantially not affected;
- II. Dietary fibers from the whole grain may be preserved;
- III. Greater sense of satiety substantially without affecting the organoleptic parameters of the product and slower digestion. Currently, there are limitations for enriching nutritional products with whole grain due to non-flowable viscosity, grainy texture, and taste issues. However, the use of hydrolyzed whole grain according to the present invention in nutritional

products allow for providing the desired viscosity, a smooth texture, minimal flavour impact, and added nutritional health and wellness values;

- IV. An additional advantage may be to improve the carbohydrate profile of the nutritional product products by replacing traditional externally supplied sweeteners such as glucose syrup, high fructose corn syrup, invert syrup, maltodextrine, sucrose, fiber concentrate, inulin, etc. with a more wholesome sweetener source.

- In the present context the term "nutritional product" relates to a packaged products in a prepared form, such as a liquid or pudding that are ready for consumption or as a product which are to be reconstituted in a liquid before consumption such as a powder. By the term "ready for consumption" is meant that the product is ready and suitable to be consumed directly from the package without the need for the addition of further ingredients. The term "ready for consumption" does not exclude pouring the product or part of the product into a glass, cup, jar or the like. Thus, in an embodiment the nutritional product is a powder, a semi-solid product such as a pudding or a liquid. In an additional embodiment the nutritional product is to be reconstituted in a liquid component before consumption.
- As mentioned above the present invention comprises at least 2 essential minerals and at least 4 essential vitamins. Minerals are components of foods that are involved in many body functions. For example, calcium and magnesium are important for bone structure, and iron is needed for our red blood cells to transport oxygen. Like vitamins, minerals are not a source of energy and are best obtained through a varied diet rather than supplements.

- The nutritional product according to the invention may be fortified with minerals and vitamins. In an embodiment the nutritional product comprises at least two essential minerals, such as at least 4, such as at least 6, and such as at least 8 essential minerals. In yet an embodiment the essential minerals are selected from the group consisting of calcium, copper, iodine, iron, magnesium, manganese, phosphorus, boron, chromium, molybdenum, nickel, potassium, selenium, silicon, tin, and vanadium, preferably, zinc, calcium, magnesium and any combination thereof.

Vitamins are compounds that help to regulate chemical reactions in the body.

There are 13 vitamins, including vitamins A, B complex, C, D, E, and K. Because most vitamins cannot be made in the body, we must obtain them through the

- 5 diet. Many people say that they feel more energetic after consuming vitamins, but vitamins are not a source of energy (calories). Vitamins are best consumed through a varied diet rather than as a supplement because there is little chance of taking too high a dose.

In a further embodiment the nutritional product may comprises at least 4

- 10 essential vitamins, such as at least 6, such as at least 8, and such as at least 10 essential vitamins. In yet a further embodiment the essential vitamins are selected from the group consisting of biotin, folic acid, niacin, pantothenic acid, riboflavin, thiamin, vitamin A, vitamin B12, vitamin B6, vitamin C, vitamin D, vitamin E and vitamin K, in particular folic acid, riboflavin, thiamin, vitamin A, vitamin B12,
15 vitamin B6, vitamin C, vitamin D, vitamin E and any combination thereof. In a preferred embodiment the vitamins are selected from the group consisting of Folic Acid, Riboflavin, Thiamin, Vitamin A, Vitamin B6, Vitamin B12, Vitamin C, Vitamin D, Vitamin E, and any combination thereof.

- 20 Providing amounts may be arbitrary and are generally referred to by serving because, many products may be designed for sole nutrition and would therefore have an amount that would be dangerous if not life threatening if put into a product which is not intended as a sole source of nutrition or useless in the reverse. The ranges provided in the table below covers the interval Lower
25 Reference Nutrient Intake (LRNI)", preferably meant to include the lower end of physiological needs, or defined as the average minus 2 standard deviation, and up to the Tolerable Upper Limit (maximum nutrient level that will likely pose no risk of adverse events) both of which are known to a person of ordinary skill in the art). Serving size vary as well from elderly product designed to provide substantial
30 nutrition during med pass (when they take their meds) (typically 60-125ml) to about 237ml for a typical Boost product to 1.5L for tube feeding.

Amount of vitamin and mineral in a product per serving:

Representative Vitamins/Minerals	In Some Embodiments Ranges Per Serving	Ranges Per Serving
Biotin	75 - 100 mcg	30 – 390 mcg
Calcium	167 - 500 mg	167 – 3000 mg
Copper	.24 - 0.5 mg	0.24 - 8.0 mg
Folic Acid	100 - 140 mcg	100 - 800 mcg
Iodine	25 – 45 mcg	25 – 900 mcg
Iron	3-5 mg	3 – 45 mg
Magnesium	47 – 100 mg	47 – 600 mg
Manganese	0.47 - 0.7 mg	0.47 – 9 mg
Niacin	4 - 7 mg	4 - 30 mg
Pantothenic Acid	2.4 - 3.5 mg	2.4 - 13 mg
Phosphorus	167 - 500 mg	167 - 3000 mg
Riboflavin	0.43 - 0.6 mg	0.42 - 40 mg
Thiamin	0.38 - .64 mg	0.37 - 100 mg
Vitamin A	650 - 2250 IU	650 - 9000 IU
Vitamin B12	1.4 - 2.1 mcg	1.4 – 7.6 mcg
Vitamin B6	0.5 - 1.0 mg	0.5 - 80 mg
Vitamin C	30 - 60 mg	30 - 1800 mg
Vitamin D	60 - 100 IU	60 - 4000 IU
Vitamin E	7 - 30 IU	7 – 1760 IU
Vitamin K	9.5 -32 mcg	9.5 -1000 mcg
Zinc	2.8 - 4.5 mg	2.8 - 34 mg

The above table indicates specific concentrations of vitamins and minerals according to the present invention.

- 5 A quality parameter of the nutritional product and an important parameter in respect of the product processability is the viscosity of the hydrolysed whole grain composition. In the present context the term “viscosity” is a measurement of “thickness” or fluidability of a fluid. Thus, viscosity is a measure of the resistance of a fluid which is being deformed by either shear stress or tensile stress. If not
- 10 indicated otherwise viscosity is given in mPa.s.

Viscosity may be measured using a Rapid Visco Analyser from Newport Scientific. The Rapid Visco Analyser measures the resistance of the product to the stirring action of a paddle. The viscosity is measured after 10 minutes stirring, at 65°C

15 and 50 rpm.

The viscosity of the nutritional product according to the invention may vary depending on the specific products. In an embodiment of the present invention,

the nutritional product is a liquid having a viscosity is in the range 1-300 mPa.s, such as in the range 10-200 mPa.s, such as in the range 10-150 mPa.s, such as in the range 10-100 mPa.s, such as in the range 10-50 mPa.s, such as in the range 2-50 mPa.s, or such as in the range 2-20 mPa.s.

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The whole grain component may be obtained from different sources. Examples of whole grain sources are semolina, cones, grits, flour and micronized grain (micronized flour). The whole grains may be grounded, preferably by dry milling. Such grounding may take place before or after the whole grain component being
10 contacted with the enzyme composition according to the invention.

In an embodiment of the present invention the whole grain component may be heat treated to limit rancidity and microbial count.

15 Whole grains are cereals of monocotyledonous plants of the Poaceae family (grass family) cultivated for their edible, starchy grains. Examples of whole grain cereals include barley, rice, black rice, brown rice, wild rice, buckwheat, bulgur, corn, millet, oat, sorghum, spelt, triticale, rye, wheat, wheat berries, teff, canary grass, Job's tears and fonio. Plant species that do not belong to the grass family also
20 produce starchy seeds or fruits that may be used in the same way as cereal grains, are called pseudo-cereals. Examples of pseudo-cereals include amaranth, buckwheat, tartar buckwheat and quinoa. When designating cereals, this will include both cereal and pseudo-cereals.

25 Thus, the whole grain component according to the invention may originate from a cereal or a pseudo-cereal. Thus, in an embodiment the hydrolyzed whole grain composition is obtained from a plant selected from the group consisting of barley, rice, brown rice, wild rice, black rice, buckwheat, bulgur, corn, millet, oat, sorghum, spelt, triticale, rye, wheat, wheat berries, teff, canary grass, Job's tears,
30 fonio, amaranth, buckwheat, tartar buckwheat, quinoa, other variety of cereals and pseudo-cereals and mixtures thereof. In general the source of grain depends on the product type, since each grain will provide its own taste profile.

Whole grain components are components made from unrefined cereal grains.

35 Whole grain components comprise the entire edible parts of a grain; i.e. the germ,

the endosperm and the bran. Whole grain components may be provided in a variety of forms such as ground, flaked, cracked or other forms, as is commonly known in the milling industry.

- 5 In the present context the phrasing "a hydrolyzed whole grain composition" refers to enzymatically digested whole grain components or a whole grain component digested by using at least an alpha-amylase, which alpha-amylase shows no hydrolytic activity towards dietary fibers when in the active state. The hydrolyzed whole grain composition may be further digested by the use of a protease, which
10 protease shows no hydrolytic activity towards dietary fibers when in the active state.

- In the present context it is also to be understood that the phrase "a hydrolyzed whole grain composition" is also relating to enzymatic treatment of flour and
15 subsequent reconstitution of the whole grain by blending flour, bran and germ. It is also to be understood that reconstitution may be done before the use in the final product or during mixing in a final product. Thus, reconstitution of whole grains after treatment of one or more of the individual parts of the whole grain also forms part of the present invention.

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Prior to or after grinding of the whole grain, the whole grain component may be subjected to a hydrolytic treatment in order to breakdown the polysaccharide structure and optionally the protein structure of the whole grain component.

- 25 The hydrolyzed whole grain composition may be provided in the form of a liquid, a concentrate, a powder, a juice or a puree. If more than one type of enzymes is used it is to be understood that the enzymatic processing of the whole grains may be performed by sequential addition of the enzymes, or by providing an enzyme composition comprising more than one type of enzyme.

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- In the present context the phrase "an enzyme showing no hydrolytic activity towards dietary fibers when in the active state" should be understood as also encompassing the enzyme mixture from which the enzyme originates. For example, the proteases, amylases, glucose isomerase and amyloglucosidase
35 described in the present context may be provided as an enzyme mixture before

use which is not completely purified and thus, comprise enzymatic activity towards e.g. dietary fibers. However, the activity towards dietary fibers may also come from the specific enzyme if the enzyme is multi-functional. As used in here, the enzymes (or enzyme mixtures) are devoid of hydrolytic activity towards
5 dietary fibers.

The term "no hydrolytic activity" or "devoid of hydrolytic activity towards dietary fibers" may encompass up to 5% degradation of the dietary fibers, such as up to 3%, such as up to 2% and such as up to 1% degradation. Such degradation may
10 be unavoidable if high concentrations or extensive incubation times are used.

The term "In the active state" refers to the capability of the enzyme or enzyme mixture to perform hydrolytic activity, and is the state of the enzyme before it is inactivated. Inactivation may occur both by degradation and denaturation.
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In general the weight percentages throughout the application are given as percentage by weight on a dry matter basis unless otherwise stated.

The nutritional product according to the invention may comprise a protease which
20 shows no hydrolytic activity towards dietary fibers when in the active state. The advantage of adding a protease according to the invention is that the viscosity of the hydrolyzed whole grain may be further lowered, which may also result in a decrease in the viscosity of the final product. Thus, in an embodiment according to the invention the nutritional product comprises said protease or fragment
25 thereof at a concentration of 0.0001 to 5% (w/w) by weight of the total whole grain content, such as 0.01-3%, such as 0.01-1%, such as 0.05-1%, such as 0.1-1%, such as 0.1-0.7%, or such as 0.1-0.5%. The optimal concentration of added proteases depends on several factors. As it has been found that the addition of protease during production of the hydrolyzed whole grain may result in a bitter
30 off-taste, addition of protease may be considered as a tradeoff between lower viscosity and off-taste. In addition the amount of protease may also depend on the incubation time during production of the hydrolyzed whole grain. For example a lower concentration of protease may be used if the incubation time is increased.

Proteases are enzymes allowing the hydrolysis of proteins. They may be used to decrease the viscosity of the hydrolyzed whole grain composition. Alcalase 2.4L (EC 3.4.21.62), from Novozymes is an example of a suitable enzyme.

Depending on the incubation time and concentration of protease a certain amount
5 of the proteins from the hydrolyzed whole grain component may be hydrolyzed to amino acid and peptide fragments. Thus, in an embodiment 1-10% of the proteins from the whole grain composition is hydrolyzed, such as 2-8%, e.g. 3-6%, 10-99%, such as 30-99%, such as 40-99%, such as 50-99%, such as 60-99%, such as 70-99%, such as 80-99%, such as 90-99%, or such as 10-40%, 40-70%, and
10 60-99%. Again protein degradation may result in a lowered viscosity and improved organoleptic parameters.

In the present context the phrase "hydrolyzed protein content" refers to the content of hydrolyzed protein from the whole grain composition unless otherwise
15 defined. The protein may be degraded into larger or smaller peptide units or even into amino acid components. The person skilled in the art will know that during processing and storage small amount of degradation will take place which is not due to external enzymatic degradation.

20 In general it is to be understood that the enzymes used in the production of the hydrolyzed whole grain composition (and therefore also present in the final product) is different from the corresponding enzymes naturally present in the whole grain component.

25 Since the nutritional product according to the invention may also comprise proteins from sources, different from the hydrolyzed whole grain component, which are not degraded, it may be appropriate to evaluate the protein degradation on more specific proteins present in the whole grain composition. Thus, in an embodiment the degraded proteins are whole grain proteins, such as gluten
30 proteins, globulins, albumins and glycoproteins.

Amylase (EC 3. 2. 1. 1) is an enzyme classified as a saccharidase: an enzyme that cleaves polysaccharides. It is mainly a constituent of pancreatic juice and saliva, needed for the breakdown of long-chain carbohydrates such as starch, into
35 smaller units. Here, alpha-amylase is used to hydrolyse gelatinized starch in order

to decrease the viscosity of the hydrolyzed whole grain composition. Validase HT 425L, Validase RA from Valley Research, Fungamyl from Novozymes and MATS from DSM are examples of alpha-amylases suitable for the present invention.

Those enzymes show no activity towards the dietary fibers in the processing
5 conditions used (duration, enzyme concentrations). On the contrary, e.g. BAN from Novozymes degrades dietary fibers besides starch into low molecular weight fibers or oligosaccharides, see also example 3.

In an embodiment of the present invention the enzymes show no activity towards
10 the dietary fibers when the enzyme concentration is below 5% (w/w), such as below, 3% (w/w), e.g. below 1% (w/w), such as below 0.75% (w/w), e.g. below 0.5% (w/w).

Some alpha-amylases generate maltose units as the smallest carbohydrate
15 entities, whereas others are also able to produce a fraction of glucose units. Thus, in an embodiment the alpha-amylase or fragments thereof is a mixed sugar producing alpha-amylase, including glucose producing activity, when in the active state. It has been found that some alpha-amylases both comprise glucose producing activity while having no hydrolytic activity towards dietary fibers when
20 in the active state. By having an alpha-amylase which comprises glucose producing activity an increased sweetness may be obtained, since glucose has almost twice the sweetness of maltose. In an embodiment of the present invention a reduced amount of external sugar source needs to be added separately to the nutritional product when a hydrolysed whole grain composition
25 according to the present invention is used. When an alpha-amylase comprising glucose producing activity is used in the enzyme composition, it may become possible to dispense or at least reduce the use of other external sugar sources or non-sugar sweeteners.

30 In the present context the term "external sugar or non-sugar sweetener source" relates to sugars and non-sugar sweeteners not originally present or originally generated in the hydrolysed whole grain composition. Examples of such external sugar or non-sugar sources could be sucrose, lactose, and artificial sweeteners.

Amyloglucosidase (EC 3.2.1.3) is an enzyme able to release glucose residues from starch, maltodextrins and maltose by hydrolyzing glucose units from the non-reduced end of the polysaccharide chain. The sweetness of the preparation increases with the increasing concentration of released glucose. Thus, in an embodiment the nutritional product further comprises an amyloglucosidase or fragments thereof. It may be advantageous to add an amyloglucosidase to the production of the hydrolyzed whole grain composition, since the sweetness of the preparation increases with the increasing concentration of released glucose. It may also be advantageous if the amyloglucosidase did not influence health properties of the whole grains, directly or indirectly. Thus, in an embodiment the amyloglucosidase shows no hydrolytic activity towards dietary fibers when in the active state. An interest of the invention, and particularly of the process for preparing the nutritional product according to the invention, is that it allows reducing the sugar (e.g. sucrose) content of the nutritional product when compared to products described in the prior art. When an amyloglucosidase is used in the enzyme composition, it may become possible to dispense with other external sugar sources e.g. the addition of sucrose.

However, as mentioned above certain alpha-amylases are able to generate glucose units, which may add enough sweetness to the product making the use of amyloglucosidase dispensable. Furthermore, application of amyloglucosidase also increases production costs of the nutritional product and, hence, it may be desirable to limit the use of amyloglucosidases. Thus, in yet an embodiment the nutritional product according to the invention does not comprise an amyloglucosidase such as an exogenic amyloglucosidase.

Glucose isomerase (D-glucose ketoisomerase) causes the isomerization of glucose to fructose. Thus, in an embodiment of the present invention the nutritional product further comprises a glucose isomerase or fragments thereof, which glucose isomerase or fragments thereof show no hydrolytic activity towards dietary fibers when in the active state. Glucose has 70-75% the sweetness of sucrose, whereas fructose is twice as sweet as sucrose. Thus, processes for the manufacture of fructose are of considerable value because the sweetness of the product may be significantly increased without the addition of an external sugar source (such as sucrose or artificial sweetening agents).

A number of specific enzymes or enzyme mixtures may be used for production of the hydrolyzed whole grain composition according to the invention. The requirement is that they show substantially no hydrolytic activity in the process conditions used towards dietary fibers. Thus, in an embodiment the alpha-amylase may be selected from Validase HT 425L and Validase RA from Valley Research, Fungamyl from Novozymes and MATS from DSM, the protease may be selected from the group consisting of Alcalase, iZyme B and iZyme G (Novozymes).

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The concentration of the enzymes according to the invention in the nutritional product may influence the organoleptic parameters of the nutritional product. In addition the concentration of enzymes may also be adjusted by changing parameters such as temperature and incubation time. Thus, in an embodiment the nutritional product comprises 0.0001 to 5% by weight of the total whole grain content in the nutritional product of at least one of:

- an alpha-amylase or fragment thereof, which alpha-amylase or fragment thereof shows no hydrolytic activity towards dietary fibers when in the active state;
- 20 - an amyloglucosidase or fragment thereof, which amyloglucosidase shows no hydrolytic activity towards dietary fibers when in the active state; and
- a glucose isomerase or fragment thereof, which amyloglucosidase shows no hydrolytic activity towards dietary fibers when in the active state.

In yet an embodiment the nutritional product comprises 0.001 to 3% of the alpha-amylase by weight of the total whole grain content in the nutritional product, such as 0.01-3%, such as 0.01-0.1%, such as 0.01-0.5%, such as 0.01-0.1%, such as 0.03-0.1%, such as 0.04-0.1%. In yet an embodiment the nutritional product comprises 0.001 to 3% of the amyloglucosidase by weight of the total whole grain content in the nutritional product, such as 0.001-3%, such as 0.01-1%, such as 0.01-0.5%, such as 0.01-0.5%, such as 0.01-0.1%, such as 0.03-0.1%, such as 0.04-0.1%. In another further embodiment the nutritional product comprises 0.001 to 3% of the glucose isomerase by weight of the total whole grain content in the nutritional product, such as 0.001-3%, such as 0.01-

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1%, such as 0.01-0.5%, such as 0.01-0.5%, such as 0.01-0.1%, such as 0.03-0.1%, such as 0.04-0.1%.

Beta-amylases are enzymes which also break down saccharides, however beta-amylases mainly have maltose as the smallest generated carbohydrate entity.

- 5 Thus, in an embodiment the nutritional product according to the invention does not comprise a beta-amylase, such as an exogenic beta-amylase. By avoiding beta-amylases a larger fraction of the starches will be hydrolyzed to glucose units since the alpha amylases do have to compete with the beta-amylases for substrates. Thus, an improved sugar profile may be obtained. This is in contrast
- 10 to US 5,686,123 which discloses a cereal suspension generated by treatment with both an alpha-amylase and a beta-amylase.

- In certain instances the action of the protease is not necessary, to provide a sufficient low viscosity. Thus, in an embodiment according to the invention, the
- 15 nutritional product does not comprise the protease, such as an exogenic protease. As described earlier the addition of protease may generate a bitter off-taste which in certain instances is desirable to avoid. This is in contrast to US 4,282,319 which discloses a process including enzymatic treatment with a protease and an amylase.

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- In general the enzymes used according to the present invention for producing the hydrolyzed whole grain composition show no hydrolytic activity towards dietary fibers when in the active state. Thus, in a further embodiment the hydrolyzed whole grain composition has a substantial intact beta-glucan structure relative to
- 25 the starting material. In yet a further embodiment the hydrolyzed whole composition has a substantial intact arabinoxylan structure relative to the starting material. By using the one or more enzymes according to the invention for the production of the hydrolyzed whole grain composition, a substantial intact beta-glucan and arabinoxylan structure may be maintained. The degree of degradation
- 30 of the beta-glucan and arabinoxylan structures may be determined by Size-exclusion chromatography (SEC). This SEC technique has been described in more detail in "Determination of beta-Glucan Molecular Weight Using SEC with Calcofluor Detection in Cereal Extracts Lena Rimsten, Tove Stenberg, Roger Andersson, Annica Andersson, and Per Åman. Cereal Chem. 80(4):485-490",

which is hereby incorporated by reference.

In the present context the phrase "substantial intact structure" is to be understood as for the most part the structure is intact. However, due to natural degradation in any natural product, part of a structure (such as beta-glucan structure or arabinoxylan structure) may be degraded although the degradation may not be due to added enzymes. Thus, "substantial intact structure" is to be understood that the structure is at least 95% intact, such as at least 97%, such as at least 98%, or such as at least 99% intact.

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In the present context enzymes such as proteases, amylases, glucose isomerases and amyloglucosidases refer to enzymes which have been previously purified or partly purified. Such proteins/enzymes may be produced in bacteria, fungi or yeast, however they may also have plant origin. In general such produced

15 enzymes will in the present context fall under the category "exogenic enzymes".

Such enzymes may be added to a product during production to add a certain enzymatic effect to a substance. Similar, in the present context, when an enzyme is disclaimed from the present invention such disclaimer refers to exogenic enzymes. In the present context such enzymes e.g. provide enzymatic

20 degradation of starch and proteins to increase viscosity. In relation to the process of the invention it is to be understood that such enzymes may both be in solution or attached to a surface, such as immobilized enzymes. In the latter method the proteins may not form part of the final product.

25 As mentioned earlier, the action of the alpha-amylase results in a useful sugar profile which may affect taste and reduce the amount of external sugar or sweetener to be added to the final product.

In an embodiment of the present invention the hydrolysed whole grain composition has a glucose content of at least 0.25% by weight of the hydrolysed whole grain composition, on a dry matter basis, such as at least 0.35%, e.g. at least 0.5%.

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Depending on the specific enzymes used the sugar profile of the final product may change. Thus, in an embodiment the nutritional product has a maltose to glucose ratio below 144:1, by weight in the product, such as below 120:1, such as below

100:1 e.g. below 50:1, such as below 30:1, such as below 20:1 or such as below 10:1.

If the only starch processing enzyme used is a glucose generating alpha-amylase, a larger fraction of the end product will be in the form of glucose compared to the use of an alpha-amylase specifically generating maltose units. Since glucose has a higher sweetness than maltose, this may result in that the addition of a further sugar source (e.g. sucrose) can be dispensed. This advantage may be further pronounced if the ratio is lowered by the conversion of the maltose present in the hydrolyzed whole grain to glucose (one maltose unit is converted to two glucose units).

The maltose to glucose ratio may be further lowered if an amyloglucosidase is included in the enzyme composition since such enzymes also generates glucose units.

If the enzyme composition comprises an glucose isomerase a fraction of the glucose is changed to fructose which has an even higher sweetness than glucose. Thus, in an embodiment the nutritional product has a maltose to glucose + fructose ratio below 144:1 by weight in the product, such as below 120:1, such as below 100:1 e.g. below 50:1, such as below 30:1, such as below 20:1 or such as below 10:1.

Furthermore, in an embodiment of the present invention the nutritional product may have a maltose to fructose ratio below 230:1 by weight in the product, such as below 144:1, such as below 120:1, such as below 100:1 e.g. below 50:1, such as below 30:1, such as below 20:1 or such as below 10:1.

In the present context the phrasing "total content of the whole grain" is to be understood as the combination of the content of "hydrolyzed whole grain composition" and "solid whole grain content". If not indicated otherwise, "total content of the whole grain" is provided as % by weight in the final product. In an embodiment the nutritional product has a total content of the whole grain in the range of 1-30% by weight of the nutritional product, such as 1-20%, such as 1-15%, such as 1-10%, and such as 1-7%.

In the present context the phrasing "content of the hydrolyzed whole grain composition" is to be understood as the % by weight of hydrolyzed whole grains in the final product. Hydrolyzed whole grain composition content is part of the total content of the whole grain composition. Thus, in an embodiment the

5 nutritional product according to the invention has a content of the hydrolyzed whole grain composition in the range 1-30% by weight of the nutritional product, such as 1-20%, such as 1-10% and such as 1-5%. The amount of the hydrolyzed whole grain composition in the final product may depend on the type of product. By using the hydrolyzed whole grain composition according to the invention in a

10 nutritional product, a higher amount of hydrolyzed whole grains may be added (compared to a non-hydrolyzed whole grain composition) without substantially affecting the organoleptic parameters of the product because of the increased amount of soluble fibers in the hydrolysed whole grain.

15 It would be advantageous to have a nutritional product comprising a high content of dietary fibers without compromising the organoleptic parameters of the product. Thus, in yet an embodiment the nutritional product has a content of dietary fibers in the range of 0.1-10% by weight of the nutritional product, preferably, in the range of 0.5-3%, even more preferably in the range of 1-2%

20 (w/w). A nutritional product according to the invention may be provided with high amounts of dietary fibers by the addition of the hydrolyzed whole grain component provided by the present invention. This may be done due to the unique setup of the process according to the present invention.

25 Dietary fibers are the edible parts of plants that are not broken down by digestion enzymes. Dietary fibers are fermented in the human large intestine by the microflora. There are two types of fibers: soluble fibers and insoluble fibers. Both soluble and insoluble dietary fibers can promote a number of positive physiological effects, including a good transit through the intestinal tract which helps to prevent

30 constipation, or a feeling of fullness. Health authorities recommend a consumption of between 20 and 35 g per day of fibers, depending on the weight, gender, age and energy intake.

Soluble fibers are dietary fibers that undergo complete or partial fermentation in

35 the large intestine. Examples of soluble fibers from cereals include beta-glucans,

arabinoxylans, arabinogalactans and resistant starch type 2 and 3, and oligosaccharides deriving from the latters. Soluble fibers from other sources include pectins, acacia gum, gums, alginate, agar, polydextrose, inulins and galacto-oligosaccharides for instance. Some soluble fibers are called prebiotics, 5 because they are a source of energy for the beneficial bacteria (e.g. Bifidobacteria and Lactobacilli) present in the large intestine. Further benefits of soluble fibers include blood sugar control, which is important in diabetes prevention, control of cholesterol, or risk reduction of cardiovascular disease.

- 10 Insoluble fibers are the dietary fibers that are not fermented in the large intestine or only slowly digested by the intestinal microflora. Examples of insoluble fibers include celluloses, hemicelluloses, resistant starch type 1 and lignins. Further benefits of insoluble fibers include promotion of the bowel function through stimulation of the peristalsis, which causes the muscles of the colon to work more, 15 become stronger and function better. There is also evidence that consumption of insoluble fibers may be linked to a reduced risk of gut cancer.

The total solid content of the nutritional product according to the invention may vary. Thus, in another embodiment the total solid content is in the range of 1- 20 50% by weight of the nutritional product, e.g. less than 50, such as less than 40%, such as less than 25% or such as less than 10%. Examples of factors influencing the solid content may be the amount of the hydrolyzed whole grain composition and the degree of hydrolysis in this composition. In the present context the phrasing "total solid content" equals 100 minus moisture content (%) 25 of the product.

It would be advantageously if a nutritional product with good organoleptic parameters, such as sweetness, could be obtained, without addition of large amounts of external sugar sources. Thus, in another embodiment the nutritional 30 product has a content of sugar or a non-sugar sweetener of less than 12% by weight of the nutritional product, such as less than 10%, less than 7%, less than 5%, less than 3%, less than 1% or such as 0%. Since the hydrolyzed whole grain composition supplements the nutritional product with a source of carbohydrates, such as glucose and maltose, the nutritional product is also sweetened from a 35 natural sugar source different from the external sugar source. Thus, the amount

of added external sweetener may be limited. Sucrose is a widely used sweetener in food products, however others sugars may also be used. Thus, in a further embodiment the sugar is a monosaccharide and/or a disaccharide and/or an oligosaccharide. In yet an embodiment the monosaccharide is glucose, galactose, 5 dextrose, fructose or any combination thereof. In yet another embodiment the disaccharide is sucrose, maltose, lactose or any combination thereof.

The water activity of the nutritional products may vary. Thus, in an embodiment the nutritional product has a water activity above 0.35, such as above 0.5, such 10 as above 0.7, or such as above 0.8. Since water activity reflects water content it often also reflects the viscosity of the products. Thus, an increased water activity may result in a lowered viscosity. Water activity or a_w is a measurement of water content. It is defined as the vapor pressure of a liquid divided by that of pure water at the same temperature; therefore, pure distilled water has a water 15 activity of exactly one. As the temperature increases a_w typically increases, except in some products with crystalline salt or sugar. At a_w -values above 0.65 crunchy products traditionally loses crunchiness. Higher a_w substances tend to support more microorganisms that may destroy the product. Bacteria usually require at least 0.91, and fungi at least 0.7. Water activity is measured according to the 20 AOAC method 978.18 and performed at 25°C, after equilibrium is reached, using a HygroLab instrument from Rotronic.

Humectants are often added to products which are to be in a dry or semi-dry state. Thus, in an embodiment the nutritional product does not comprise a 25 humectant. Supplementary ingredients of the nutritional product include, preservatives such as tocopherol, and emulsifiers, such as lecithin, protein powders, cocoa solid, alkylresorcinols, phenolics and other active ingredients, such as DHA, caffeine, and prebiotics.

30 In a further embodiment the nutritional product has a fat content in the range 1-60%, such as in the range 5-50%, such as in the range 5-40%, such as in the range 5-30%, by weight of the nutritional product. . The amount of fat may vary depending on the type of product. Fat components are preferably vegetable fats such as cocoa butter, rapeseed oil, sunflower oil or palm oil, preferably not 35 hydrogenated.

In yet an embodiment the nutritional product may have salt content in the range 0-2% by weight of the nutritional product. In a more specific embodiment the salt is sodium chloride.

5

Depending on the specific type of nutritional product, different flavor components may be added to provide the desired taste. Thus, in a further embodiment the flavor component is selected from the group consisting butterscotch, vanilla, cocoa, coffee, fruit, malt, soya, tea, vegetable, and combinations thereof.

10

The nutritional product according to the invention may be supplemented with a liquid component to provide the right consistency and viscosity. Thus, in an embodiment the nutritional product further comprises a liquid component. In another embodiment the liquid component is selected from the group consisting of
15 water, milk, liquid fruit extract, liquid vegetable extracts, liquid coffee extract, liquid chocolate extract, tea concentrate, malt extract, plant extracts, a soya component or any combination hereof. In yet an embodiment the milk is selected from the group consisting of whole milk, cream, 2% fat milk, 1% fat milk, non-fat skim milk, non-dairy creamer, whey fractions, casein, and any combination
20 hereof. Addition of a liquid component may improve factors such as taste, viscosity and the nutritional profile.

For the aspect of providing the product of the present invention a process is provided for preparing a nutritional product, said process comprising:

25 1) preparing a hydrolyzed whole grain composition, comprising the steps of:

a) contacting a whole grain component with an enzyme composition in water, the enzyme composition comprising at least one alpha-amylase, said enzyme composition showing no hydrolytic activity towards dietary fibers,

30

b) allowing the enzyme composition to react with the whole grain component, to provide a whole grain hydrolysate,

- c) providing the hydrolyzed whole grain composition by inactivating said enzymes when said hydrolysate has reached a viscosity comprised between 50 and 5000 mPa.s measured at 65°C;
- 2) providing the nutritional product by mixing the hydrolyzed whole grain composition with at least 2 essential minerals and at least 4 essential vitamins.

In an embodiment the enzyme composition further comprises a protease or fragment thereof, which protease or fragment thereof shows no hydrolytic activity towards dietary fibers when in the active state. Similar, the enzyme composition may comprise an amyloglucosidase and/or and glucose isomerase according to the present invention.

Several parameters of the process may be controlled to provide the nutritional products according to the invention. Thus, in an embodiment step 1b) is performed at 30-100°C, preferably 50 to 85°C. In a further embodiment step 1b) is performed for 1 minute to 24 hours, such as 1 minute to 12 hours, such as 1 minute to 6 hours, such as 5-120 minutes. In yet an embodiment step 1b) is performed at 30-100°C for 5-120 minutes.

In yet a further embodiment step 1c) is allowed to proceed at 70-150°C for at least 1 second, such as 1-5 minutes, such as 5-120 minutes, such as 5-60 minutes. In an additional embodiment step 1c) is performed by heating to at least 90°C for 5-30 minutes.

In yet an embodiment the reaction in step 1c) is stopped when the hydrolysate has reached a viscosity comprised between 50 and 4000 mPa.s, such as between 50 and 3000 mPa.s, such as between 50 and 1000 mPa.s, such as between 50 and 500 mPa.s. In an additional embodiment viscosity is measured at TS 50.

In another embodiment the the hydrolyzed whole grain composition in step 1) is provided when said hydrolysate has reached a total solid content of 25-60%. By controlling viscosity and solid content the hydrolyzed whole grain may be provided in different forms.

In an additional embodiment the hydrolyzed whole grain component in step 1c) is provided in the form of a liquid, a concentrate, a powder, a juice or a pure. An

advantage of having hydrolyzed whole grain composition in different forms is that when used in a food product dilution may be avoided by using a dry or semi dry form. Similarly, if a more moisten product is desirable, a hydrolyzed whole grain composition in a liquid state may be used.

- 5 The above parameters can be adjusted to regulate the degree of starch degradation, the sugar profile, the total solid content and to regulate the overall organoleptic parameters of the final product.

- To improve the enzymatic processing of the whole grain component it may be
10 advantageous to process the grains before or after the enzymatic treatment. By grounding the grains a larger surface area is made accessible to the enzymes, thereby speeding up the process. In addition the organoleptic parameters may be improved by using a smaller particle size of the grains. In an additional embodiment the whole grains are roasted or toasted before or after enzymatic
15 treatment. Roasting and toasting may improve the taste of the final product.

- To prolong the storage time of the product several treatment can be performed. Thus, in an embodiment the process further comprises at least one of the following treatments: UHT, pasteurization, thermal treatment, retort and any
20 other thermal or non-thermal treatments, such as pressure treatment. In a further embodiment the nutritional product is applied to an enclosure under aseptic conditions. In yet an embodiment the nutritional product is applied to an enclosure under non-aseptic conditions, such as by retort or hot-for-hold.
- 25 It should be noted that embodiments and features described in the context of one of the aspects or embodiments of the present invention also apply to the other aspects of the invention.

- All patent and non-patent references cited in the present application, are hereby
30 incorporated by reference in their entirety.

The invention will now be described in further details in the following non-limiting examples.

Examples***Example 1 - Preparation of a hydrolyzed whole grain composition***

Enzyme compositions comprising Validase HT 425L (alpha-amylase) optionally in combination with Alcalase 2.4 L (protease) were used for the hydrolysis of wheat,
5 barley and oats.

Mixing may be performed in a double jacket cooker, though other industrial equipment may be used. A scraping mixer works continuously and scrapes the inner surface of the mixer. It avoids product burning and helps maintaining a
10 homogeneous temperature. Thus enzyme activity is better controlled. Steam may be injected in the double jacket to increase temperature while cold water is used to decrease it.

In an embodiment, the enzyme composition and water are mixed together at
15 room temperature, between 10 and 25°C. At this low temperature, the enzymes of the enzyme composition have a very weak activity. The whole grain component is then added and the ingredients are mixed for a short period of time, usually less than 20 minutes, until the mixture is homogeneous.

20 The mixture is heated progressively or by thresholds to activate the enzymes and hydrolyse the whole grain component.

Hydrolysis results in a reduction of the viscosity of the mixture. When the whole grain hydrolysate has reached a viscosity comprised between 50 and 5000 mPa.s
25 measured at 65°C and e.g. a total solid content of 25 to 60% by weight, the enzymes are inactivated by heating the hydrolysate at a temperature above 100°C, preferably by steam injection at 120°C.

Enzymes are dosed according to the quantity of total whole grain. Quantities of
30 enzymes are different depending on the type of whole grain component, as protein rates are different. The ratio water/whole grain component can be adapted according to required moisture for the final liquid whole grain. Usually, the water/whole grain component ratio is 60/40. Percents are by weight.

Hydrolysed whole wheat	
Whole wheat flour	Substrate
Enzyme amylase	0.10% based on the substrate
Enzyme protease	0.05% based on the substrate

Hydrolysed whole barley	
Whole barley flour	Substrate
Enzyme amylase	0.10% based on the substrate
Enzyme protease	0.05% based on the substrate

Hydrolysed whole oats	
Whole oats flour	Substrate
Enzyme amylase	0.10% based on the substrate
Enzyme protease	0.05% based on the substrate

Example 2 - Sugar profile of the hydrolyzed whole grain composition

- 5 Hydrolyzed whole grain compositions comprising wheat, barley and oat were prepared according to the method in example 1.

Carbohydrates HPAE:

- The hydrolyzed whole grain compositions were analysed by HPAE for illustrating
10 the sugar profile hydrolysed whole grain composition.

- Carbohydrates are extracted with water, and separated by ion chromatography on an anion exchange column. The eluted compounds are detected electrochemically by means of a pulsed amperometric detector and quantified by comparison with
15 the peak areas of external standards.

Total dietary fibres:

- Duplicate samples (defatted if necessary) are digested for 16 hours in a manner that simulates the human digestive system with 3 enzymes (pancreatic alpha-
20 amylase, protease, and amyloglucosidase) to remove starch and protein. Ethanol is added to precipitate high molecular weight soluble dietary fibre. The resulting mixture is filtered and the residue is dried and weighed. Protein is determined on

the residue of one of the duplicates; ash on the other. The filtrate is captured, concentrated, and analyzed via HPLC to determine the value of low molecular weight soluble dietary fibre (LMWSF).

5 Whole wheat:

	Wheat Reference	Wheat Hydrolysed Alcalase/Validase
Total sugars (% w/w))	2.03	24.36
Glucose	0.1	1.43
Fructose	0.1	0.1
Lactose (monohydrate)	<0.1	<0.1
Sucrose	0.91	0.69
Maltose (monohydrate)	0.91	22.12
Mannitol	<0.02	<0.02
Fucose	<0.02	<0.02
Arabinose	<0.02	0.02
Galactose	<0.02	<0.02
Xylose	<0.02	<0.02
Mannose	<0.02	<0.02
Ribose	<0.02	<0.02
Insoluble and soluble fibers	12.90	12.94
LMW fibers	2.63	2.96
Total fibers	15.53	15.90

Whole oats:

	Oats Reference	Oats Hydrolysed Alcalase/Validase
Total sugars (% w/w))	1.40	5.53
Glucose	0.1	0.58
Fructose	0.1	0.1
Lactose (monohydrate)	<0.1	<0.1
Sucrose	1.09	1.03
Maltose (monohydrate)	0.11	3.83
Mannitol	<0.02	<0.02
Fucose	<0.02	<0.02
Arabinose	<0.02	<0.02
Galactose	<0.02	<0.02
Xylose	<0.02	<0.02
Mannose	<0.02	<0.02
Ribose	<0.02	<0.02
Insoluble and soluble fibers	9.25	11.28
LMW fibers	0.67	1.21
Total fibers	9.92	12.49

Whole Barley:

	Barley Reference	Barley Hydrolysed Alcalase/Validase
Total sugars (% w/w))	1.21	5.24
Glucose	0.1	0.61
Fructose	0.1	0.1
Lactose (monohydrate)	<0.1	<0.1
Sucrose	0.90	0.88
Maltose (monohydrate)	0.11	3.65
Mannitol	<0.02	<0.02
Fucose	<0.02	<0.02
Arabinose	<0.02	<0.02
Galactose	<0.02	<0.02
Xylose	<0.02	<0.02
Mannose	<0.02	<0.02
Ribose	<0.02	<0.02
Glucose	0.1	0.61
Fructose	0.1	0.1
Insoluble and soluble fibers	9.70	10.44
LMW fibers	2.23	2.63
Total fibers	11.93	13.07

The results clearly demonstrate that a significant increase in the glucose content is provided by the hydrolysis where the glucose content of the hydrolysed barley is 0.61% (w/w) on a dry matter basis; the glucose content of the hydrolysed oat is 0.58% (w/w) on a dry matter basis; and the glucose content of the hydrolysed wheat is 1.43% (w/w) on a dry matter basis.

Furthermore, the results also demonstrates that the maltose:glucose ratio is ranging from about 15:1 to about 6:1.

Thus, based on these results a new sugar profile is provided having a increased sweetness compared to the prior art.

In conclusion, an increased sweetness may be obtained by using the hydrolyzed whole grain composition according to the invention and therefore the need for further sweetening sources may be dispensed or limited.

In addition, the results demonstrate that the dietary fiber content is kept intact and the ratio and amount of soluble and insoluble fibers are substantially the

same in the non-hydrolyzed whole grain and in the hydrolyzed whole grain composition.

Example 3 – Hydrolytic activity on dietary fibers

- 5 The enzymes Validase HT 425L (Valley Research), Alcalase 2.4L (Novozymes) and BAN (Novozymes) were analysed using a thin layer chromatography analysis for activity towards arabinoxylan and beta-glucan fibre extracts both components of dietary fibers of whole grain.
- 10 The results from the thin layer chromatography analysis showed that the amylase Validase HT and the protease Alcalase showed no hydrolytic activity on either beta-glucan or arabinoxylan, while the commercial alpha-amylase preparation, BAN, causes hydrolysis of both the beta-glucan and arabinoxylan, see figure 1. See also example 4.

15

Example 4 - Oat β -Glucan and Arabinoxylan molecular weight profile following enzymatic hydrolysis

Hydrolysis:

- A solution of 0.5 % (w/v) of Oat β -Glucan medium viscosity (Megazyme) or Wheat
- 20 Arabinoxylan medium viscosity (Megazyme) was prepared in water.
- The enzyme was added at an enzyme to substrate ratio (E/S) of 0.1 % (v/v). The reaction was allowed to proceed at 50°C for 20 minutes, the sample was then placed at 85°C during 15 min to enable starch gelatinization and hydrolysis. The enzymes were finally inactivated at 95°C for 15 minutes. Different batches of the
- 25 following enzymes have been evaluated.

- | | |
|--|-----------------|
| Alcalase 2.4L (Valley Research): | batch BN 00013 |
| | batch 62477 |
| | batch 75039 |
| 30 Validase HT 425L (Valley Research): | batch RA8303A |
| | batch 72044 |
| MATS L (DSM): | batch 408280001 |

Molecular weight analysis

Hydrolyzed samples were filtered on a syringe filter (0.22 µm) and 25 µL were injected on a High Pressure Liquid Chromatography Agilent 1200 series equipped with 2 TSKgel columns in serie (G3000PWXL 7,8 x 300 mm), (GMPWXL 7,8X 305 mm) and with a guard column (PWXL 6 x 44 mm). (Tosoh Bioscience) Sodium Nitrate 0.1M/ at 0.5ml/min was used as running buffer. Detection was done by reflective index measurement.

Results

- 10 On figures 2-4 graphs for both a control (no enzyme) and test with enzymes are plotted. However, since there are substantially no difference between the graphs it may be difficult to differentiate both graphs from each other.

Conclusions

- 15 No shift in oat beta glucan and wheat arabinoxylan fibre molecular weight profile was determined following hydrolysis with the Alcalase 2.4 L (figure 2), Validase HT 425 L (figure 3) or MATS L (figure 4).

20

25

30

Example 5 – Nutritional ready to drink beverage comprising a hydrolyzed whole grain composition.

The hydrolyzed whole grain composition (HWGC) is provided according to example 1.

Sugar	4%
MPC	2.5%
Milk powder	5.5%
1.5% oil	1.5%
Water	80%
HWGC (dry)	2.5%
Vitamin A (IU):	2250
Vitamin C (mg):	30
Calcium (mg):	500
Iron (mg):	4.5
Vitamin D (IU):	100
Vitamin E (IU):	7.5
Vitamin K (mcg):	20
Thiamin (mg):	0.4
Riboflavin (mg):	0.4
Niacin (mg):	5
Vitamin B6 (mg):	0.5
Folic Acid (mcg):	100
Vitamin B12 (mcg):	1.5
Biotin (mcg):	75
Pantothenic Acid (mg):	2.5
Phosphorus (mg):	500
Iodine (mcg):	45
Magnesium (mg):	100
Zinc (mg):	3.8
Copper (mg):	0.5
Manganese (mg):	0.5

5

Example 6 – Nutritional powder comprising a hydrolyzed whole grain composition.

The hydrolyzed whole grain composition (HWGC) is provided according to example 1.

10 The powder is to be reconstituted in a liquid before consumption.

Sugar	20%
Maltodextrin	20%
NFDM	40%
Cocoa	10%
Lactose	3%
HWGC (dry)	2.5%
Vitamin A (IU):	2250

Vitamin C (mg):	30
Calcium (mg):	500
Iron (mg):	4.5
Vitamin D (IU):	100
Vitamin E (IU):	7.5
Vitamin K (mcg):	20
Thiamin (mg):	0.4
Riboflavin (mg):	0.5
Niacin (mg):	5
Vitamin B6 (mg):	0.5
Folic Acid (mcg):	100
Vitamin B12 (mcg):	1.5
Biotin (mcg):	75
Pantothenic Acid (mg):	2.5
Phosphorus (mg):	500
Iodine (mcg):	75
Magnesium (mg):	100
Zinc (mg):	3.8
Copper (mg):	0.5
Manganese (mg):	0.5

Example 7 – Nutritional tube feed comprising a hydrolyzed whole grain composition.

- 5 The hydrolyzed whole grain composition (HWGC) is provided according to example 1.

Water	74%
HWGC (dry)	3.5%
Soy protein	6%
Oil	3.5%
Vitamin A (IU):	1070
Vitamin C (mg):	50
Calcium (mg):	257
Iron (mg):	4.24
Vitamin D (IU):	85.7
Vitamin E (IU):	12.9
Vitamin K (mcg):	20
Thiamin (mg):	0.32
Riboflavin (mg):	0.36
Niacin (mg):	4.29
Vitamin B6 (mg):	0.5
Folic Acid (mcg):	171
Vitamin B12 (mcg):	1.29
Biotin (mcg):	64.3
Pantothenic Acid (mg):	2.14
Phosphorus (mg):	257
Iodine (mcg):	37.5

Magnesium (mg):	87.5
Zinc (mg):	4.82
Selenium (mcg):	17.5
Copper (mg):	0.47
Manganese (mg):	0.43
Chromium (mcg):	28.3
Molybdenum (mcg):	32.1
Chloride (mg):	225
Choline (mg):	85.7

Example 8 – RTD Complete Nutrition Product for Weight Loss comprising a hydrolyzed whole grain composition.

The hydrolyzed whole grain composition (HWGC) is provided according to example

5 1.

Water	81%
HWGC (dry)	3.5%
Caseinate	6.5%
Oil	1%
Maltodextrin	8%
Vitamin A (IU):	1000
Vitamin C (mg):	18
Calcium (mg):	250
Iron (mg):	3.6
Vitamin D (IU):	80
Vitamin E (IU):	6.0
Vitamin K (mcg):	16
Thiamin (mg):	0.45
Riboflavin (mg):	0.52
Niacin (mg):	4.0
Vitamin B6 (mg):	0.6
Folic Acid (mcg):	80
Vitamin B12 (mcg):	1.2
Biotin (mcg):	60
Pantothenic Acid (mg):	2.0
Phosphorus (mg):	200
Iodine (mcg):	30
Magnesium (mg):	80
Zinc (mg):	3.0
Selenium (mcg):	14
Copper (mg):	0.4
Manganese (mg):	0.4
Chromium (mcg):	24
Molybdenum (mcg):	15
Chloride (mg):	340
Choline (mg):	20

Claims

1. A nutritional product comprising

- a hydrolyzed whole grain composition; and
- an alpha-amylase or fragment thereof, which alpha-amylase or fragment thereof shows no hydrolytic activity towards dietary fibers when in the active state;

wherein said nutritional product is fortified with at least 2 essential minerals and at least 4 essential vitamins.

10

2. The nutritional product according to claim 1, wherein the nutritional product further comprises a liquid component.

3. The nutritional product according to any one of claims 1 or 2, with the proviso that it does not comprise a beta-amylase.

4. The nutritional product according any one of the preceding claims, further comprising a protease or fragments thereof, at a concentration of 0.001-5% by weight of the total whole grain content, which protease or fragments thereof shows no hydrolytic activity towards dietary fibers when in the active state.

5. The nutritional product according to any one claim 1-3, with the proviso that it does not comprise the protease.

6. The nutritional product according to any one of the preceding claims, wherein the nutritional product further comprises at least one of an amyloglucosidase or fragment thereof and an glucose isomerase or fragment thereof which amyloglucosidase or glucose isomerase show no hydrolytic activity towards dietary fibers when in the active state.

30

7. The nutritional product according to any one of the preceding claims, having a total content of the whole grain composition in the range 1-30% by weight of the nutritional product, such as 1-20% and 1-15%.

8. The nutritional product according to any one of the preceding claims, wherein the hydrolyzed whole grain composition has a substantial intact beta-glucan structure relative to the starting material.
- 5 9. The nutritional product according to any one of the preceding claims, wherein the hydrolyzed whole grain composition has a substantial intact arabinoxylan structure relative to the starting material.
10. The nutritional product according to any one of the preceding claims, wherein
10 the nutritional product has a maltose to glucose ratio below 144:1 by weight in the product, such as below 120:1, such as below 100:1 e.g. below 50:1, such as below 30:1, such as below 20:1 or such as below 10:1.
11. The nutritional product according to any one of the preceding claims, wherein the nutritional product is a powder, a semi-solid product such as a pudding or a
15 liquid.
12. The nutritional product according to any one of the preceding claims, wherein the at least two essential minerals, such as at least 4, such as at least 6, and such as at least 8 essential minerals are selected from the group consisting of calcium, copper, iodine, iron, magnesium, manganese, phosphorus, boron, chromium,
20 molybdenum, nickel, potassium, selenium, silicon, tin, and vanadium, preferably, zinc, calcium and/or magnesium.
13. The nutritional product according to any one of the preceding claims, wherein the at least 4 essential vitamins, such as at least 6, such as at least 8, and such
25 as at least 10 essential vitamins are selected from the group consisting of biotin, folic acid, niacin, pantothenic acid, riboflavin, thiamin, vitamin A, vitamin B12, vitamin B6, vitamin C, vitamin D, vitamin E and vitamin K, in particular folic acid, riboflavin, thiamin, vitamin A, vitamin B12, vitamin B6, vitamin C, vitamin D and/or vitamin E.
- 30 14. A process for preparing a nutritional product according to claims 1-13, said process comprising:
- 1) preparing a hydrolyzed whole grain composition, comprising the steps of:

- a) contacting a whole grain component with an enzyme composition in water, the enzyme composition comprising at least one alpha-amylase, said enzyme composition showing no hydrolytic activity towards dietary fibers,
 - 5 b) allowing the enzyme composition to react with the whole grain component, to provide a whole grain hydrolysate,
 - c) providing the hydrolyzed whole grain composition by inactivating said enzymes when said hydrolysate has reached a viscosity comprised between 50 and 5000 mPa.s measured at 65°C;
 - 10 2) providing the nutritional product by mixing the hydrolyzed whole grain composition with at least 2 essential minerals and at least 4 essential vitamins.
- 15 15. The process according to claim 14, wherein the hydrolyzed whole grain composition in step 1) is provided when said hydrolysate has reached a total solid content of 25-60%.