

Cereal plant-based beverage rich in beta-glucan

Field of the invention

5 The present invention relates to a cereal-based plant beverage rich in beta-glucan, as well as methods for preparing such a plant beverage.

Technical background

10 The consumption of plant-based beverages is ancient and practiced worldwide. They are mentioned in cookbooks as early as the tenth century.

 Today, there are many plant-based beverages. In particular, plant-based beverages can be produced from oilseeds, such as almond, peanut, hazelnut, walnut, cashew, and pistachio; cereals, such as oat, rice, spelt, barley, and millet; legumes, such as soy, lupin, and pea; coconut; or other seeds, such as chia seeds, 15 pumpkin seeds, flax seeds, quinoa seeds, sesame seeds, sunflower seeds, and hemp seeds.

 In addition to taste considerations, plant-based beverages are consumed for various reasons, for example, due to the adoption of a vegetarian or vegan diet or due to an allergy or intolerance to a component of animal milk (notably, milk protein 20 allergy or lactose intolerance).

 Generally, plant-based beverages are more digestible than animal milks, as they are less fatty and do not contain casein. Plant-based beverages are also used for the production of many food preparations, such as ice creams or cheeses.

25 Among all these plant-based beverages, the use of cereals, such as oat or barley, can result in health benefits. These two cereals contain a significant amount of beta-glucan, which can be the basis for new plant-based beverages.

 Beta-glucans are natural polysaccharides present in various organisms, notably plants (such as oat and barley), fungi (such as shiitake and reishi), and certain algae and bacteria. These are molecules composed of glucose linked 30 together by glycosidic bonds.

 Beta-glucans are known for their biological and functional properties beneficial to health. They are often considered soluble dietary fibers and have been

studied for their immunomodulatory, antioxidant, hypocholesterolemic, and potential antitumor benefits. Beta-glucans are therefore used as functional ingredients in dietary supplements, health foods, and cosmetic products.

Oat and barley, as well as co-products derived from these cereals and originating from malt houses, breweries, and plant dairies, are known to contain high levels of beta-glucan. Among the main cereals (wheat, rye, oat, and barley), oat and barley are those whose grains contain the largest amounts of beta-glucans. Oat and barley grains are composed of four main components:

- The lemmas or awns (also called hull in this text): this is the fibrous shell that surrounds the whole grain. The operation consisting of removing this part is called “de-awning” or “dehulling”. The grain freed from these hulls is called groat.
- The bran: this is the protective envelope (outer layer) of the seed. This part is very rich in fiber and beta-glucan.
- The kernel: this is the core of the seed without its protective envelope. The operation that consists of removing the envelope from the grain is called debranning. The ground kernel is known as flour.
- The endosperm: this is the main part of the kernel. It contains carbohydrates in the form of starch and proteins.
- The germ: this is the smallest part of the kernel. It mainly contains the fats of the grain.

Oat beta-glucans are found in the endosperm and its envelope. It is therefore necessary to dehull and fractionate the whole grain to produce commercial bran enriched in beta-glucans. By using technology and certain processing conditions, it is possible to obtain natural oat bran with a high content of dietary fiber (such as up to 44%) and beta-glucans (up to 22%). In naked barley, beta-glucans are distributed more evenly throughout the grain; consequently, even refined products, such as barley flour, contain beta-glucans.

Products and co-products resulting from the use of oat and barley, notably in malting, brewing, distillation, plant dairies, and milling, are also rich in beta-glucans.

Diets comprising soluble fibers from certain foods and having a low content of saturated fatty acids and cholesterol can reduce the risk of coronary heart

disease. Recent studies have determined that beta-glucan is the physiologically active component responsible for the hypocholesterolemic effect observed with oat consumption. The health claim that regular consumption of beta-glucan helps reduce cholesterol levels and the risks of coronary heart disease is currently
5 authorized by the FDA (Food and Drug Administration) of the United States and by EFSA (the European Food Safety Authority).

Beta-glucans are linear, unbranched, non-amylose polysaccharides composed of glucose molecules linked by $\beta(1\rightarrow4)$ and $\beta(1\rightarrow3)$ bonds, and thus exhibit physical properties of water solubility and gelation. It is believed that the
10 ability of beta-glucans to form highly viscous solutions at relatively low concentrations in the human intestine is a fundamental element of the health benefits of these substances. The hypocholesterolemic effect of soluble beta-glucan fibers is thought to be attributable to several mechanisms of action: increased excretion of bile acids and cholesterol, reduced insulin secretion (leading to reduced
15 cholesterol synthesis), production of short-chain fatty acids (which may inhibit cholesterol biosynthesis), reduced fat absorption rates, as well as inhibition of pancreatic lipase or reduced gastric lipase activity.

It has also been shown that cereal beta-glucans reduce the glycemic response, which could help improve metabolic regulation in diabetics.

20 The use of different fractionation technologies to recover the beta-glucans contained in cereal grains, notably oat or barley, as well as in products and co-products resulting from the use of these two cereals, is unfortunately almost impossible due to a high fat content in the grains and the products derived from their use. Thus, the average lipid content in oat groats varies between 4 and 8% of the
25 dry matter weight, causing them to stick to the walls of the grinder in the case of direct grinding of the grain or groat.

In order to be able to fractionate the oat or barley grain or the products and co-products resulting from their use, a preliminary de-oiling step is necessary. The historical process is extraction with hexane. For example, the article by Wu et al.,
30 "*Enriched Protein- and β -Glucan Fractions from High-Protein Oats by Air Classification*," *Cereal Chemistry*, 1995, vol. 72, no. 1, p. 132–134, describes a method for obtaining fractions enriched in proteins and beta-glucans from oat,

wherein the oat is first depellicled in a pin mill, the recovered groat is then defatted using hexane, and the defatted groat is then ground and subjected to air classification.

However, the use of this solvent has several major drawbacks. First, it is produced from petroleum, resulting in high greenhouse gas emissions (for example, 620 kg CO₂eq/t). Moreover, its degree of toxicity is significant, and, after extraction, hexane residues are always present in the cereal subjected to the treatment.

More recently, hexane has been replaced by supercritical CO₂ as an extraction solvent. The main advantage of using this solvent is that it does not leave toxic residues in the powder, but this new technology remains very energy-intensive and costly and requires significant investments.

For example, document WO 2008/096044 describes a method for producing beta-glucan, protein, starch, and lipid concentrates from oat, comprising a step of extracting the oat using a supercritical fluid, a step of dry grinding the defatted fraction, a step of separating the obtained fraction into a starch-enriched fraction and a beta-glucan-enriched fraction, and a step of separation by sieving or air classification of the starch-enriched fraction to obtain three fractions: one comprising a protein concentrate, one comprising a beta-glucan concentrate, and one comprising a starch concentrate.

The article by Sibakov et al., "*Lipid Removal Enhances Separation Of Oat Grain Cell Wall Material From Starch And Protein*," *Journal of Cereal Science*, 2011, vol. 54, no. 1, p. 104–109, describes a method comprising grinding oat groats, extracting lipids using supercritical CO₂, followed by grinding and a first step of air classification of the defatted oat. The fraction of larger particles obtained is subjected to grinding and a second step of air classification to obtain a fraction enriched in beta-glucans. The fraction of finer particles obtained at the end of the first air classification step is also subjected to another air classification step to obtain a protein-enriched fraction and a starch-enriched fraction.

Furthermore, the methods for extracting cereal beta-glucans currently used can lead to certain negative effects that may alter their properties and functionality. For example, they may alter their native structure, which can reduce their ability to form a viscous gel in the intestinal tract. This loss of structure can result in a

decrease in their beneficial effects, such as cholesterol reduction and glycemic regulation.

There is therefore a real need to provide plant-based beverages capable of helping to reduce cholesterol levels and the risks of coronary heart disease in the consumer and which can be produced in a more environmentally friendly manner and with limited or even absent denaturation of the components.

Summary of the invention

The invention firstly relates to a cereal plant-based beverage comprising an amount of beta-glucan of at least 1.2 g/100 mL of plant-based beverage.

In some embodiments, the plant-based beverage is an oat or barley plant-based beverage, preferably an oat plant-based beverage.

In some embodiments, the plant-based beverage comprises an amount of beta-glucan of at least 1.5 g/100 mL of plant-based beverage, preferably from 1.5 to 5 g/100 mL of plant-based beverage.

In some embodiments, the plant beverage comprises an amount of protein of at least 0.2 g/100 mL of plant-based beverage, preferably from 0.4 to 1.2 g/100 mL of plant-based beverage, more preferably from 0.5 to 1 g/100 mL of plant-based beverage.

In some embodiments, the plant-based beverage comprises an amount of carbohydrates of at least 2 g/100 mL of plant-based beverage, preferably from 4 to 10 g/100 mL of plant-based beverage, more preferably from 6 to 9 g/100 mL of plant-based beverage.

In some embodiments, the plant-based beverage comprises a lipid content less than or equal to 2.5 g/100 mL of plant-based beverage, preferably less than or equal to 2 g/100 mL of plant-based beverage, more preferably from 1 to 2 g/100 mL of plant-based beverage.

In some embodiments, the plant-based beverage has a dextrose equivalent of less than 20.

In some embodiments, the plant-based beverage comprises a dry matter content of 8 to 30% by weight, preferably 8 to 15% by weight, relative to the total weight of the plant-based beverage.

The invention also relates to a method for preparing a plant-based beverage as described above, comprising the following steps:

- providing a powdered cereal fraction comprising starch and comprising an amount of beta-glucan greater than or equal to 10% by weight, relative to the total weight of the fraction;
- mixing said fraction with water, so as to obtain a suspension; and
- hydrolyzing the starch in the suspension.

In some embodiments, the hydrolysis of the starch is carried out by introducing into the suspension at least one enzyme selected from the group consisting of saccharidases, preferably an alpha-amylase.

In some embodiments, the method further comprises, after the starch hydrolysis step, a solid/liquid separation step, preferably by centrifugation, decantation, pressing using a filter press, and/or filtration.

In some embodiments, the method further comprises a step of preparing the provided powdered cereal fraction, said preparing step comprising the following steps:

- providing at least one cereal material comprising starch, proteins, lipids, and beta-glucans, preferably an oat and/or barley cereal material;
- treating the cereal material by solid/liquid extraction with an alcohol solution comprising at least 50% by volume of alcohol, so as to obtain a solid fraction depleted in lipids and a liquid fraction enriched in lipids;
- grinding the solid fraction depleted in lipids;
- separating the particles of the ground fraction depleted in lipids according to their size, so as to obtain a fraction enriched in beta-glucans and a fraction depleted in beta-glucans; and
- recovering the fraction enriched in beta-glucans as the powdered cereal fraction.

In some embodiments, the cereal material is at least one cereal grain and/or at least one product derived from the malting, malt extract manufacturing, brewing, cereal distillation, plant-based dairy, and/or milling industries.

The present invention meets the need expressed above. More particularly, it provides a plant-based beverage having good organoleptic properties and a

nutritional composition beneficial to the health of its consumer, and in particular capable of having a hypocholesterolemic effect, reducing the risk of coronary heart disease and/or reducing the glycemic response. The plant-based beverage according to the invention can furthermore be produced by means of a simple and economical process, leading to low denaturation of the components of interest of the plant-based beverage, and which is environmentally friendly.

This is achieved by the presence of a certain minimum amount of beta-glucan in the plant-based beverage.

This amount of beta-glucan in the plant-based beverage can in particular be achieved by implementing a preparation method using as raw material a cereal-based material and including, in advantageous embodiments, a specific separation method of a cereal material allowing the fractionation of components of interest, including beta-glucans.

The preparation method according to the invention advantageously comprises an improved separation method allowing the isolation of a fraction rich in beta-glucan, which is simple, efficient, more economical, leads to low denaturation (transformation) of the fractionated components, notably beta-glucans, is environmentally friendly, i.e. results in lower water consumption and reduced greenhouse gas emissions, and generates a minimum of effluents that are easy to recycle. This is achieved by combining a de-oiling step by extraction using a specific solvent, namely an alcohol solution comprising at least 50% by volume of alcohol, and a dry fractionation process using one or more grinding and separation steps. In particularly advantageous embodiments, wherein the alcohol, and in particular ethanol, used for de-oiling is recycled for reuse in the extraction step, the method according to the invention allows further reduction of greenhouse gas emissions as well as solvent consumption and effluent generation.

Brief description of the figures

Figure 1 shows a flowchart of an example of a separation method that can be implemented in embodiments of the preparation method according to the invention.

Detailed description

The invention is now described in more detail and in a non-limiting manner in the following description.

Unless otherwise indicated, all percentages are by mass.

5 In the present text, the quantities indicated for a given species may apply to that species according to all its definitions (as mentioned in the present text), including narrower definitions.

In the present text, “*fraction enriched in a substance X*” obtained after a certain treatment means a fraction wherein the ratio of the mass proportions
10 substance X / total dry matter is greater than that of the fraction before treatment.

In the present text, the terms “*lipids*”, “*oil*”, and “*fats*” have the same meaning and are used interchangeably. The terms “*plant-based beverage*” and “*plant-based milk*” also have the same meaning.

For the purposes of the invention, “*hydrolysis step*” means hydrolysis of any
15 degree.

Plant-based beverage

According to a first aspect, the invention relates to a plant-based beverage based on cereal.

20 Cereals are part of the poaceae family. They produce grains, which comprise starch, proteins, lipids, and soluble fibers, in particular beta-glucans. In general, cereal grains comprise at least an endosperm surrounded by an envelope. However, in the present text, the term “*grain*” may generally refer to the whole (complete) grain as well as any part of the grain (for example, the grain stripped of its lemmas, or the
25 kernel, etc.), unless otherwise indicated.

In the present invention, the cereal at the origin of the plant-based beverage may be any suitable cereal. Examples of cereals include oat, barley, rice, spelt, millet, and combinations thereof. Preferably, the cereal is selected from the group consisting of oat, barley, and mixtures thereof. Even more preferably, the plant-
30 based beverage according to the invention is oat-based.

The plant-based beverage comprises beta-glucans, in an amount of at least 1.2 g per 100 mL of plant-based beverage. Preferably, the plant-based beverage

comprises at least 1.3, more preferably at least 1.4, even more preferably at least 1.5, still more preferably at least 1.6, still more preferably at least 1.7, still more preferably at least 1.8 g (grams) of beta-glucan/100 mL of plant-based beverage.

5 The plant-based beverage may advantageously comprise from 1.2 to 5, preferably from 1.5 to 5, more preferably from 1.5 to 3 g of beta-glucan/100 mL of plant-based beverage. In some embodiments, the plant-based beverage according to the invention comprises from 1.2 to 1.5, or from 1.5 to 1.7, from 1.7 to 2, or from 2 to 2.3, or from 2.3 to 2.5, or from 2.5 to 2.7, or from 2.7 to 3, or from 3 to 3.5, or from 3.5 to 4, or from 4 to 4.5, or from 4.5 to 5 g of beta-glucan/100 mL of plant-based beverage.

The amount of beta-glucan may be measured according to the AOAC 995.16 method.

Advantageously, the plant-based beverage comprises proteins. More preferably, the amount of protein in the plant-based beverage is at least 0.2 g/100 mL of plant-based beverage, more preferably at least 0.4, more preferably at least 0.5, still more preferably at least 0.6 g/100 mL of plant-based beverage. The plant-based beverage may more particularly comprise from 0.2 to 2, preferably from 0.3 to 2, more preferably from 0.4 to 1.2, more preferably from 0.5 to 1 g of protein/100 mL of plant-based beverage. For example, the plant-based beverage according to the invention may comprise from 0.2 to 0.4, or from 0.4 to 0.5, or from 0.5 to 0.6, or from 0.6 to 0.7, or from 0.7 to 0.8, or from 0.8 to 1, or from 1 to 1.2, or from 1.2 to 1.5, or from 1.5 to 1.7, or from 1.7 to 2 g of protein/100 mL of plant-based beverage.

The amount of protein may be measured according to ISO 5983-2 (Kjeldahl method).

25 Preferably, the plant-based beverage comprises carbohydrates. The amount of carbohydrates in the plant-based beverage, in g/100 mL of plant-based beverage, may be greater than or equal to 2, preferably greater than or equal to 4, in particular greater than or equal to 6. Advantageously, the amount of carbohydrates in the plant-based beverage is from 2 to 12, preferably from 4 to 10, more preferably from 6 to 9 g/100 mL of plant-based beverage. In particular, the plant-based beverage may comprise from 2 to 4, or from 4 to 6, or from 6 to 8, or from 8 to 10, or from 10 to 12 g/100 mL of plant-based beverage.

The total amount of carbohydrates may be calculated by subtracting the content of proteins, fibers, lipids, ash, and water from the weight of the product. The protein content may be measured as indicated above, the lipid content may be measured as indicated below, and the ash content may be measured according to NF EN ISO 2171. The water content may be obtained by calculating the difference between the initial total weight and the dry extract measured according to the ISO 6731 method and the amount of fiber may be measured according to the AOAC 2011.25 method.

The dextrose equivalent (DE) value of the plant-based beverage according to the invention is preferably less than 20. Advantageously, the dextrose equivalent of the plant-based beverage is from 10 to less than 20, preferably from 12 to less than 20, for example, from 15 to less than 20. The plant-based beverage may have a dextrose equivalent of 10 to 12, or from 12 to 15, or from 15 to 17, or from 17 to less than 20. The DE is an indicator of starch hydrolysis. At DE = 0, the starch is intact. At DE = 100, the starch is completely converted to glucose. To measure the DE, the Lane-Eynon method (ISO 5377:1981) may be used.

The plant-based beverage may comprise lipids. Preferably, the plant-based beverage according to the invention comprises a lipid content less than or equal to 2.5, more preferably less than or equal to 2 g/100 mL of plant-based beverage. In some embodiments, the plant-based beverage comprises from 0.8 to 2.5, preferably from 1 to 2, for example, from 1.2 to 1.8, g of lipid/100 mL of plant-based beverage. In particular, the plant-based beverage may comprise from 0.8 to 1, or from 1 to 1.2, or from 1.2 to 1.4, or from 1.4 to 1.6, or from 1.6 to 1.8, or from 1.8 to 2, or from 2 to 2.2, or from 2.2 to 2.5 g of lipids/100 mL of plant-based beverage.

The amount of fat may be measured according to the AOAC 922.06 method.

Advantageously, the plant-based beverage according to the invention comprises a dry matter content of 8 to 30% by weight, preferably from 8 to 20% by weight, more preferably from 8 to 15% by weight. More particularly, the dry matter content of the plant-based beverage according to the invention may be from 8 to 10% by weight, or from 10 to 12% by weight, or from 12 to 15% by weight, or from 15 to 17% by weight, or from 17 to 20% by weight, or from 20 to 22% by weight, or from 22 to 25% by weight, or from 25 to 30% by weight.

Preferably, the plant-based beverage comprises an amount of beta-glucan greater than or equal to 15% by weight, preferably an amount of 15 to 40% by weight, more preferably from 15 to 30% by weight, relative to the total weight of dry matter of the plant-based beverage; in particular, the plant-based beverage may
5 comprise an amount of beta-glucan of 15 to 18% by weight, or from 18 to 20% by weight, or from 20 to 25% by weight, or from 25 to 30% by weight, or from 30 to 35% by weight, or from 35 to 40% by weight, relative to the total weight of dry matter of the plant-based beverage.

Preferably, the plant-based beverage comprises an amount of protein greater
10 than or equal to 2% by weight, preferably an amount of 2 to 4% by weight, more preferably from 2.5 to 4% by weight, relative to the total weight of dry matter of the plant-based beverage; in particular, the plant-based beverage may comprise an amount of protein of 2 to 2.5% by weight, or from 2.5 to 2.7% by weight, or from 2.7 to 3% by weight, or from 3 to 3.3% by weight, or from 3.3 to 3.5% by weight, or from
15 3.5 to 4.0% by weight, relative to the total weight of dry matter of the plant-based beverage.

Preferably, the plant-based beverage comprises an amount of carbohydrates greater than or equal to 15% by weight, preferably an amount of 15 to 40% by weight, more preferably from 15 to 35% by weight, relative to the total weight of dry
20 matter of the plant-based beverage; in particular, the plant-based beverage may comprise an amount of carbohydrates of 15 to 20% by weight, or from 20 to 25% by weight, or from 25 to 30% by weight, or from 30 to 35% by weight, or from 35 to 40% by weight, relative to the total weight of dry matter of the plant-based beverage.

Preferably, the plant-based beverage comprises an amount of fat (lipids) less
25 than or equal to 20% by weight, preferably an amount of 5 to 20% by weight, more preferably from 5 to 15% by weight, relative to the total weight of dry matter of the plant-based beverage; in particular, the plant-based beverage may comprise an amount of fat of 5 to 10% by weight, or from 10 to 12% by weight, or from 12 to 15% by weight, or from 15 to 18% by weight, or from 18 to 20% by weight, relative
30 to the total weight of dry matter of the plant-based beverage.

Preparation method

According to another aspect, the invention relates to a method for preparing a plant-based beverage as described above.

The method according to the invention comprises a step of providing a powdered cereal fraction (i.e., in powder form). The term "*cereal fraction*", within the
5 meaning of the present invention, means any material derived from one (or more) cereals. The cereal fraction may be entirely derived from cereal or may also comprise components of other origin(s).

The powdered cereal fraction preferably has particles with a median volume diameter (D50) greater than or equal to 100 μm , more preferably from 100 to 500
10 μm , more preferably from 100 to 300 μm , most preferably from 100 to 250 μm . The D50 of the particles may be measured according to NF ISO 13320-1.

The cereal fraction of the invention comprises at least 10% by weight of beta-glucan, relative to the total weight of the fraction. Preferably, the cereal fraction comprises an amount of 10 to 40% by weight, preferably from 12 to 25% by weight,
15 more preferably from 15 to 25% by weight, of beta-glucan, relative to the total weight of the fraction; in particular, the cereal fraction may comprise an amount of beta-glucan of 10 to 12% by weight, or from 12 to 13% by weight, or from 13 to 15% by weight, or from 15 to 17% by weight, or from 17 to 20% by weight, or from 20 to 22% by weight, or from 22 to 25% by weight, or from 25 to 30% by weight, or from
20 30 to 35% by weight, or from 35 to 40% by weight, relative to the total weight of the fraction.

The cereal fraction used in the invention further comprises starch.

Preferably, the cereal fraction comprises an amount of starch greater than or equal to 35% by weight (for example, from 35 to 90% by weight), preferably greater
25 than or equal to 40% by weight, more preferably an amount of 40 to 90% by weight, more preferably from 40 to 80% by weight, most preferably from 45 to 70% by weight (relative to the total weight of the cereal fraction). In particular, the amount of starch in the cereal fraction may be from 40 to 50% by weight, or from 50 to 60% by weight, or from 60 to 65% by weight, or from 65 to 70% by weight, or from 70 to 75% by
30 weight, or from 75 to 80% by weight, or from 80 to 90% by weight, relative to the total weight of the cereal fraction. The amount of starch may be measured according to ISO 15914.

Preferably, the cereal fraction comprises an amount of carbohydrates greater than or equal to 40% by weight, preferably an amount of carbohydrates of 40 to 90% by weight, preferably from 40 to 85% by weight, more preferably from 40 to 80% by weight, most preferably from 42 to 75% by weight (relative to the total weight of the cereal fraction). In particular, the amount of carbohydrates in the cereal fraction may be from 40 to 42% by weight, or from 42 to 45% by weight, or from 45 to 47% by weight, or from 47 to 50% by weight, or from 50 to 55% by weight, or from 55 to 60% by weight, or from 60 to 65% by weight, or from 65 to 70% by weight, or from 70 to 75% by weight, or from 75 to 80% by weight, or from 80 to 90% by weight, relative to the total weight of the cereal fraction.

Preferably, the cereal fraction further comprises proteins, advantageously in an amount less than or equal to 30% by weight, preferably an amount of 0.5 to 30% by weight, more preferably from 3 to 20% by weight, most preferably from 5 to 17% by weight, most preferably from 5 to 15% by weight (relative to the total weight of the fraction). In some embodiments, the amount of protein in the cereal fraction may be, relative to the total weight of the cereal fraction, from 0.5 to 3% by weight, or from 3 to 5% by weight, or from 5 to 7% by weight, or from 7 to 10% by weight, or from 10 to 12% by weight, or from 12 to 15% by weight, or from 15 to 18% by weight, or from 18 to 20% by weight, or from 20 to 30% by weight, relative to the total weight of the cereal fraction.

Preferably, the cereal fraction further comprises lipids. Preferably, it comprises an amount of fat (lipids) less than or equal to 5% by weight, preferably an amount of 0.5 to 5% by weight, more preferably from 0.5 to 3% by weight, more preferably from 1 to 3% by weight, relative to the total weight of the fraction; in particular, the cereal fraction may comprise an amount of fat of 0.5 to 1% by weight, or from 1 to 2% by weight, or from 2 to 3% by weight, or from 3 to 4% by weight, or from 4 to 5% by weight, relative to the total weight of the fraction.

The amounts of beta-glucan, carbohydrate, protein, and fat may be determined as indicated above.

The cereal fraction is then mixed with water, so as to form a suspension. Preferably, the water is mineralized water. Even more preferably, the water used comprises at least 40 mg of calcium per liter of water.

Advantageously, the amount of cereal fraction mixed with the water is from 8 to 30% by weight, preferably from 8 to 20% by weight, more preferably from 8 to 15% by weight, relative to the total weight of the mixture. The amount of cereal fraction mixed with the water may be from 8 to 10% by weight, or from 10 to 12% by weight, or from 12 to 15% by weight, or from 15 to 17% by weight, or from 17 to 20% by weight, or from 20 to 22% by weight, or from 22 to 25% by weight, or from 25 to 30% by weight, relative to the total weight of the mixture.

The method according to the invention comprises a step of hydrolyzing the starch of the suspension obtained by mixing the cereal fraction with the water.

Preferably, the hydrolysis of the starch is carried out by introducing into the suspension at least one enzyme. The enzyme is preferably a saccharidase, and more particularly an alpha-amylase. Most preferably, the enzyme is thermostable, in particular at temperatures of 70 to 110°C.

The amount of enzyme added is preferably from 0.2 to 1 g of enzyme per 100 g of dry starch, preferably from 0.3 to 0.6 g of enzyme per 100 g of dry starch. The pH of the suspension is preferably adjusted to a pH between 4.5 and 7.5, more particularly between 5.0 and 6.5. This pH range allows optimal enzyme efficiency. Alpha-amylases are enzymes capable of hydrolyzing starch into dextrins. Advantageously, the suspension is heated to a temperature of 70 to 110°C, more preferably from 80 to 100°C, and preferably this temperature is reached after addition of the enzyme. Preferably, the suspension is preheated, more preferably to a temperature of 30 to 60°C, most preferably from 40 to 55°C, prior to addition of the enzyme to the suspension. Preferably, the heating of the suspension is carried out by steam contact and/or by direct steam injection. Advantageously, the hydrolysis is carried out in a reactor, under agitation. Preferably, the incubation time of the enzyme in the suspension is from 3 to 15 min, more preferably from 3 to 7 min. Advantageously, the suspension is then cooled, preferably to a temperature of 50 to 60°C.

Preferably, the method according to the invention comprises a solid/liquid separation step. This step makes it possible to reduce, or even eliminate, the insoluble materials present in the suspension. The solid/liquid separation results in obtaining a liquid fraction, separated from a solid fraction. At the end of this

separation step, the liquid fraction (or at least a part of the liquid fraction) is recovered. This liquid fraction is depleted in insoluble materials, i.e., the mass concentration of insoluble material is lower than before carrying out the separation step.

5 More preferably, the solid/liquid separation is carried out by centrifugation. At the end of this step, at least a part of the supernatant is collected (the supernatant corresponding to the liquid fraction and the pellet corresponding to the solid fraction). Preferably, the centrifugation is carried out by applying an acceleration of 29420 m.s^{-2} (3000 g) to 49033 m.s^{-2} (5000 g), for example, 39227 m.s^{-2} (4000 g),
10 preferably for a duration of up to 15 min, for example, 10 min.

 Alternatively, or additionally, the solid/liquid separation may be carried out by decantation, by pressing using a filter press, and/or by filtration, preferably using one or more membranes.

 At the end of the liquid/solid separation step, the recovered liquid fraction
15 preferably comprises an amount of insoluble materials, as measured in particular according to NF EN 872, less than or equal to 0.5% by weight, more preferably less than or equal to 0.2% by weight, most preferably less than or equal to 0.1% by weight, relative to the total weight of the recovered liquid fraction.

 Advantageously, an oil is added to the liquid fraction. This oil may be any
20 edible oil. It is preferably a natural oil, more preferably a non-GMO oil, and even more preferably a vegetable oil. The oil may in particular be any edible vegetable oil (or any mixture of such oils), such as, for example, sunflower oil, rapeseed oil, and/or olive oil, and is more particularly sunflower oil. The addition of this oil to the liquid fraction imparts a milky appearance to the preparation. Preferably, the oil is added
25 to the liquid fraction in an amount of 0.3 to 10% by weight, more preferably 0.5 to 5% by weight, even more preferably 1 to 3% by weight, relative to the total weight of the mixture (for example, in an amount of 0.3 to 1% by weight, or 1 to 2% by weight, or 2 to 3% by weight, or 3 to 4% by weight, or 4 to 5% by weight, or 5 to 6% by weight, or 6 to 8% by weight, or 8 to 10% by weight). Preferably, the mixture is
30 stirred, for example, for a period of 1 to 15 min, in particular 3 to 10 min, more particularly 5 min. This mixing may be carried out using any suitable device, for example, a disperser.

The method according to the invention preferably comprises a homogenization step. This step imparts to the plant-based beverage the appearance of a milk-based beverage. This step may be carried out using any suitable device known to the person skilled in the art, for example, a homogenizer, such as a high-pressure homogenizer.

The method according to the invention advantageously comprises a step of pasteurization or heat treatment of the obtained beverage. Preferably, pasteurization is carried out by heating to a temperature of 100 to 160°C, preferably 120 to 150°C, for example, for a period of 1 to 5 s. A preheating step, in particular at a temperature of 70 to 120°C, preferably 90 to 110°C, may be carried out. The beverage is then advantageously cooled, preferably to ambient temperature (between 15 and 30°C, preferably between 17 and 23°C).

The powdered cereal fraction used to produce the plant-based beverage may be prepared according to the separation method described below.

Separation method

This process is a method for separating a cereal material, in particular to obtain a fraction enriched in lipids, a fraction enriched in beta-glucans, which may be used as a powdered cereal fraction as described above, and a fraction enriched in starch and, advantageously, in proteins. In the context of the present invention, "*cereal material*" means any material based on, or derived from, at least one cereal, in any possible form (for example, whole, ground, powdered, flattened, etc.). More particularly, it may be the cereal itself (raw), any part thereof, or any material obtained after processing, transformation, or use of the cereal.

This separation method involves a step of de-oiling the cereal material by extraction using an alcohol solution comprising at least 50% by volume of alcohol, followed by dry fractionation of the cereal material. "*Dry*" means any operation, such as grinding or air classification operations, carried out without the use of water.

Within the scope of the present invention, the starting cereal material may be, or may be derived from, any suitable cereal. The source cereal is in particular as described above. Particularly preferably, this cereal is selected from the group consisting of oats, barley, and mixtures thereof; more preferably the cereal is oats.

In the present invention, any suitable cereal material may be used, comprising beta-glucans, starch, lipids, and preferably proteins.

Thus, advantageously, the starting cereal material used in the invention may be a cereal grain (in particular an oat and/or barley grain). Dehulled oat grain (i.e.,
5 the grain from which the lemmas have been removed) is called groats. Dehulled barley grain is called pearled barley. In the present text, the terms "*oat grain*" and "*barley grain*" mean both the whole grain and any part of the grain (for example, oat groats or pearled barley), unless otherwise indicated. Oat and barley grains have the advantage of being rich in beta-glucan (they may comprise 3 to 7% by weight
10 for oats and 3 to 11% by weight for barley). Preferably, the starting raw material is a cereal grain, in particular an oat and/or barley grain, comprising a hull and a groat.

Alternatively or additionally, it is advantageously possible to use as starting cereal material any product resulting from the use or processing of a cereal (in particular, oats or barley), notably in fermentation and distillation processes, for the
15 production of sprouted cereal (in particular, malt), for the production of plant-based beverages or for the production of flours. More particularly, products that can be used in the method according to the invention are:

- co-products of malting and malt extract production: during the germination process of barley, rootlets (small roots) are formed. After drying, the grains
20 are processed to remove the rootlets as well as the grain envelope. These two products are rich in proteins and beta-glucans.
- co-products of brewing and/or cereal distillation: after the fermentation step, the "must" is filtered to remove all solid residues from the cereal grain. This substrate is rich in proteins and beta-glucans.
- 25 - co-products of plant-based dairy production: during the production of the plant-based beverage, a filtration or decantation operation is carried out to remove the solid residues from the cereal grain. These residues are called okara. These residues contain a high level of proteins and beta-glucans.
- milling products.

30 When the cereal material is a cereal grain, and more particularly an oat and/or barley grain, the method according to the invention advantageously comprises a step of removing the hull (or dehulling) from the cereal grains (in particular, oats

and/or barley). Indeed, the hull is mainly composed of non-soluble, poorly edible fibers. Moreover, most of the contaminants of the oat or barley seed are found in the hull, so its removal reduces the risk of contamination of the prepared fractions.

Preferably, dehulling is mechanical dehulling, carried out, for example, by abrasion, compression, impact, shearing, or any other suitable mechanical action. More preferably, dehulling is carried out by abrasion.

Dehulling may be carried out using any suitable device, notably using one of the mechanical forces mentioned above, in particular abrasion. Advantageously, dehulling is carried out using a de-awner. De-awners operate on the principle of a friction polishing machine. They can be used to remove awns, separate double grains, and to treat the surface of cereal grains. According to an example of a dehulling process using a de-awner, a feed screw conveys the cereals into the working chamber where a rotor in a perforated sleeve subjects the processed product to mechanical friction forces. The intensity of the friction can be adjusted, for example, by an adjustable counterweight, or by adjustable springs at the outlet of the machine. The detached elements that are separated from the processed product (the grain), such as awns or impurities adhering to the surface, can exit the machine through a separate suction outlet.

The use of a de-awner to carry out dehulling is advantageous since the de-awner cleans the surface of the grain at the same time as it detaches the hull from the grain by mechanical stress. Moreover, this processing step improves the flow properties of the grains.

The cereal material may be subjected to a grinding and/or flattening step, and a ground and/or flattened fraction is then collected. This step is particularly carried out when the starting cereal material is a cereal grain. When the method comprises a dehulling step as described above, the grinding and/or flattening step is preferably carried out after dehulling (the cereal material subjected to this grinding and/or flattening step then being a dehulled grain). This grinding and/or flattening step may be omitted, notably when the starting cereal material is in powdered or flattened form, for example, in embodiments in which the starting cereal material is a product resulting from the use of a cereal.

Grinding may be carried out using all types of grinders, notably by any mechanical grinder using compression, impact, shearing, or any other suitable mechanical action. Preferably, the particles obtained after grinding have a median volume diameter (D50) greater than or equal to 500 μm (the D50 may be measured according to NF ISO 13320-1). This grinding step may be carried out regardless of the cereal material (notably, cereal grain and/or product resulting from the use of a cereal).

Flattening may be carried out using a cereal flattener, preferably using the mechanical force of compression. This flattening step is preferably carried out when the cereal material used is a cereal grain.

The cereal material (in some embodiments, the ground and/or flattened fraction obtained after grinding and/or flattening) is subjected to a solid/liquid extraction carried out using an alcohol solution. The alcohol solution according to the invention comprises at least 50% by volume of alcohol. The alcohol solution may be the alcohol itself (thus comprising 100% by volume of alcohol). However, it is preferably a mixture comprising at least one alcohol and at least one solvent. The solvent is preferably selected from the group consisting of water, 2-methyloxolane, and mixtures thereof. More preferably, the alcohol solution is an aqueous alcohol solution, i.e., a solution comprising water and alcohol. Even more preferably, the aqueous ethanol solution consists of water and alcohol.

The alcohol solution preferably comprises from 50 to 90% by volume, more preferably from 60 to 90% by volume, even more preferably from 70 to 90% by volume, and even more preferably from 80 to 90% by volume, of alcohol (relative to the total volume of the alcohol solution used for extraction). In some embodiments, the alcohol solution comprises from 50 to 60%, or from 60 to 70%, or from 70 to 80%, or from 80 to 90%, by volume, of alcohol.

The alcohol is preferably selected from the group consisting of ethanol, methanol, pentanol, isoamyl alcohol, and mixtures thereof. Particularly preferably, the alcohol is ethanol. In other words, the alcohol solution used according to the invention is preferably an ethanol solution.

The extraction is advantageously carried out by bringing the cereal material (for example, the ground and/or flattened fraction) into contact with the alcohol

solution (preferably ethanol) in a reactor, preferably under agitation. Preferably, the cereal material (for example, the ground and/or flattened fraction) is brought into contact with the alcohol solution (preferably ethanol) in a mass ratio of 1:3 to 1:8, more preferably in a mass ratio of 1:4 to 1:7. The contact advantageously takes place for a duration of 15 to 120 min, preferably 20 to 60 min. Preferably, the cereal material particles are then separated from the alcohol solution by filtration, for example, on a 10 µm mesh cloth.

In a particularly advantageous manner, when the alcohol solution is an ethanol solution, the ethanol used in the ethanol solution is produced by fermentation from a substrate as described in patent application FR 2211884 filed on November 11, 2022, and entitled "*Method for preparing a substrate for fermentation.*" In particular, the fermentation substrate may be prepared by a method comprising the following steps: providing at least one legume seed comprising starch and proteins; micronizing said at least one seed, so as to obtain a micronized fraction; purifying the micronized fraction (preferably by air classification), so as to collect a fraction enriched in starch and depleted in protein; mixing the fraction enriched in starch and depleted in protein with a liquid, so as to form a starch fluid; hydrolyzing the starch by mixing water vapor with the starch fluid (preferably carried out using a direct steam injection device in continuous mode), so as to obtain a hydrolyzed starch fluid; and preferably introducing into the hydrolyzed starch fluid one or more glucosidase and/or saccharidase enzymes. The use of such a method to prepare the fermentation substrate for ethanol production has the advantage of having a relatively low greenhouse gas emission rate, which may be less than 400 kg of CO_{2eq}/t of ethanol.

Preferably, the alcohol (preferably ethanol) used to prepare the alcohol solution is a recycled alcohol, i.e., it has already been previously used in a treatment method, preferably in an extraction method, more preferably in an extraction step of a method according to the invention.

The extraction step according to the invention makes it possible to extract at least part of the lipids from the cereal material into the alcohol solution (preferably ethanol). Thus, at the end of the extraction step, and preferably the filtration step, a

liquid fraction enriched in lipids and a solid fraction depleted in lipids (also called oil cake) are obtained.

5 The oil cake is advantageously subjected to a drying step. Preferably, it is dried in a vacuum oven, preferably at a temperature of 30 to 50°C. Preferably, the cake is dried for a duration of 2 to 10 hours.

The extraction step may be repeated one or more times on the oil cake, preferably after drying the oil cake. In other words, the method according to the invention may comprise one, two, or more extraction steps using an alcohol solution (preferably ethanol).

10 The liquid fraction enriched in lipids (comprising the alcohol-fat mixture) is preferably subjected to a purification step in order to separate the alcohol (preferably ethanol) from the fraction enriched in lipids. More preferably, the alcohol (preferably ethanol) is separated by distillation. In particular, the liquid fraction enriched in lipids may be distilled at a temperature of 30 to 70°C, preferably in a vacuum tray column.

15 The oil is recovered at the bottom of the column (forming a purified lipid-enriched fraction) while the alcohol (preferably ethanol) is collected at the top of the column.

In a particularly advantageous manner, the alcohol (preferably ethanol) recovered after separation from the liquid fraction enriched in lipids is recycled, and is more particularly reused for a new extraction cycle of the method according to the invention.

20

The separation method according to the invention comprises a grinding step of the solid fraction depleted in lipids (oil cake), preferably dried, then a step of separating the obtained particles according to their size. These steps are intended to separate the beta-glucan fraction from the starch and protein fractions. For grinding, any suitable grinder may be used, in particular any grinder using a mechanical force of abrasion, compression, impact, shearing, or any other mechanical action. In particular, a pendulum grinder using compression force may be used. After grinding, a mixture of envelope fragments (essentially fibers) (also called bran in the present text) and kernel powder (also called flour in the present text) is obtained.

25

30

The step of separating the particles obtained after grinding is preferably carried out by sieving. In particular, the particles may be separated by passing over

a suitable mesh sieve allowing separation of the bran from the flour. For example, particles of a size less than a size between 200 and 600 μm may be separated from bran of a size greater than or equal to such a size. The bran separated during this step corresponds to a fraction enriched in beta-glucans; the flour obtained after separation corresponds to a fraction depleted in beta-glucans.

The fraction enriched in beta-glucans may then serve as the powdered cereal fraction in the method for preparing a plant-based beverage described above. Preferably, the fraction enriched in beta-glucans is the powdered cereal fraction, i.e., it does not undergo any further treatment before its use in the method for preparing the plant-based beverage.

Preferably, the obtained fraction enriched in beta-glucans comprises amounts of beta-glucan, carbohydrates, protein, and/or fat (as a percentage relative to the total dry weight of the fraction enriched in beta-glucans) as indicated above for the powdered cereal fraction.

The fraction depleted in beta-glucans (flour) corresponds to a fraction enriched in starch and preferably in proteins.

An example of a method for separating a cereal material is shown in **Figure 1**. In this example, a cereal material 1, in particular oat and/or barley, preferably undergoes a first grinding 2 and a ground fraction 3 is obtained. This ground fraction 3 is subjected to an extraction treatment 4 using an alcohol solution, preferably an ethanol solution. At the end of this extraction 4, a liquid fraction 5 enriched in lipids comprising an alcohol/lipid mixture and a solid fraction 6 depleted in lipids are collected. The solid fraction depleted in lipids 6 is then subjected to a second grinding step 7. The recovered fraction 8 corresponds to a mixture of flour (ground almond) and bran. A separation step 9 of the particles of fraction 8, according to their size, in particular by sieving, is then carried out in order to separate the flour from the bran. Two fractions are collected: the fraction of larger particles corresponds to the bran and to a fraction enriched in beta-glucans 10 and the fraction of finer particles corresponds to the flour and to a fraction depleted in beta-glucans 11.

Examples

The following examples illustrate the invention without limiting it.

In the examples, the following analysis and measurement methods were used:

- Measurement of protein content: Kjeldahl method using a FOSS titrator according to ISO 5983-2;
- Measurement of lipid content: AOAC 922.06 method;
- Measurement of starch content: method according to ISO 15914;
- Carbohydrate content: determined by calculating the difference between the total weight of the product and the sum of the weights of proteins, fats, total fibers, water, and ash;
- Measurement of ash content: method according to NF EN ISO 2171;
- Measurement of beta-glucan content: AOAC 995.16 method;
- Measurement of dextrose equivalent: Lane-Eynon method;
- Water content: obtained by the difference between the initial total weight of the sample and the dry extract measured according to ISO 6731;
- Measurement of total fiber content: according to the AOAC 2011.25 method.

Example 1: Production of a fraction enriched in beta-glucan

25 kg of coarsely ground oat groats were introduced into a Nutsche-type reactor with a capacity of 250 liters.

The reactor is equipped with a 10 µm filter at the bottom of the tank.

The composition of the oat groats introduced into the reactor is indicated in the table below (in mass percentage).

[Table 1]

Humidity	12.0%
Proteins	11.1 %
Fats	5.8%
Carbohydrates	58.9%
Fibers	10.8%
Ash	1.4%

134 kg (170 liters) of dehydrated ethanol were mixed with 30 kg of water to obtain an aqueous ethanol solution with an ethanol concentration of 85% v/v. The ethanol solution was prepared at room temperature.

5 The ethanol solution was introduced into the reactor, the mass ratio of ethanol solution:groats being 6.6:1. The groats/ethanol solution mixture was kept under agitation for 45 minutes at room temperature.

After this extraction time, the liquid was drained through the 10 μm filter, under a constant pressure of 0.2 MPa. The cake was then dried in a vacuum oven at a temperature of 45°C until all traces of ethanol disappeared.

10 The ethanol solution containing the fats was distilled in a tray column configured to obtain ethanol at 96% v/v at the top of the column. This alcohol can thus be recycled in a new extraction.

The oat oil was recovered at the bottom of the column.

15 A second extraction was carried out on the dried oil cake under the same conditions as the first (i.e., 45 minutes of contact time under agitation with 200 liters of ethanol at 85% v/v in water).

The extraction yield of fats is 91% (by weight). A small amount of flour is present in the oil obtained, this flour coming from the passage of particles smaller than 10 μm through the filter of the extraction reactor.

20 The lipid balance of the extraction operations is indicated in the table below:

25 [Table 2]

	Quantity (kg)	Fats (% in weight)	Quantity of fats (kg)	Oil yield of the extraction (%)
Groat	25	5.8	1.45	

Oil collected after the first extraction			1.13	77.9
Oil collected after the second extraction			0.19	91.0
De-oiled flour obtained after the first extraction	23.87	1.3	0.31	
De-oiled flour obtained after the second extraction	23.68	0.5	0.12	

The de-oiled flour was then ground according to the following method. The bran (outer fibrous envelope of the oat) is separated using a Buhler MLU 202 mill in soft wheat configuration and a 250 μm sieve. The bran fraction obtained after this separation is a fraction enriched in beta-glucans; the white flour fraction remaining after separation of the bran corresponds to a fraction depleted in beta-glucans.

The mass balance of the separation operation is summarized in the table below:

[Table 3]

	Mass balance (% by weight)
Bran fraction	24.7
White flour fraction	73.8
Losses	1.5

Losses are due to a decrease in moisture and to some traces of powder remaining on the walls of the powder conveying ducts.

The fiber content balance given in the table below (in mass percentage relative to the total dry matter (DM) weight) indicates an almost threefold increase in the beta-glucan content in the fraction enriched in beta-glucan (bran) compared to the flour obtained after extraction, for a mass yield of the bran fraction of 24.7%.

[Table 4]

	Total fiber content (TDF) (%/DM)	Beta-glucan content (%/DM)
De-oiled oat flour	10.6	5.1
Bran fraction	26.3	14.9
White flour fraction	5.3	2.2

The fraction enriched in beta-glucans (bran fraction) has the following composition (in mass percentage):

[Table 5]

	Quantity by mass relative to the total weight of the fraction	Quantity by mass relative to the total dry matter weight of the fraction
Humidity	9.8%	-
Proteins	14.9%	16.5%/DM
Fats	2.7%	3.0%/DM
Carbohydrates	46.2%	51.2%/Dm
Fibers	23.7%, including 13.4% of beta-glucan	26.3%/DM, including 14.9%/DM of beta-glucan
Ash	2.7%	3.0%/DM

5

Example 2: Production of a plant-based beverage rich in beta-glucan

1.5 kg of beta-glucan-enriched oat fraction as prepared in Example 1 above were mixed with 13.5 liters of mineralized water to be introduced into a 20-liter capacity reactor from OMVE.

10

A starch hydrolysis was carried out by enzymatic hydrolysis. The parameters of the fraction/water mixture and the enzymatic hydrolysis parameters are indicated in the table below:

[Table 6]

Dilution	10% w/w
Water	Mineralized, comprising at least 40 mg/L of Ca ²⁺
pH	6.0

Starch quantity	0.5 kg
Enzyme	Termamyl® Classic, in an amount of 0.4% by weight relative to the starch weight
OMVE reactor configuration	Tubular exchanger
Flow rate	50 L/h
Preheating temperature	50°C
Heat-transfer fluid temperature	100°C
Hydrolysis temperature	85 – 90°C
Incubation time	5 minutes
Jacket temperature	95°C
Cooling temperature	60°C

15 kg of the hydrolyzed mixture was introduced into a JOUAN centrifuge according to the following parameters:

[Table 7]

Force	39,227 m.s ⁻² (4000 g)
Temperature	20°C
Time	10 minutes
Volume of insoluble matter contained in the centrifugation pellet	Less than 0.1%

5

10 kg of supernatant obtained after centrifugation were recovered, and 1.5% by weight (relative to the weight of the supernatant) of sunflower oil was added to this supernatant. The mixture was then stirred for 5 minutes using an Ultraturax-type stirrer. The stirred mixture was then homogenized using a PANDA Plus 2000 homogenizer to obtain a beverage having the appearance of a milk-based beverage. The parameters of the PANDA Plus 2000 homogenizer are as follows:

[Table 8]

1st-stage pressure	50 MPa
2nd-stage pressure	3 to 5 MPa
Number of passes	1

10

The plant-based beverage thus obtained was then heat-treated using an OMVE pasteurizer, then cooled in 2 steps, according to the parameters indicated below:

[Table 9]

Configuration	Tubular exchanger
Flow rate	20 L/h
Preheating temperature	100°C
Heating temperature	142°C
Product temperature	140°C
Contact time at 140°C	2 seconds
Pre-cooling temperature	50°C
Cooling temperature	20°C

5

The nutritional composition of the plant-based beverage obtained is given in the table below (in g/100 ml of plant-based beverage)

[Table 10]

Proteins	0.7
Carbohydrates	7.7
Fats	1.7
Beta-glucan	1.6
Ash	0.3

10

By drinking 1 glass of 200 mL of plant-based beverage as prepared above each day, the consumer will have taken a daily dose of 3.2 g of beta-glucan. This threshold corresponds to the minimum dose to benefit from the medical benefits of this component.

Example 3: Production of a plant-based beverage rich in beta-glucan and containing maltodextrins

15

1.5 kg of beta-glucan-enriched oat fraction as prepared in Example 1 above were mixed with 13.5 liters of mineralized water to be introduced into a 20-liter capacity reactor from OMVE.

Starch hydrolysis was carried out by enzymatic hydrolysis. The parameters of the fraction/water mixture and the enzymatic hydrolysis parameters are indicated in the table below:

[Table 11]

Dilution	10% w/w
Water	Mineralized, comprising at least 40 mg/L of Ca^{2+}
pH	6.0
Starch quantity	0.5 kg
Enzyme	BAN® 480 L, in an amount of 0.4% by weight relative to the starch weight
OMVE reactor configuration	Tubular exchanger
Flow rate	50 L/h
Preheating temperature	50°C
Heat-transfer fluid temperature	100°C
Hydrolysis temperature	85–90°C
Incubation time	5 minutes
Jacket temperature	95°C
Cooling temperature	60°C

5

15 kg of the hydrolyzed mixture was introduced into a JOUAN centrifuge according to the following parameters:

[Table 12]

Force	39,227 m.s ⁻² (4,000 g)
Temperature	20°C
Time	10 minutes
Volume of insoluble matter contained in the centrifugation pellet	Less than 0.1%

10 kg of supernatant obtained after centrifugation were recovered, and 1.5% by weight (relative to the weight of the supernatant) of sunflower oil was added to this supernatant. The mixture was then stirred for 5 minutes using an Ultraturax-type stirrer. The stirred mixture was then homogenized using a PANDA Plus 2000 homogenizer to obtain a beverage having the appearance of a milk-based beverage. The parameters of the PANDA Plus 2000 homogenizer are as follows:

[Table 13]

1st-stage pressure	50 MPa
2nd-stage pressure	3 to 5 MPa
Number of passes	1

The plant-based beverage is then heat-treated using an OMVE pasteurizer according to the parameters indicated below:

[Table 14]

Configuration	Tubular exchanger
Flow rate	20 L/h
Holding time	2 seconds
Preheating temperature	100°C
Heating temperature	142°C
Product temperature	140°C
Pre-cooling temperature	50°C
Cooling temperature	20°C

The nutritional composition of the plant-based beverage obtained is given in the table below (in g/100 ml of plant-based beverage)

[Table 15]

Proteins	0.6
Carbohydrates	7.5
Fats	1.8
Beta-glucan	1.6
Ash	0.3
Dextrose equivalent	19.6

- 5 The use of the enzyme BAN® 480 L to carry out the hydrolysis of the starch allows a moderate hydrolysis of the starch without (or almost without) production of simple sugars. The maltodextrins thus created during the starch hydrolysis step provide slow sugars allowing a moderate glycemic index to be obtained. The measurement of dextrose equivalent is a good indicator of starch hydrolysis. When
- 10 the dextrose equivalent is less than or equal to 20 without the presence of (simple) sugars, the hydrolyzed residues are maltodextrins.

By drinking 1 glass of 200 mL of plant-based beverage as prepared above each day, the consumer will have taken a daily dose of 3.2 g of beta-glucan. This threshold corresponds to the minimum dose to benefit from the medical benefits of

15 this component.

Claims

1. A cereal plant-based beverage comprising an amount of beta-glucan of at least 1.2 g/100 mL of plant-based beverage.
5
2. The plant-based beverage according to claim 1, being an oat or barley plant-based beverage, preferably an oat plant-based beverage.
3. The plant-based beverage according to claim 1 or 2, comprising an amount of beta-glucan of at least 1.5 g/100 mL of plant-based beverage, preferably from 1.5 to 5 g/100 mL of plant-based beverage.
10
4. The plant-based beverage according to any one of claims 1 to 3, comprising an amount of protein of at least 0.2 g/100 mL of plant-based beverage, preferably from 0.4 to 1.2 g/100 mL of plant-based beverage, more preferably from 0.5 to 1 g/100 mL of plant-based beverage.
15
5. The plant-based beverage according to any one of claims 1 to 4, comprising an amount of carbohydrates of at least 2 g/100 mL of plant-based beverage, preferably from 4 to 10 g/100 mL of plant-based beverage, more preferably from 6 to 9 g/100 mL of plant-based beverage.
20
6. The plant-based beverage according to any one of claims 1 to 5, comprising an amount of lipid less than or equal to 2.5 g/100 mL of plant-based beverage, preferably less than or equal to 2 g/100 mL of plant-based beverage, more preferably from 1 to 2 g/100 mL of plant-based beverage.
25
7. The plant-based beverage according to any one of claims 1 to 6, having a dextrose equivalent less than 20.
30

8. The plant-based beverage according to any one of claims 1 to 7, comprising a dry matter content of from 8 to 30% by weight, preferably from 8 to 15% by weight, relative to the total weight of the plant-based beverage.
- 5 9. A method for preparing a plant-based beverage according to any one of claims 1 to 8, comprising the following steps:
 - providing a powdered cereal fraction comprising starch and comprising an amount of beta-glucan greater than or equal to 10% by weight, relative to the total weight of the fraction;
 - 10 - mixing said fraction with water, so as to obtain a suspension; and
 - hydrolyzing the starch in the suspension.
10. The method according to claim 9, wherein the hydrolysis of the starch is carried out by introducing into the suspension at least one enzyme selected from the group consisting of saccharidases, preferably an alpha-amylase.
- 15 11. The method according to claim 9 or 10, further comprising after the starch hydrolysis step, a solid/liquid separation step, preferably by centrifugation, decantation, pressing using a filter press, and/or filtration.
- 20 12. The method according to any one of claims 9 to 11, further comprising a step of preparing the provided powdered cereal fraction, said preparing step comprising the following steps:
 - providing at least one cereal material (1) comprising starch, proteins, lipids, and beta-glucans, preferably an oat and/or barley cereal material;
 - 25 - treating the cereal material by solid/liquid extraction (4) with an alcohol solution comprising at least 50% by volume of alcohol, so as to obtain a solid fraction depleted in lipids (6) and a liquid fraction enriched in lipids (5);
 - grinding (7) the solid fraction depleted in lipids (6);
 - 30 - separating (9) the particles of the ground fraction depleted in lipids (8) according to their size, so as to obtain a fraction enriched in beta-glucans (10) and a fraction depleted in beta-glucans (11); and

- recovering the fraction enriched in beta-glucans (10) as a powdered cereal fraction.

- 5 13. The method according to claim 12, wherein the cereal material (1) is at least one cereal grain and/or at least one product derived from the malting, malt extract manufacturing, brewing, cereal distillation, plant-based dairy, and/or milling industries.