



(43) International Publication Date
11 May 2017 (11.05.2017)

(10) International Publication Number
WO 2017/078519 A1

(51) International Patent Classification:

A23L 7/126 (2016.01) A23L 33/21 (2016.01)
A23L 29/244 (2016.01) A23L 33/22 (2016.01)

(21) International Application Number:

PCT/NL2016/050758

(22) International Filing Date:

1 November 2016 (01.11.2016)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

15192878.5 4 November 2015 (04.11.2015) EP

(71) Applicant: **KONINKLIJKE COÖPERATIE COSUN**
U.A. [NL/NL]; Van de Reijtstraat 15, 4814 NE Breda
(NL).

(72) Inventors: **DE ROODE, Bartholomeus Mattheus**; Lenie
Sarishof 17, 3051 PT Rotterdam (NL). **HENDRIKS, Rudi**
Anthonius Gerardus; Vlaszak 19, 4611 JZ Bergen op
Zoom (NL).

(74) Agent: **NEDERLANDSCH OCTROOIBUREAU**; P.O.
Box 29720, 2502 LS The Hague (NL).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,
ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments (Rule 48.2(h))

(54) Title: HIGH DIETARY FIBER CEREAL BARS

(57) Abstract: This invention relates to cereal bars comprising high amounts of dietary fiber, more particularly to cereal bars comprising soluble dietary fiber chosen from fructo-oligosaccharide and/or inulin and insoluble dietary fiber from the same plant source, and to a method for the manufacture of said cereal bars. Said high dietary fiber cereal bars have a low weight percentage of fructo-oligosaccharides and/or inulin while still having acceptable organoleptic properties. Specific aspects of the invention concern said insoluble dietary fiber in the form of particles, a method to produce said insoluble dietary fiber particles and a binding syrup comprising said insoluble dietary fiber particles for use in cereal bars.



WO 2017/078519 A1

HIGH DIETARY FIBER CEREAL BARS

FIELD OF THE INVENTION

The invention relates to cereal bars comprising high amounts of dietary fiber, more particularly to cereal bars comprising soluble dietary fiber chosen from fructo-oligosaccharide and/or inulin and insoluble dietary fiber from the same plant source, and to a method for the manufacture of said cereal bars. The invention further relates to said insoluble dietary fiber in the form of particles, to a method to produce said insoluble dietary fiber particles and to a binding syrup comprising said insoluble dietary fiber particles for use in cereal bars.

BACKGROUND OF THE INVENTION

Inulin and fructo-oligosaccharide are considered to be dietary fibers due to the unique nature of their glycosidic bridges which prevents their hydrolysis in the upper gastrointestinal tract by human alimentary enzymes. Therefore, they do not lead to a rise in serum glucose. Since inulin and fructo-oligosaccharide reach the colon undigested, they are available to stimulate the growth of bifidobacteria, resulting in health benefits for the human host.

Both inulin and fructo-oligosaccharide are widely used as food ingredients, not only for their health promoting effect but also for their physical properties. Both fibers are water soluble where inulin is less water soluble than fructo-oligosaccharide due to the difference in chain length. As a short chain oligomer, fructo-oligosaccharide can provide about 30%-50% of the sweetness of sucrose. Additionally, inulin and fructo-oligosaccharide have sensorial superiority compared to other fibers since they have no 'off flavors'.

Chicory (*Cichorium intybus*) is the main source of inulin and fructo-oligosaccharide in food industry. By using a hot water diffusion process followed by sequential purification and drying steps, inulin can be extracted from chicory roots. The fructo-oligosaccharide derived from chicory is produced by a partial enzymatic hydrolysis of inulin. As a by-product during the manufacture of inulin from chicory roots, the insoluble remains of extracted chicory root are used as feed without further processing. However, these remains still contain more than 70% edible fiber on dry matter. These fibers, mainly cellulose and hemicellulose, which travel through the digestive system unchanged, may contribute to bowel movement improving laxation, thereby preventing constipation. Therefore, it would be a double-benefit solution for both consumers and producers if these insoluble chicory root fibers together with the soluble chicory root fibers (inulin and fructo-oligosaccharide) can be applied in food products.

Among the main uses of inulin and fructo-oligosaccharide in the food industry is application in cereal bars. Cereal bars are perceived to be convenient snacks to provide a quick source of energy and are suitable for a busy lifestyle. In addition, consumption of cereal bars is considered to have a health benefit because of the dietary fiber intake. Thus, an ideal food product for the soluble and insoluble chicory fiber combination is a cereal bar. Cereal bars having varying amounts of soluble dietary fiber, insoluble dietary fiber and total dietary fiber content are extensively described in the art. These cereal bars either have low total dietary fiber content, high soluble dietary fiber content or poor organoleptic properties.

US6,248,375B1 discloses a nutritional bar comprising soluble and insoluble dietary fibers. The nutritional bar comprises less than 2.5 wt% of indigestible oligosaccharides.

WO03/061405A1 describes a cereal bar comprising debittered insoluble chicory root fibers and fructo-oligosaccharides. The total dietary fiber content of the cereal bar is about 13 wt%.

WO2011/008095A1 discloses a cereal bar comprising extracted insoluble chicory root pulp and fructo-oligosaccharide. Extracted insoluble chicory root fibers are infused with fructo-oligosaccharides (FrutaloseTM L92) and high maltose syrup to mask the bitter off-flavours in the product which are commonly associated with fresh chicory root. The total dietary fiber content of the cereal bar is 46 wt% and the fructo-oligosaccharide content is 34 wt%.

WO2014/172486A9 describes a cereal bar having 16 wt% of dietary fibers, based on the weight of the cereal bar. The insoluble dietary fibers are debittered insoluble chicory root fibers. The cereal bar contains a binding syrup comprising inulin.

US2014/0308389A1 discloses a nutritional bar comprising soluble and insoluble dietary fibers. It is described that the insoluble fiber can be milled to different particle sizes.

US2007/0104853A1 describes low-calorie whole grain cereal bars comprising at least about 6 wt% of soluble fiber and at least about 3.5 wt% of insoluble fiber. The binder of these cereal bars provides from about 25 to about 35 wt% of the fiber in the cereal bars.

The addition of high levels of insoluble dietary fibers to cereal bars is known to adversely affect the organoleptic properties of these food products. Cereal bars high in insoluble dietary fiber can have a dry, tough, chewy or dense structure, making them less appealing to consumers. Furthermore, addition of high levels of insoluble dietary fiber to cereal bars may negatively affect the textural properties such as hardness and water activity of the final cereal bar. In addition, rheological and textural properties during processing may be negatively affected.

High dietary fiber cereal bars having acceptable organoleptic properties can be obtained by increasing the amount of soluble dietary fibers like inulin and fructo-oligosaccharide since these soluble dietary fibers offer the advantage that they may mask off-flavors in the food product, enhance sweetness and/or improve taste perception. However, it is known that addition of high amounts of soluble dietary fibers like fructo-oligosaccharides and/or inulin to food products, such as for example more than 9 gram on a daily basis, can lead to feelings of discomfort by consumers. Due to fermentation of fructo-oligosaccharides and/or inulin in the large intestine gases are produced, which can lead to flatulence and/or bloating.

Accordingly, it is an object of the invention to provide high dietary fiber cereal bars with a lower weight percentage of fructo-oligosaccharides and/or inulin while still having acceptable organoleptic properties. It is a further object of the invention to apply insoluble dietary fibers together with the soluble dietary fibers (inulin and fructo-oligosaccharide) from the same plant source in a cereal bar while still having acceptable organoleptic properties.

SUMMARY OF THE INVENTION

The present inventors found that the above objects can be met by replacing part of the fructo-oligosaccharides and/or inulin in a high dietary fiber cereal bar with insoluble dietary fiber such that the total amount of healthy dietary fiber is not decreased while at the same time the amount of soluble dietary fiber is reduced to a level at which consumer discomfort due to flatulence and/or bloating is considerably reduced.

The present invention thus provides a cereal bar comprising a cereal mix and a binding syrup, said cereal bar comprising between 17 wt% and 35 wt%, based on dry solids content, of soluble and insoluble dietary fiber, wherein the cereal bar comprises between 12 and 20 wt%, based on dry solids content, of soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof, which soluble dietary fiber is contained in the binding syrup, and wherein the weight percentages are based on the weight of the cereal bar.

Remarkably, the present inventors have established that particularly good results were obtained by replacing part of the fructo-oligosaccharides and/or inulin in a high dietary fiber cereal bar with insoluble dietary fiber from the same plant source.

Accordingly, the present invention also provides a cereal bar comprising a cereal mix and a binding syrup, said cereal bar comprising between 17 wt% and 35 wt%, based on dry solids content, of soluble and insoluble dietary fiber from the same plant source, wherein the cereal bar comprises between 12 and 20 wt%, based on dry solids content, of soluble dietary fiber

chosen from fructo-oligosaccharides, inulin or combinations thereof, which soluble dietary fiber is contained in the binding syrup, and wherein the weight percentages are based on the weight of the cereal bar.

5 The present inventors have further established that the organoleptic properties of the new cereal bar may depend on the amount and the particle size of the insoluble dietary fibers and on their location in the cereal bar.

10 In comparison with a reference bar wherein the binding syrup contains high amounts of soluble dietary fiber in the form of fructo-oligosaccharides and inulin and wherein the cereal bar does not comprise insoluble dietary fiber from the same plant source, a high dietary fiber cereal bar having a reduced weight percentage of fructo-oligosaccharides and/or inulin with satisfactory organoleptic properties is obtained when the binding syrup comprises insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 30 and 250 μm as measured by nest sieving, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein the amount of said insoluble dietary fiber particles, based on dry solids content, is between 3 and 13 wt%, based on the weight of the binding syrup.

20 The weight percentage of fructo-oligosaccharides and/or inulin can be reduced even further while retaining satisfactory organoleptic properties when the cereal mix comprises insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 30 and 250 μm as measured by nest sieving, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein the amount of said insoluble dietary fiber particles, based on dry solids content, is between 5 and 20 wt%, based on the weight of the cereal mix.

25 More satisfactory taste properties with respect to the previous bar are obtained when the cereal mix comprises insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 30 and 2500 μm and a particle size distribution characterized by a D_{10} of 440 μm , a D_{50} of 1250 μm and a D_{90} of 2050 μm as measured by nest sieving, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein the amount of said insoluble dietary fiber particles, based on dry solids content, is between 5 and 20 wt%, based on the weight of the cereal mix.

30 Still more satisfactory textural properties with respect to the previous bar are obtained when the cereal mix comprises insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 800 and 2500 μm and a particle size distribution characterized by a D_{10} of 1060 μm , a D_{50} of 1580 μm and a D_{90} of 2080 μm as measured by

nest sieving, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein the amount of said insoluble dietary fiber particles, based on dry solids content, is between 5 and 20 wt%, based on the weight of the cereal mix.

Particularly good taste and textural properties with respect to the previous bar are obtained when the cereal mix comprises insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 30 and 2500 μm and a bimodal particle size distribution, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein the amount, based on dry solids content, of said insoluble dietary fiber particles is between 5 and 20 wt%, based on the weight of the cereal mix and wherein said insoluble dietary fiber particles consist of:

- a) between 3 wt% and 35 wt%, based on the total weight of insoluble dietary fiber particles, of a first fraction of insoluble dietary fiber particles having a particle size of between 30 and 800 μm and a particle size distribution characterized by a D_{10} of 60 μm , a D_{50} of 370 μm and a D_{90} of 680 μm as measured by nest sieving; and
- b) between 65 wt% and 97 wt%, based on the total weight of insoluble dietary fiber particles, of a second fraction of insoluble dietary fiber particles having a particle size of between 800 and 2500 μm and a particle size distribution characterized by a D_{10} of 1060 μm , a D_{50} of 1580 μm and a D_{90} of 2080 μm as measured by nest sieving.

The invention further provides an uncooked binding syrup and a cooked binding syrup for a cereal bar, said uncooked binding syrup comprising:

- a) 15 - 45 wt%, based on dry solids content, of a mixture of one or more of glucose syrup, fructose syrup, sugar and glycerol;
- b) 15 - 30 wt% of water;
- c) 0.01 - 1 wt% of emulsifier;
- d) 1 - 7 wt% of fat;
- e) 32 - 47 wt%, based on dry solids content, of soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof;
- f) insoluble dietary fiber particles in the form of a flour having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, and having a particle size of between 30 and 250 μm as measured by nest sieving;

wherein the combined amount of said soluble dietary fiber and said insoluble dietary fiber particles is at least 40 wt%, based on dry solids content, wherein the amount of said insoluble dietary fiber particles is between 2 and 11 wt%, based on dry solids content, wherein the

soluble and insoluble dietary fibers originate from the same plant source, and wherein the weight percentages are based on the weight of the binding syrup.

In a further aspect, the invention relates to a method for the manufacture of a cereal bar, said method comprising the steps of:

- 5 a) washing inulin- and/or fructo-oligosaccharide-containing plant material;
 - b) slicing or mincing said washed plant material to obtain extractable pieces;
 - c) extracting water soluble components from the pieces obtained in step b) to obtain soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof;
 - d) drying the extracted pieces obtained in step c) to a water content of less than 10 wt% to
10 obtain insoluble dietary fiber pieces;
 - e) milling the insoluble dietary fiber pieces obtained in step d) to obtain insoluble dietary fiber particles;
 - f) preparing a binding syrup comprising between 12 and 20 wt%, based on dry solids content, of soluble dietary fiber chosen from fructo-oligosaccharides, inulin or
15 combinations thereof as obtained in step c);
 - g) preparing a cereal mix;
 - h) adding insoluble dietary fiber particles as obtained in step e) to the cereal mix or to the binding syrup to obtain between 17 wt% and 35 wt%, based on dry solids content, of insoluble dietary fiber from said plant material and soluble dietary fiber chosen from
20 fructo-oligosaccharides, inulin or combinations thereof from said plant material;
 - i) combining the binding syrup and the cereal mix to obtain the cereal bar;
- wherein the weight percentages are based on the weight of the cereal bar.

The invention further provides insoluble dietary fiber particles having a particle size between 30 μm and 2500 μm and a bimodal particle size distribution, said particles having an
25 insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein said insoluble dietary fiber particles consist of:

- a) between 3 wt% and 35 wt%, based on the total weight of insoluble dietary fiber particles, of a first fraction of insoluble dietary fiber particles having a particle size of between 30 and 800 μm and a particle size distribution characterized by a D_{10} of 60 μm , a D_{50} of 370
30 μm and a D_{90} of 680 μm as measured by nest sieving; and
- b) between 65 wt% and 97 wt%, based on the total weight of insoluble dietary fiber particles, of a second fraction of insoluble dietary fiber particles having a particle size of between 800 and 2500 μm and a particle size distribution characterized by a D_{10} of 1060 μm , a D_{50} of 1580 μm and a D_{90} of 2080 μm as measured by nest sieving.

The invention also relates to a method for preparing these particles. In a still further aspect, the invention relates to the use of:

- a) insoluble dietary fiber particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, and having a particle size of between 30 and 2500 μm as measured by nest sieving; and
- b) soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof, said insoluble dietary fiber and soluble dietary fiber originating from the same plant source, in cereal bars.

10 DEFINITIONS

The term 'cereal bar' in the context of the present invention refers to a nutritional bar comprising cereals, said cereals typically having the size of a few millimeter, that are held together by a binding syrup.

The term 'binding syrup' is considered to be synonymous to 'binder' or 'binding agent' and refers in the context of the present invention to a material that essentially acts as an edible glue for combining and holding together the relatively dry ingredients of the cereal mix in a cereal bar as a self-supporting body.

The terms 'flatulence' and 'bloating' in the context of the present invention refer to the condition wherein excessive gases are generated in the intestines of a human being.

As used herein, the term 'about' means plus or minus 10% of the numerical value of the number with which it is being used. For example, about 50% means in the range of 40%-60%.

The term 'dietary fiber' as used herein refers to all dietary fibers that are not or partly digested by the endogenous secretions of the human digestive tract.

The term 'insoluble dietary fiber' as used herein refers to 100% insoluble dietary fiber whereas the terms 'insoluble dietary fiber particles' or 'insoluble chicory root fiber (iCRF) particles' refer to particles that are obtained by slicing plant material and by extracting water-soluble components therefrom, followed by milling the extracted material. Hence, 'insoluble dietary fiber particles' may in addition to insoluble dietary fibers such as cellulose, hemicellulose, pectin and lignin also comprise other material that is not easily extracted using water.

The wording 'the composition comprises xx wt% of component y, based on dry solids content' as used herein means that the dry solids in component y amount to xx wt% of the total weight of the composition, wherein said composition as a whole may comprise water. In

reality, component *y* may however contain some water. Hence, the total weight percentage of a water-containing component *y* as applied in the composition is higher than *xx* wt%.

The term 'fructo-oligosaccharide', also called oligofructose and often abbreviated as FOS, refers to glucose- and/or fructose-terminated fructose chains with a degree of polymerization of 2 to 10. Thus, fructo-oligosaccharide can be described as GF_{*n*+1} chains and/or F_{*n*+1} chains, wherein G is a glucosyl unit, F is fructosyl unit and *n* = 1-9. The term fructo-oligosaccharide as used throughout the description refers to native fructo-oligosaccharide as present in plant material and/or to partially hydrolyzed native inulin.

Inulin is a polyfructose mixture having a degree of polymerization of 2 - 60 or more. Thus, inulin can be described as GF_{*n*+1} chains wherein G is a glucosyl unit, F is a fructosyl unit and *n* is 1-59. Hence, inulin also encompasses native fructo-oligosaccharides as present in plant material.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 depicts textural properties of cereal bars Reference, Bar 1 and Bar 2 with increasing levels of insoluble chicory root fiber (iCRF) particles (flour fraction) having a particle size of between 30 and 250 µm, in the binding syrup up to 30 days of shelf life at room temperature. Error bars represent SEM (standard error of the mean). Figure 1A shows water activity (each column represents the mean value of 4 measurements), Figure 1B the moisture content (each column represents the mean value of 3 measurements), Figure 1C the cutting force (each column represents the mean of 12 measurements), Figure 1D the hardness (each column represents the mean of 12 measurements) and Figure 1E the cohesiveness (each column represents the mean values of 12 measurements). White bars represent values at 0 days of shelf life (freshly prepared cereal bars), dotted bars represent values at 10 days of shelf life, grey bars represent values at 20 days of shelf life and black bars represent values at 30 days of shelf life.

Figure 2 shows a radar chart of the sensory evaluation results of cereal bars Reference, Bar 1 and Bar 2 after 4 weeks of storage at ambient conditions. The cereal bars have increasing levels of insoluble chicory root fiber (iCRF) particles (flour fraction) having a particle size of between 30 and 250 µm, in the binding syrup. Significant differences between the cereal bars are indicated with one or more asterisks. The symbols '*', '**' and '***' indicate significance at 5, 1 and 0.1%, respectively. The abbreviation BS stand for binding syrup. The solid line with circles represents the Reference bar without iCRF particles in the binding syrup, the dashed line with squares represents Bar 1 with 5.25 wt%, based on dry

solids content, of iCRF particles (flour fraction) in the binding syrup and the dashed line with triangles represents Bar 2 with 9.79 wt%, based on dry solids content, of iCRF particles (flour fraction) in the binding syrup.

Figure 3 shows a radar chart of the sensory evaluation of the Reference bar, Bar 3, Bar 8 and Bar 10 directly after preparation. All attributes are scored against the Reference bar that by definition is ranked at the value of zero for all attributes. Scores were given as “less” (-1), “much less” (-2), “equal to” (0), “more” (+1), and “much more” (+2). The results in the charts are the average scores of 5 panelists. Cereal bars Bar 3, Bar 8 and Bar 10 comprise 8.55 wt%, based on dry solids content, of iCRF particles in the cereal mix at different iCRF particle sizes. The thin line at the value of 0 for all attributes represents the Reference bar, the dashed line represents Bar 3 (flour fraction), the dotted line represents Bar 8 (medium fraction, monomodal flakes), and the thick line represents Bar 10 (bimodal fraction 1, bimodal flakes).

Figure 4 shows a radar chart of the sensory evaluation of the Reference bar, Bar 4, Bar 9 and Bar 11 directly after preparation. All attributes are scored against the Reference bar that by definition is ranked at the value of zero for all attributes. Scores were given as “less” (-1), “much less” (-2), “equal to” (0), “more” (+1), and “much more” (+2). The results in the charts are the average scores of 5 panelists. Cereal bars Bar 4, Bar 9 and Bar 11 comprise 14.25 wt%, based on dry solids content, of iCRF particles in the cereal mix at different iCRF particle sizes. The thin line at the value of 0 for all attributes represents the Reference bar, the dashed line represents Bar 4 (flour fraction), the dotted line represents Bar 9 (medium fraction, monomodal flakes), and the thick line represents Bar 11 (bimodal fraction 2, bimodal flakes).

Figure 5 shows a radar chart of the sensory evaluation of the Reference bar, Bar 1, Bar 2 and Bar 3 directly after preparation. All attributes are scored against the Reference bar that by definition is ranked at the value of zero for all attributes. Scores were given as “less” (-1), “much less” (-2), “equal to” (0), “more” (+1), and “much more” (+2). The results in the charts are the average scores of 5 panelists. The cereal bars have different levels of iCRF flour in the binding syrup and in the cereal mix. The thin line at the value of 0 for all attributes represents the Reference bar, the dashed line represents Bar 1 (5.25 wt%, based on dry solids content, of iCRF particles in the binding syrup; flour fraction), the dotted line represents Bar 2 (9.79 wt%, based on dry solids content, of iCRF particles in the binding syrup; flour fraction), and the thick line represents Bar 3 (8.55 wt%, based on dry solids content, of iCRF particles in the cereal mix; flour fraction).

Figure 6 shows a radar chart of the sensory evaluation of the Reference bar, Bar 6, Bar 9 and Bar 11 directly after preparation. All attributes are scored against the Reference bar that by definition is ranked at the value of zero for all attributes. Scores were given as “less” (-1), “much less” (-2), “equal to” (0), “more” (+1), and “much more” (+2). The results in the charts are the average scores of 5 panelists. The cereal bars have 14.25 wt%, based on dry solids content, of iCRF particles in the cereal mix at different iCRF particle sizes. The thin line at the value of 0 for all attributes represents the Reference bar, the dashed line represents Bar 6 (total fraction, monomodal flakes from 30 to 2500 μm), the dotted line represents Bar 9 (medium fraction, monomodal flakes from 800 to 2500 μm), and the thick line represents Bar 11 (bimodal fraction 2, bimodal flakes from 30 to 2500 μm).

DETAILED DESCRIPTION

In a first aspect of the invention, a cereal bar is provided, said cereal bar comprising a cereal mix and a binding syrup, said cereal bar comprising between 17 wt% and 35 wt%, based on dry solids content, of soluble and insoluble dietary fiber from the same plant source, wherein the cereal bar comprises between 12 and 20 wt%, based on dry solids content, of soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof, which soluble dietary fiber is contained in the binding syrup, and wherein the weight percentages are based on the weight of the cereal bar.

The cereal bars according to the invention are sweet-type cereal bars since the binding syrup contains substantial amounts of inulin and/or fructo-oligosaccharides which have an intrinsic sweet taste.

In a preferred embodiment, the cereal bar comprises between 17.5 wt% and 30 wt%, based on dry solids content, of soluble and insoluble dietary fibers from the same plant source, even more preferably between 18 wt% and 25 wt%.

A high fiber food product must have at least 6 grams of dietary fiber per 100 grams of product, which comes down to about 3 grams of dietary fiber per 100 kcal of product (see for example Regulation (EC) No 1924/2006 of the European Parliament and of the Council of 20 December 2006 on nutrition and health claims made on foods). The cereal bar according to the invention contains at least 17 wt% of dietary fibers, which comes down to at least 17 gram of dietary fiber per 100 gram of cereal bar and can therefore be classified as a high fiber product.

It is envisaged that, in addition to the 17 wt% to 35 wt% of soluble and insoluble dietary fibers from the same plant source, the cereal bar can also comprise other soluble and insoluble

dietary fibers from different plant sources. For example the cereals themselves such as for example oat flakes or rice crisps may contain dietary fibers. Hence, the total dietary fiber content of the cereal bar may be even higher than 35 wt%, based on the weight of the cereal bar.

5 In a preferred embodiment, the cereal bar comprises between 45 and 70 wt% of a cereal mix and between 30 and 55 wt% of binding syrup, wherein the weight percentages are based on the weight of the cereal bar. In a more preferred embodiment, the cereal bar comprises between 55 and 65 wt% of a cereal mix and between 35 and 45 wt% of binding syrup, wherein the weight percentages are based on the weight of the cereal bar. The ratio of binding
10 syrup to cereals not only determines the organoleptic properties but also influences the mechanical strength of the cereal bar since the binding syrup – as its name already suggests – glues together the cereals.

Non-limiting examples of preferred cereals that can be applied in the cereal mix are chosen from the group consisting of rice crisps, oat flakes, wheat flakes, barley flakes, and
15 combinations thereof. The cereal mix can further contain other components like dried nuts and dried fruit pieces such as dried peaches, apricots, orange rind, apple and raisins. The cereal mix may further comprise insoluble dietary fiber particles.

In addition to inulin and/or fructo-oligosaccharides, the binding syrup typically comprises emulsifiers, flavors, fat and additional sweeteners such as glucose syrup, sugar and glycerol.

20 The emulsifier can be any food-grade emulsifier suitable for improving the mixing of hydrophobic parts and hydrophilic parts in the binding syrup. In a preferred embodiment the emulsifier is chosen from the group consisting of mono- and diglycerides, lecithin and sucrose esters of fatty acids.

The fat portion of the binding syrup may comprise a single fat or a combination of fats.
25 The fat may be chosen from the group consisting of fractionated fats, hydrogenated oils, partially hydrogenated oils, unsaturated oils and combinations thereof. In the context of the present invention the terms fat and oil are used interchangeably. In a preferred embodiment, the fat is chosen from the group consisting of coconut oil, palm oil, palm kernel oil, cottonseed oil, safflower oil, sunflower oil, soy oil, corn oil and combinations thereof. In a
30 particularly preferred embodiment, the fat is palm fat.

In addition to the ingredients of the binding syrup already described, the binding syrup may further comprise components like caramel, cane juice and brown rice syrup.

Excess moisture is undesirable for both the manufacturing of the cereal bar and for the finished cereal bar. Yet the final cereal bar must not be so dry as to give a perceptible fibrous

mouthfeel. Thus, moisture content and balance is important. In this regard, the cereal bar has a water activity (A_w) of about 0.40 to about 0.60, preferably about 0.45 to about 0.55. Higher water activities can result in the agglomerates, and hence the bar as a whole, becoming too soft and less chewy in texture and mouthfeel. Higher water activities are also undesirable due to migration problems occurring between discrete food components having higher water content and food components of lower water content within the product, leading to loss in texture and/or flavor. The cereal bars according to the present invention provide good microbial stability without addition of antimicrobials.

Fructo-oligosaccharides and inulin are naturally occurring indigestible carbohydrates that can be found in root, tubers or leaves of some plants. Preferred plant sources comprise substantial amounts of fructo-oligosaccharides and/or inulin. In a preferred embodiment, the source of the soluble and insoluble dietary fiber is chosen from the family of Asteraceae, the family of Alliaceae, the family of Asparagaceae or the tribe of Triticeae. Preferred members of the family of Asteraceae that can be the source of the soluble and insoluble dietary fiber include chicory root, Jerusalem artichoke tubers, dandelion, sunflower and globe artichoke. Preferred members of the family of Alliaceae that can be the source of the soluble and insoluble dietary fiber include garlic, leek and onion. Preferred members of the family of Asparagaceae that can be the source of the soluble and insoluble dietary fiber include agave or asparagus. Preferred members of the tribe of Triticeae that can be the source of the soluble and insoluble dietary fiber include wheat, barley and rye. In a particularly preferred embodiment the source of the soluble and insoluble dietary fiber is chosen from chicory root and Jerusalem artichoke tubers, most preferably the source is chicory root.

Procedures for the extraction of inulin and fructo-oligosaccharide from plant material are extensively described in the art. The inulin and/or fructo-oligosaccharide obtained by extraction may be used as such or may be further processed by partial hydrolysis of the inulin to fructo-oligosaccharide, for example by enzymatic hydrolysis. Partial hydrolysis results in an alternative chain length distribution with an increase in glucose- and/or fructose-terminated fructose chains with a lower degree of polymerization. Hence, in an embodiment, the inulin and fructo-oligosaccharide in the binding syrup may differ in size distribution and weight ratios from the inulin and fructo-oligosaccharide originally present in the plant tissue prior to extraction of the soluble fraction therefrom.

Examples of inulin- and/or fructo-oligosaccharide-containing syrups that can advantageously be applied in the binding syrup of the cereal bars according to the invention are Frutalose® L85 as provided by Sensus B.V., The Netherlands, having 85 wt%

inulin/fructo-oligosaccharide based on dry solids content and a relative sweetness of 50 % compared to a sucrose solution of the same concentration, and Frutalose® L92 as provided by Sensus B.V., The Netherlands, having 92 wt% inulin/fructo-oligosaccharide based on dry solids content and a relative sweetness of 40 % compared to a sucrose solution of the same concentration. These syrups are obtained by extraction of chicory roots followed by partial hydrolysis.

The extracted pulp obtained after extracting the soluble fraction therefrom is dried, milled and optionally sieved to the desired particles size to obtain the insoluble dietary fiber particles according to the invention. The insoluble dietary fiber particles typically comprise about 75 wt% of insoluble dietary fibers such as cellulose, hemicellulose pectin and lignin, less than 7 wt% of soluble dietary fibers like inulin, about 8 wt% of protein, about 5 wt% of ashes and less than 2 wt% of other components, wherein the weight percentages are based on dry matter. The insoluble dietary fiber particles typically have a water content of about 5 wt%.

The particle size and the particle size distribution of the insoluble dietary fiber particles influence the organoleptic and textural properties of the cereal bar. The particle size of a sample can be defined by the upper and lower limit of the particle diameter and by the mean particle diameter. One standard way of defining the particle size distribution in a sample of particles is to refer to D_{10} , D_{50} and D_{90} values, based on a volume distribution. D_{10} is the particle diameter value that 10% of the population of particles lies below. D_{50} is the particle diameter value that 50 % of the population lies below and 50% of the population lies above. D_{50} is also known as the median particle size value. D_{90} is the particle diameter value that 90 % of the population lies below. A sample of particles that has a wide particle size distribution will have a large difference between the D_{10} and D_{90} values. Likewise, a sample of particles that has a narrow particle size distribution will have a small difference between D_{10} and D_{90} .

Particle size and particles-size distribution of the insoluble dietary fiber particles can be determined using nest sieving, a technique which is also called analytical sieving in the art. Sieves used in nest sieving are constructed from wire mesh typically having square apertures. Nest sieving using wire-mesh sieves provides a two-dimensional estimate of particle size because the smallest lateral dimension of each particles determines its ability to pass through a given sieve opening. Since the insoluble dietary fiber particles typically take the form of chips or flakes instead of perfect spheres, nest sieving consistently underestimates particle size of the insoluble dietary fiber particles.

In nest sieving, sieves having different mesh size are stacked on top of each other in order of increased mesh size. The nest of sieves is completed by a collection bin at the base and a

lid at the top. Material of which the particle size distribution is to be tested is placed on the top sieve. The nest of sieves is then subjected to a period of agitation which causes the particles to distribute between the sieves. The particle size distribution is obtained by determining the weight percentage of particles retained in each sieve. For further details on nest sieving, reference is made to standards ICUMSA GS2/9-37 (2007), ANSI/ASAE S319.3 (2003) and ASTM C136 (2014). In a particular embodiment, nest sieving is performed in accordance with standard ICUMSA GS2/9-37 (2007).

Instead of or in addition to measuring particle size distribution of insoluble dietary fiber particles, nest sieving can also be used to separate insoluble dietary fiber particles having certain lower and upper particles sizes. The lower and upper particle sizes of a particle fraction in a particular sieve are respectively determined by the mesh size of that particular sieve and of the sieve on top of that particular sieve. Using this technique, it is possible to prepare insoluble dietary fiber particles having a bimodal or multimodal particle size distribution. This can be accomplished by combining fractions retained on two or more sieves.

The present inventors have established that the organoleptic and textural properties of the new cereal bar are also affected by the location of the insoluble dietary fiber particles in the cereal bar.

In comparison with a reference cereal bar wherein the binding syrup contains high amounts of soluble dietary fiber in the form of fructo-oligosaccharide and inulin and wherein the cereal bar does not comprise insoluble dietary fiber from the same plant source, a high dietary fiber cereal bar having a reduced weight percentage of fructo-oligosaccharides and/or inulin with satisfactory organoleptic properties is obtained when the binding syrup comprises insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 30 and 250 μm as measured by nest sieving, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein the amount of said insoluble dietary fiber particles, based on dry solids content, is between 3 and 13 wt%, preferably between 4 and 11 wt%, more preferably between 5 and 10 wt%, based on the weight of the binding syrup.

Higher reduction of the weight percentage of fructo-oligosaccharides and/or inulin with still satisfactory organoleptic properties is obtained when the cereal mix comprises the insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 30 and 250 μm as measured by nest sieving, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein the

amount of said insoluble dietary fiber particles, based on dry solids content, is between 5 and 20 wt%, preferably between 6 and 18 wt%, more preferably between 7 and 16 wt%, based on the weight of the cereal mix.

5 More satisfactory taste properties with respect to the previous bar are obtained when the cereal mix comprises insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 30 and 2500 μm and a particle size distribution characterized by a D_{10} of 440 μm , a D_{50} of 1250 μm and a D_{90} of 2050 μm as measured by nest sieving, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein the amount of said insoluble dietary fiber particles,
10 based on dry solids content, is between 5 and 20 wt%, preferably between 6 and 18 wt%, more preferably between 7 and 16 wt%, based on the weight of the cereal mix.

Still more satisfactory textural properties with respect to the previous bars are obtained when the cereal mix comprises insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 800 and 2500 μm and a particle size distribution
15 characterized by a D_{10} of 1060 μm , a D_{50} of 1580 μm and a D_{90} of 2080 μm as measured by nest sieving, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein the amount of said insoluble dietary fiber particles, based on dry solids content, is between 5 and 20 wt%, preferably between 6 and 18 wt%, more preferably between 7 and 16 wt%, based on the weight of the cereal mix.

20 Particularly good taste and textural properties with respect to the previous bar are obtained when the cereal mix comprises insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 30 and 2500 μm and a bimodal particle size distribution, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein the amount, based on dry solids content, of
25 said insoluble dietary fiber particles is between 5 and 20 wt%, preferably between 6 and 18 wt%, more preferably between 7 and 16 wt%, based on the weight of the cereal mix and wherein said insoluble dietary fiber particles consist of:

- a) between 3 wt% and 35 wt%, based on the total weight of insoluble dietary fiber particles, of a first fraction of insoluble dietary fiber particles having a particle size of between 30
30 and 800 μm and a particle size distribution characterized by a D_{10} of 60 μm , a D_{50} of 370 μm and a D_{90} of 680 μm as measured by nest sieving; and
- b) between 65 wt% and 97 wt%, based on the total weight of insoluble dietary fiber particles, of a second fraction of insoluble dietary fiber particles having a particle size of

between 800 and 2500 μm and a particle size distribution characterized by a D_{10} of 1060 μm , a D_{50} of 1580 μm and a D_{90} of 2080 μm as measured by nest sieving.

In a preferred embodiment, said insoluble dietary fiber particles having a particle size of between 30 and 2500 μm and a bimodal particle size distribution consist of:

- 5 a) between 8 wt% and 22 wt%, such as 10 wt%, 15 wt% or 20 wt%, based on the total weight of insoluble dietary fiber particles, of a first fraction of insoluble dietary fiber particles having a particle size of between 30 and 800 μm and a particle size distribution characterized by a D_{10} of 60 μm , a D_{50} of 370 μm and a D_{90} of 680 μm as measured by nest sieving; and
- 10 b) between 78 wt% and 92 wt%, such as 80 wt%, 85 wt% or 90 wt%, based on the total weight of insoluble dietary fiber particles, of a second fraction of insoluble dietary fiber particles having a particle size of between 800 and 2500 μm and a particle size distribution characterized by a D_{10} of 1060 μm , a D_{50} of 1580 μm and a D_{90} of 2080 μm as measured by nest sieving.

15 In a second aspect of the invention, an uncooked binding syrup for a cereal bar is provided, said syrup comprising:

- a) 15 - 45 wt%, based on dry solids content, of a mixture of one or more of glucose syrup, fructose syrup, sugar and glycerol;
- b) 15 - 30 wt% of water;
- 20 c) 0.01 - 1 wt% of emulsifier;
- d) 1 - 7 wt% of fat;
- e) 32 - 47 wt%, based on dry solids content, of soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof;
- f) insoluble dietary fiber particles in the form of a flour having an insoluble dietary fiber
- 25 content of between 60 and 80 wt%, based on dry solids content, and having a particle size of between 30 and 250 μm as measured by nest sieving,

wherein the combined amount of said soluble dietary fiber and said insoluble dietary fiber particles is at least 40 wt%, based on dry solids content, wherein the amount of said insoluble dietary fiber particles is between 2 and 11 wt%, based on dry solids content, wherein the

30 soluble and insoluble dietary fibers originate from the same plant source, and wherein the weight percentages are based on the weight of the binding syrup.

In a preferred embodiment, the uncooked binding syrup for a cereal bar comprises:

- a) 20 - 30 wt%, based on dry solids content, of a mixture of one or more of glucose syrup, fructose syrup, sugar and glycerol;

- b) 20 - 28 wt% of water;
- c) 0.02 – 0.5 wt% of emulsifier;
- d) 2 - 5 wt% of fat;
- e) 34 - 44 wt%, based on dry solids content, of soluble dietary fiber chosen from fructo-
5 oligosaccharides, inulin or combinations thereof;
- f) insoluble dietary fiber particles in the form of a flour having an insoluble dietary fiber
content of between 60 and 80 wt%, based on dry solids content, and having a particle size
of between 30 and 250 μm as measured by nest sieving,

wherein the combined amount of said soluble dietary fiber and said insoluble dietary fiber
10 particles is at least 42 wt%, based on dry solids content, wherein the amount of said insoluble
dietary fiber particles is between 4 and 9 wt%, based on dry solids content, wherein the
soluble and insoluble dietary fibers originate from the same plant source, and wherein the
weight percentages are based on the weight of the binding syrup.

The uncooked binding syrup contains a substantial amount of water. This water content
15 assures that the viscosity of the combined ingredients is sufficiently low for the ingredients of
the binding syrup to be mixed.

As will be appreciated by those skilled in the art, the ingredients of the binding syrup,
such as for example glycerol, insoluble dietary fiber particles and the ingredient source
providing the fructo-oligosaccharides and/or inulin, are usually not available as completely
20 dry products. They typically comprise some water. If the uncooked binding syrup as defined
herein before is prepared using water-containing ingredients, the amount of water that is to be
added to the binding syrup is to be compensated for the water content of the other ingredients.

Although the uncooked binding syrup as defined in the foregoing has all the necessary
ingredients to be applied as a binding syrup for a cereal bar, rheology and organoleptic needs
25 may require further concentration. Hence, in a preferred embodiment, the binding syrup
precursor is cooked to a Brix value of between 84-86. Cooking typically only reduces the
water content with a concomitant increase in Brix value, but it may also slightly change the
composition due to thermal instability of the ingredients. Wherever reference is made to the
term 'binding syrup' in the specification, cooked binding syrup is meant, unless specified
30 otherwise.

The term 'Brix value' in the context of the present invention, which is considered to be
synonymous to the term 'degrees Brix' (symbol $^{\circ}\text{Bx}$), is a measure of the percent total soluble
solids in a given weight of binding syrup. It is measured with a saccharimeter that measures
specific gravity of a liquid or more easily with a refractometer or a Brix hydrometer. In

accordance with the present invention the Brix value of the binding syrup is preferably determined using a Brix hydrometer. Methods of determining the Brix value of a binding syrup employing a Brix hydrometer are generally known in the art.

5 If the binding syrup contains a flavor, this flavor is added after cooking the binding syrup precursor to a Brix value of between 84-86.

The amount of the insoluble dietary fiber in the form of a flour in the binding syrup affects viscosity, yield stress and shear-thinning behavior. In order to get a binding syrup with acceptable rheology during the production of cereal bars the upper limit of the amount of insoluble dietary fiber in the form of a flour having a particle size of between 30 and 250 μm as measured by nest sieving is preferably about 13 wt%, based on the weight of the binding syrup.

Non-limiting examples of emulsifiers, fats and any further ingredients of the binding syrup in cooked or uncooked form are as defined herein before.

15 The binding syrup as defined herein can advantageously be used in the cereal bar according to the invention. As explained herein before, it is also envisaged that the binding syrup does not comprise insoluble dietary fiber particles in the form of a flour but that larger insoluble dietary fiber particles are incorporated in the cereal mix instead.

In a third aspect of the invention, insoluble dietary fiber particles having a particle size of between 30 and 2500 μm and a bimodal particle size distribution are provided, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein said insoluble dietary fiber particles consist of:

- a) between 3 wt% and 35 wt%, based on the total weight of insoluble dietary fiber particles, of a first fraction of insoluble dietary fiber particles having a particle size of between 30 and 800 μm and a particle size distribution characterized by a D_{10} of 60 μm , a D_{50} of 370 μm and a D_{90} of 680 μm as measured by nest sieving; and
- 25 b) between 65 wt% and 97 wt%, based on the total weight of insoluble dietary fiber particles, of a second fraction of insoluble dietary fiber particles having a particle size of between 800 and 2500 μm and a particle size distribution characterized by a D_{10} of 1060 μm , a D_{50} of 1580 μm and a D_{90} of 2080 μm as measured by nest sieving.

30 Said insoluble dietary fiber particles preferably comprise less than 7 wt% of soluble dietary fibers like inulin, about 8 wt% of protein, about 5 wt% of ashes and less than 2 wt% of other components, wherein the weight percentages are based on dry matter.

In a preferred embodiment, said insoluble dietary fiber particles having a particle size of between 30 μm and 2500 μm and a bimodal particle size distribution consist of:

- a) between 8 wt% and 22 wt%, such as 10 wt%, 15 wt% or 20 wt%, based on the total weight of insoluble dietary fiber particles, of the first fraction as defined herein before; and
- b) between 78 wt% and 92 wt%, such as 80 wt%, 85 wt% or 90 wt%, based on the total weight of insoluble dietary fiber particles, of a second fraction as defined herein before.

The preferred plant sources from which the insoluble dietary fiber particles are obtained are as defined herein before.

In a preferred embodiment, the insoluble dietary fiber particles have the form of flakes or crisps.

In a fourth aspect of the invention, a method for the manufacture of insoluble dietary fiber particles having a particle size of between 30 and 2500 μm and a bimodal particle size distribution as defined herein before is provided, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, said method comprising the following consecutive steps:

- a) washing inulin- and/or fructo-oligosaccharide-containing plant material;
- b) slicing or mincing said washed plant material to obtain extractable pieces;
- c) extracting water-soluble components from the pieces obtained in step b);
- d) drying the extracted pieces obtained in step c) to a water content of less than 10 wt% to obtain insoluble dietary fiber pieces;
- e) milling the insoluble dietary fiber pieces obtained in step d) to obtain insoluble dietary fiber particles;
- f) nest sieving the insoluble dietary fiber particles obtained in step e) to obtain a first fraction of insoluble dietary fiber particles having particle sizes between 30 μm and 800 μm and a second fraction of insoluble dietary fiber particles having particle sizes between 800 μm and 2500 μm ;
- g) combining between 3 wt% and 35 wt% of the first fraction and between 65 wt% and 97 wt% of the second fraction,

wherein the weight percentages are based on the weight of the bimodal particle size distribution.

In a preferred embodiment, a method as defined herein before is provided wherein step g) comprises combining between 8 wt% and 22 wt%, such as 10 wt%, 15 wt% or 20 wt%, of the first fraction with between 78 wt% and 92 wt%, such as 80 wt%, 85 wt% or 90 wt%, of the second fraction.

In another preferred embodiment, the first fraction of insoluble dietary fiber particles has a particle size distribution characterized by a D_{10} of 60 μm , a D_{50} of 370 μm and a D_{90} of 680 μm as measured by nest sieving and the second fraction of insoluble dietary fiber particles has a particle size distribution characterized by a D_{10} of 1060 μm , a D_{50} of 1580 μm and a D_{90} of 2080 μm as measured by nest sieving.

As described herein before, due to fermentation of fructo-oligosaccharides and/or inulin in the large intestine gases are produced, which can lead to feelings of discomfort by consumers. Replacing part of the fructo-oligosaccharide and/or inulin in the cereal bar with insoluble dietary fiber particles does not decrease the amount of healthy dietary fiber while at the same time the amount of soluble fibers responsible for flatulence and bloating is reduced. Nevertheless, the total amount of fructo-oligosaccharide and/or inulin per serving, i.e. per cereal bar, preferably is below certain values. This can be accomplished by defining the weight of the cereal bar for a given weight fraction of fructo-oligosaccharides and/or inulin or by defining the total amount of fructo-oligosaccharides and/or inulin in the cereal bar. In a preferred embodiment, the cereal bar according to the invention has a weight of between 25 and 60 gram, preferably between 30 and 50 gram. In an equally preferred embodiment, the cereal bar according to the invention comprises an amount of soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof of between 4 and 9 gram, more preferably between 4.5 and 8 gram, even more preferably between 5 and 7 gram, still more preferably between 5.2 and 6.8 gram.

In a fifth aspect of the invention, a method for the manufacture of a cereal bar is provided, said method comprising the steps of:

- a) washing inulin- and/or fructo-oligosaccharide-containing plant material;
- b) slicing or mincing said washed plant material to obtain extractable pieces;
- c) extracting water soluble components from the pieces obtained in step b) to obtain soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof;
- d) drying the extracted pieces obtained in step c) to a water content of less than 10 wt% to obtain insoluble dietary fiber pieces;
- e) milling the insoluble dietary fiber pieces obtained in step d) to obtain insoluble dietary fiber particles;
- f) preparing a binding syrup comprising between 12 and 20 wt%, based on dry solids content, of soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof as obtained in step c);
- g) preparing a cereal mix;

h) adding insoluble dietary fiber particles as obtained in step e) to the cereal mix or to the binding syrup to obtain between 17 wt% and 35 wt %, based on dry solids content, of insoluble dietary fiber from said plant material and soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof from said plant material;

- 5 i) combining the binding syrup and the cereal mix to obtain the cereal bar;
wherein the weight percentages are based on the weight of the cereal bar.

In a preferred embodiment, the method for the manufacture of a cereal bar includes the manufacture of the cereal bars as defined herein before.

10 In another preferred embodiment, the method for the manufacture of a cereal bar encompasses the binding syrup, cereal mix, insoluble dietary fiber particles and the detailed process steps to produce these ingredients as defined herein before.

The cereal mix is typically added to the binding syrup at a temperature of about 75°C after which the cereal bar can be shaped. The shaped material is allowed to cool for about 2 hours and subsequently cut into cereal bars of the desired size. The cereal bars are then ready
15 to be packaged.

In a sixth aspect, the invention relates to the use of:

- a) insoluble dietary fiber particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, and having a particle size of between 30 and 2500 μm as measured by nest sieving; and
20 b) soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof, said insoluble dietary fiber and soluble dietary fiber originating from the same plant source, in cereal bars.

In a preferred embodiment, said use relates to all insoluble dietary fiber particles as defined herein before.

25 Thus, the invention has been described by reference to certain embodiments discussed above. It will be recognized that these embodiments are susceptible to various modifications and alternative forms well known to those of skill in the art.

Furthermore, for a proper understanding of this document and its claims, it is to be understood that the verb 'to comprise' and its conjugations are used in its non-limiting sense
30 to mean that items following the word are included, but items not specifically mentioned are not excluded. In addition, reference to an element by the indefinite article 'a' or 'an' does not exclude the possibility that more than one of the element is present, unless the context clearly requires that there be one and only one of the elements. The indefinite article 'a' or 'an' thus usually means 'at least one'.

All patent and literature references cited in the present specification are hereby incorporated by reference in their entirety.

The following examples are offered for illustrative purposes only, and are not intended to limit the scope of the present invention in any way.

5

EXAMPLES

Example 1: preparation of insoluble chicory root fiber (iCRF) and fructo-oligosaccharide syrup from chicory root tubers

10

Whole chicory roots tubers were washed and sliced to obtain chicory root slices having an average size of a few centimeters. The chicory root slices were subsequently extracted using water of ca. 70°C. The extraction process removes virtually all the water-soluble components from the chicory root slices, including the bitter compounds. Extracted chicory root slices were subjected to subsequent drying in a belt dryer and milling in a cutting mill. In one sieving step with different sieve sizes flake-like insoluble chicory root fiber (iCRF) particles were obtained having a particle size of between 30 and 800 µm and of between 800 and 2500 µm and a fraction having a particle size of above 2500 µm as determined by nest sieving according to standards ICUMSA GS2/9-37 (2007), ANSI/ASAE S319.3 (2003) or ASTM C136 (2014). The particle fraction having a particle size of above 2500 µm was subjected to further milling to obtain a flour like product with a particle size of between 30 and 250 µm, having an average particle size of about 80 µm.

15

Table 1 discloses several iCRF fractions obtained, characterized by their lower and upper particle size, and their D₁₀, D₅₀ and D₉₀ values, as determined by nest sieving. Since nest sieving using wire-mesh sieves provides a two-dimensional estimate of particle size - the smallest lateral dimension of each particles determines its ability to pass through a given sieve opening - nest sieving consistently underestimates the true size of the iCRF particles which are flakes and not perfect spheres.

20

25

30

Table 1: particle size and particle size distributions of different fractions of iCRF particles

Fraction	Lower diameter, [μm]	Upper diameter, [μm]	D ₁₀ [μm]	D ₅₀ [μm]	D ₉₀ [μm]
Flour	30	250	35	80	230
Total	30	2500	440	1250	2050
Small	30	800	60	370	680
Medium	800	2500	1060	1580	2080
Bimodal 1, 10 wt% small + 90 wt% medium	30	2500	820	1480	2160
Bimodal 2, 20 wt% small + 80 wt% medium	30	2500	720	1390	2080

The insoluble chicory root dietary fiber particles comprise about 75 wt% of insoluble dietary fibers such as cellulose, hemicelluloses, pectin and lignin, less than 7 wt% of soluble dietary fibers like inulin, about 8 wt% of protein, about 5 wt% of ash and less than 2 wt% of other components, wherein the weight percentages are based on dry matter. The insoluble dietary fiber particles have a water content of about 5 wt%.

Inulin and fructo-oligosaccharides were prepared from the water-soluble components, obtained by extracting the chicory root slices using techniques extensively described in the art.

Example 2: Preparation of binding syrups

Binding syrups were prepared for rheological measurements by mixing glucose syrup (Pfeifer & Langen GmbH & Co. KG, Germany), fructo-oligosaccharide syrup (Frutalose® L92, Sensus B.V., The Netherlands, extracted from chicory root and having 92 wt% fructo-oligosaccharide content and 75 wt% dry matter), insoluble iCRF particles (flour fraction as defined in Example 1), vegetable fat (Chocofill™ BR60) partly based on lauric oil (Aarhus Karlshamn Netherlands B.V., The Netherlands), fine sugar (Suiker Unie, The Netherlands), glycerol, water and sucrose fatty acid ester emulsifier (Sisterna B.V., The Netherlands).

The resulting mixture was cooked in a pan aiming to evaporate water and to reach 85 ± 1 °Brix. The end point of the cooking procedure was determined by the weight loss which was calculated based on the total dry weight of all the ingredients. The cooked mixture was immediately cooled down to room temperature in a cold water sink as soon as the end point was reached. Six different binding syrups were prepared for rheological measurements of which the composition is shown in Table 2.

Table 2: composition of binding syrup samples with increasing levels of iCRF particles (flour fraction) before cooking. During cooking, the water in the binding syrup was evaporated until an 85 ± 1 °Brix was reached.

Sample	Glucose syrup ^a (g)	Fine sugar (g)	Oligo fructose ^b (g)	iCRF ^c (g)	Sucrose ester (g)	Glycerol (g)	Water (g)	Fat (g)	Flavor (g)
S1-0% iCRF (control)	71.2	12	165.0	0.0	0.2	12	24.7	14.2	0.7
S2-1% iCRF	71.2	12	177.0	3.0	0.2	12	9.7	14.2	0.7
S3-3% iCRF	71.2	12	171.6	8.4	0.2	12	9.7	14.2	0.7
S4-5% iCRF	71.2	12	166.2	13.8	0.2	12	9.7	14.2	0.7
S5-7% iCRF	71.2	12	160.5	19.5	0.2	12	9.7	14.2	0.7
S6-9% iCRF	71.2	12	154.8	25.2	0.2	12	9.7	14.2	0.7

^a dry matter content 80%.

^b dry matter content 75%.

^c dry matter content 95%.

Rheological measurements

Dynamic shear rheological measurements using a decreasing shear rate ($0.1 \sim 100 \text{ s}^{-1}$) were performed on the six binding syrups described in Table 2 with a rheometer (Physica MCR 301, Anton Paar GmbH, Austria) using a parallel-plate geometry (50 mm diameter, 1 mm gap). A 30 s preshear stage at the shear rate of 5 s^{-1} and a 60 s resting stage was added before the rotational test to ensure the identical shear histories of samples and to allow temperature equilibration. The flow curves (a plot of shear stress versus shear rate at different temperatures) were subsequently measured. The temperature was controlled by a Peltier system equipped with a fluid circulator. Evaporation was minimized by applying a thin layer of paraffin oil around the probe as well as covering samples with the solvent trap. The flow index (n), consistency (K) and yield stress (τ_0) of samples at different temperatures were obtained by fitting the Herschel-Bulkley model to each flow curve:

$$\tau = \tau_0 + K\dot{\gamma}^n$$

where $\dot{\gamma}$ is the shear rate (s^{-1}) and τ is the calculated shear stress (Pa). The sum of squared residuals (SSR) between the calculated shear stress and the measured shear stress was minimized to obtain good fits. The resulting consistency (K) was fitted to the reduced Krieger-Dougherty equation instead of viscosity to eliminate the possible effect of non-Newtonian behavior and to obtain the maximum packing fraction (Φ_m) which is the iCRF particle content (flour fraction) where the viscosity becomes infinite:

$$K = K_0 \left(1 - \frac{\Phi}{\Phi_m}\right)^{-2}$$

where K_0 is the consistency of the sample S1 (0 wt% iCRF) and Φ is the iCRF (flour fraction) content (wt%) of the sample.

By fitting the flow curves of the binding syrups containing increasing weight percentages of iCRF particles (flour fraction) at different temperatures to the Herschel-Bulkley model, the flow index (n), consistency (K) and yield stress (τ_0) of different binding syrups could be determined. The results are summarized in Table 3.

Table 3: flow index, consistency and yield stress of binding syrups with increasing levels of iCRF particles (flour fraction) at four different temperatures as determined with the Herschel-Bulkley equation.

iCRF content (wt%)	Flow index n			
	30 °C	50 °C	70 °C	85 °C
0%	1.01	0.98	0.99	1.00
1%	1.19	0.96	0.98	1.00
3%	1.10	0.95	0.98	0.98
5%	0.98	0.94	0.96	0.96
7%	0.90	0.90	0.92	0.92
9%	0.89	0.86	0.86	0.85
iCRF content (wt%)	Consistency K			
	30 °C	50 °C	70 °C	85 °C
0%	39.63	7.85	1.75	0.64
1%	22.91	11.70	2.40	0.89
3%	53.38	19.87	3.42	1.30
5%	137.85	26.99	5.15	2.03
7%	310.33	45.00	9.87	3.65
9%	507.21	80.30	19.24	8.53
iCRF content (wt%)	Yield stress τ_0			
	30 °C	50 °C	70 °C	85 °C
0%	16.85	-0.04	-0.04	-0.01
1%	83.18	-0.24	-0.14	0.00
3%	79.52	-0.82	-0.07	0.01
5%	31.21	-0.36	0.06	0.02
7%	28.36	0.46	0.17	0.11
9%	62.71	6.38	0.82	0.17

The flow index n at increasing temperature of binding syrup without iCRF particles was 1.00 ± 0.02 (mean $\pm$ standard deviation) suggesting a Newtonian behavior. By adding the iCRF particles (flour fraction) to the binding syrup, the flow indices of samples decreased significantly ($p < 0.001$), which indicated an increased degree of non-Newtonian behavior. Since the flow index was smaller than 1.00, a shear-thinning behavior is suggested for the

binding syrup containing iCRF particles (flour fraction). The break point of the iCRF particle content (flour fraction), defined as the point where significantly altered flow behavior of binding syrups was observed, appeared to be between 5 and 7 wt%. The shear indices of the samples below 5 wt% of iCRF particles (flour fraction) were not significantly different ($p = 0.74$), while above 5 wt% iCRF content the shear indices decreased significantly ($p < 0.001$). Increasing temperature also influenced the flow indices significantly though less than the iCRF content ($p = 0.03$). The consistency of the samples significantly decreased ($p = 0.01$) with increasing temperature. Due to the large variation between the consistency at different temperatures, no significant difference could be observed at increasing content of iCRF particles (flour fraction) ($p = 0.23$). However, a positive correlation between the content of iCRF particles (flour fraction) and the consistencies at the same temperature was found ($r = 0.89\sim 0.94$, $p = 0.005\sim 0.018$). Also shown in Table 3 is the fact that the yield stress of the samples significantly decreased ($p < 0.001$) with increasing temperature while the influence of the content of iCRF particles (flour fraction) on the yield stress was not significant ($p = 0.43$). This yield stress indicates a stress below which there is no flow of the binding syrups, which means that a binding syrup with a lower yield stress starts to flow more easily. The calculated consistencies of the samples at different temperatures were fitted to the reduced Kreiger-Dougherty equation. The resulting maximum packing fraction (Φ_m) of binding syrups containing iCRF particles (flour fraction) at different temperatures were within a narrow range of 0.127 ± 0.003 (mean $\pm$ standard deviation) indicating there was no correlation between the Φ_m -value and temperature ($r = -0.039$). Based on this value for the maximum packing fraction, it can be concluded that the theoretical maximum amount of iCRF particles (flour fraction) where the binding syrup still exhibits flow behavior is approximately 13 wt%.

Example 3: preparation of cereal bars

Cereal bars were prepared using the recipes as described in Table 4 to 15. Tables 4 to 15 respectively describe the recipes of cereal bars Reference and Bar 1 to Bar 11. The abbreviations DS, BS, CM and CB as used in Tables 4 to 15 respectively stand for dry solids content, binding syrup, cereal mix and cereal bar. Frutafit HD is native inulin, Frutalose L85 and Frutalose L92 are fructo-oligosaccharides. Frutafit HD, Frutalose L85 and Frutalose L92 are obtained from chicory root. All recipes are based on a 40 grams cereal bar with 24 grams of cereal mix (60 wt%) and 16 grams of binding syrup (40 wt%).

The Reference bar is a comparative cereal bar not comprising iCRF particles. Tables 5 and 6 (Bar 1 and 2) describe cereal bar recipes wherein iCRF particles (flour fraction) are incorporated in the binding syrup. Tables 7 to 9 (Bar 3 to 5) describe cereal bar recipes wherein iCRF particles (flour fraction) are incorporated in the cereal mix. Tables 10 and 11 (Bar 6 and 7) describe cereal bar recipes wherein iCRF particles (total fraction) are incorporated in the cereal mix. Tables 12 and 13 (Bar 8 and 9) describe cereal bar recipes wherein iCRF particles (medium fraction) are incorporated in the cereal mix. Table 14 (Bar 10) describes a cereal bar recipe wherein iCRF particles (bimodal fraction 1) are incorporated in the cereal mix. Finally, Table 15 (Bar 11) describes a cereal bar recipe wherein iCRF particles (bimodal fraction 2) are incorporated in the cereal mix.

The procedure of preparing binding syrup was similar to that described in Example 2, the only difference being that the binding syrups were cooled to 75 °C instead of to room temperature and that not every binding syrup contains iCRF particles. Additionally, caramel flavor (Dawn Foods b.v., The Netherlands) was added to the binding syrup after cooling to 75°C. Subsequently, the binding syrup was incorporated and mixed with the cereal mix which contained rice crisps (Tefco Euro Ingredients b.v., The Netherlands) and oat flakes (Meneba b.v., The Netherlands). After shaping, the material was cooled to room temperature for 2 hours before cutting, which was followed by the packaging step. Each bar was packaged in an aseptic bag (110 × 150 mm, SUPER EXPORT[®], Hevel Vacuüm B.V., The Netherlands) and stored at room temperature prior to physical measurements and sensory analysis.

Water activity and moisture content of Reference bar, Bar 1 and Bar 2

The water activity of cereal bars Reference, Bar 1 and Bar 2 was analyzed using a water activity meter (Aw Sprint TH 500, Novasina, Switzerland) at 25°C. These cereal bars were tested in quadruplicate after 0, 10, 20, and 30 days of storage at ambient conditions. The moisture content of cereal bars was measured by drying in an air-oven followed by the two-stage procedure as described in AACC 44-15.02. Triplicate measurements were made for each type of cereal bar at 0 and 30 days of storage.

The results of water activity and moisture content measurements are shown in Figure 1A and 1B, respectively. After 30 days of storage, the water activity increased within a narrow range (0.535 ± 0.013 ; mean $\pm$ standard deviation) for all samples with a significant sample effect ($p < 0.001$). Water activity is an indicator of storage stability. The fact that the water activity of all bars was below 0.6 is favorable since this low water activity inhibits bacterial growth. Moisture content (see Figure 1B) is an important property that relates to different

sensory attributes of foods such as softness and firmness. The moisture content of the three bars was significantly different ($p = 0.01$ for 0 days, $p = 0.02$ for 30 days). The difference between the moisture content of Bar 0 and Bar 1 was not significant ($p = 0.53$). However, significant difference was found between the moisture contents of the Reference bar and Bar 2 ($p = 0.02$) as well as between Bar 1 and Bar 2 ($p = 0.01$).

Color measurement of Reference bar, Bar 1 and Bar 2

Color measurements of cereal bars Reference, Bar 1 and Bar 2 were performed with a bench-top colorimeter (CR-5, Konica Minolta, Inc., Japan) using a $\phi 30$ mm target mask with a 10° standard observer, a D65 illuminant and ΔE_{00} color difference. The results were recorded as L^* (lightness, 0 = black, 100 = white), a^* ($+a^*$ = redness, $-a^*$ = greenness) and b^* ($+b^*$ = yellowness, $-b^*$ = blueness) values, which were in accordance with International Commission on Illumination (CIE) color space system (CIELAB). Data were reported as the mean of four measurements.

Color has a considerable influence on consumer acceptance of food products. Due to the grayish color of iCRF particles (flour fraction), the color change of Bar 1 and Bar 2 mainly came from the color change of the binding syrups. Addition of iCRF particles (flour fraction) in the binding syrups resulted in significant differences in L^* , a^* and b^* values ($p < 0.001$) across three samples but all within a narrow value range suggesting no relevant visual effect.

Texture analysis of Reference bar, Bar 1 and Bar 2

Two instrumental tests, a cutting test and a modified texture profile analysis (TPA), were performed on the cereal bars Reference, Bar 1 and Bar 2 after 0, 10, 20, and 30 days of storage with the texture analyzer (TA.XT plus, Stable Micro Systems Ltd., UK). A 50 kg load was equipped on the texture analyzer in all tests. A cutting test was applied to mimic a “bite” in the middle of an intact bar which was a 30-mm-wide strip. The bar was placed on the base plate and cut 70% of its original height with a perspex blade (6 cm long, 3 mm thick) at 10 mm/s. Then the half bar samples were cut into 30×30 mm squares for the modified TPA test. The square samples were put in the center of the base plate and then compressed twice to 40% of their original height by a 25-mm-diameter perspex cylinder probe. The test and return speed were set to 2 mm/s. A trigger load of 5 g was used in all tests. The force-time curves were obtained from these two tests and the following textural results were determined. Cutting force (g) was defined as the maximum load applied to the samples during cutting in the cutting test. Hardness (g) was defined as the maximum load applied to the samples during

the first compression in the modified TPA test. Cohesiveness was defined as the ratio of the area under the force-time curve for the second compression to the area under the curve for the first compression in the modified TPA test.

The effects of adding iCRF particles (flour fraction) on texture properties of cereal bars is summarized in Figures 1C, 1D and 1E. There was a significant difference between the cereal bar without iCRF particles (Reference) and the cereal bars with iCRF particles in the binding syrup (flour fraction) (Bar 1 and Bar 2) in the force required for cutting the 70% of their original height after 30 days of storage ($p < 0.001$). A similar significant effect of iCRF particles (flour fraction) on the cohesiveness and hardness of the cereal bars was found. Both cohesiveness and hardness of the Reference bar was significantly lower than that of the two iCRF bars ($p = 0.006$ for cohesiveness and $p < 0.001$ for firmness).

Sensory evaluation of Reference bar, Bar 1 and Bar 2

Cereal bar samples Reference (without iCRF particles), Bar 1 and Bar 2 (with iCRF particles in the binding agent, flour fraction) were evaluated by 13 selected and trained sensory panelists according to the quantitative descriptive analysis (QDA) method. The panelists evaluated the bars using FIZZ software (Biosystèmes, France) in separate booths where drinking water was available. A nine-point line scale was used for each attribute for each cereal bar. All the samples were coded with three-digit random numbers. The three cereal bar samples were presented to the panel with an additional reference cereal bar (identical to the Reference bar) in one evaluation session. The Reference bar is used to set the relative standard point (middle point = 5) for every attribute. Two evaluation sessions were organized to obtain more reliable results. The repeatability, discrimination and the homogeneity of judges' score were checked by FIZZ software. The attributes which were generated from the preliminary section of QDA are shown in Table 16.

Table 16: tested attributes of the QDA sensory test of cereal bars with iCRF particles (flour fraction) in the binding syrup.

Attributes	Definition	Scale end points (1-9)
<i>Appearance</i>		
Color	Surface color of cereal bar	Light – Dark
Gloss	Shininess of the cereal bar surface	Dull – Shiny
<i>Odor</i>		
Caramel odor	Caramel odor perceived by aspiration before the cereal bar is chewed	No caramel odor – Very intense caramel odor
<i>Taste</i>		
Sweetness	Perception of sweetness	Not sweet - Very sweet
Caramel taste	Caramel flavor sensed during chewing	No caramel taste - Very much caramel taste
Bitterness	Perception of sweetness	Not bitter - Very bitter
Grainy	Perception of small particles when chewing and swallowing	No small particles - A lot of small particles
<i>Texture</i>		
Stickiness (manual)	The degree of difficulty when removing a sample from the plate	Not sticky - Very sticky
Hardness (first bite)	Force required to break the cereal bar with front teeth	Soft - Hard
Swallow	The degree of the ease with which sample is swallowed	Easy to swallow – Hard to swallow

All experiments were performed in a completely randomized design. The data was expressed as the mean with standard error ($\bar{x} \pm \text{SEM}$), and the statistical significance was determined at $P < 0.05$ by using ANOVA. Least significant difference (LSD) was applied as post-hoc analysis to determine group differences. Linear regression was used to reveal the potential correlations between properties and parameters under the significant level of 95%.

The results of the QDA test of cereal bars are shown in Figure 2. The scores of most attributes were significantly affected by the level of iCRF particles (flour fraction) in binding syrups ($p < 0.05$). The only exception was the color of the cereal bars, where no significant differences were observed thus confirming the small differences in the instrumental color measurement. In Figure 2, it is shown that the major differences between the Reference bar, Bar 1 and Bar 2 were mainly taste attributes (caramel odor, sweetness and caramel taste). Although significant, the actual differences between the maximum and the minimum scores for most texture attributes was not that big (ranging from 0.49 for stickiness to 1.15 for ease of swallow). These differences indicate that the effects of adding iCRF particles (flour fraction) to the binding syrup on the textural properties of cereal bars is not as strong as was expected from the rheological measurements of the binding syrups. The largest difference between the samples was observed in the attribute “gloss”, which was 2.47. However, there was no evident correlation between consumer preference and the gloss of the cereal bars.

Negative correlations were found between the iCRF content and the intensity of caramel odor ($r = -1.00$, $p < 0.05$) and iCRF content and the sweetness ($r = -1.00$, $p < 0.05$), while bitterness was positively correlated with the iCRF content ($r = 1.00$, $p < 0.05$). Apparently, the somewhat bland taste of iCRF itself influences the perception of these taste attributes although the effect of powder addition alone on these taste attributes cannot be excluded. Clearly, this last property of iCRF particles (flour fraction, 'being a powder') resulted in a positive correlation between the grainy perception and the level of iCRF addition ($r = 1.00$, $p < 0.01$). Another consequence of adding iCRF flour was an increment in the difficulty of swallowing ($r = 1.00$, $p < 0.001$).

Sensory evaluation of Bars 3 to 11

Cereal bars Bar 3 to Bar 11 (with iCRF particles in the cereal mix) were evaluated by 5 selected and trained sensory panelists according to good sensory practices. The panel tested the following attributes: sweetness, hardness, stickiness, crunchiness, aroma, bitterness, color, cohesiveness and powdery taste. Again, the Reference bar was used for comparison. Figures 3 to 6 show radar charts of the sensory evaluation results of cereal bars Bar 3, 4, 6 and 8-11. The sensory evaluation results of Bar 5 were comparable to those of Bar 4 and the sensory evaluation results of Bar 7 were comparable to those of Bar 6.

Figure 3 shows a comparison of cereal bars Bar 3, Bar 8 and Bar 10 comprising 8.55 wt%, based on dry solids content, of iCRF particles in the cereal mix at different iCRF particle sizes. All evaluated bars did have an acceptable taste and texture. However, the results show that addition of the flour fraction (Bar 3) has an effect on powdery taste, color, bitterness, sweetness and aroma when compared to the Reference bar. All these attributes improve when using iCRF particles with a particle size between 800 and 2500 μm (Bar 8, medium fraction). However, in this case the cohesiveness is lower than that of the Reference bar. Upon using iCRF particles with a bimodal particle size distribution between 30 and 2500 μm (Bar 10, bimodal fraction 1) all attributes are non-significantly different from the Reference bar.

Figure 4 shows a comparison of cereal bars Bar 4, Bar 9 and Bar 11 comprising 14.25 wt%, based on dry solids content, of iCRF particles in the cereal mix at different particle sizes. All evaluated bars did have an acceptable taste and texture. However, the results show that flour addition (Bar 4) has an effect on powdery taste, color, bitterness, sweetness and aroma when compared to the Reference bar. All these attributes improve when using iCRF particles with a particle size of between 800 and 2500 μm (Bar 9). However, in this case the

cohesiveness is negatively affected. Upon using iCRF particles with a bimodal particle size distribution between 30 and 2500 μm (Bar 11, bimodal fraction 2) the cohesiveness is improved and all other attributes are close to those of the Reference bar.

Figure 5 shows a comparison of iCRF addition (flour fraction) at different levels to binding syrup or cereal mix. All evaluated bars did have an acceptable taste and texture. However, the results show that increasing levels of iCRF flour addition to the binding syrup (Bar 1 and Bar 2) has an effect on all attributes except for crunchiness. By adding the iCRF flour fraction to the cereal mix instead of to the binding syrup cohesiveness, aroma and stickiness are improved but all other attributes are still different from the Reference bar.

Figure 6 shows a comparison of cereal bars Bar 6, Bar 9 and Bar 11 comprising 14.25 wt%, based on dry solids content, of iCRF particles in the cereal mix at different particle sizes. All evaluated bars did have an acceptable taste and texture. The results show that addition of iCRF particles with a monomodal distribution between 30 and 2500 μm (Bar 6) results in a bar that is well comparable to the Reference bar except for color and hardness. These attributes can be improved by using iCRF particles with a monomodal distribution between 800 and 2500 μm (Bar 9), but this has an effect on the cohesiveness of the bar. This cohesiveness can be improved by adding iCRF particles with a bimodal distribution between 30 and 2500 μm (Bar 11).

Table 4: recipe Reference bar, no iCRF

Ingredients	DS content [wt%]	Fiber content of DS [wt%]	BS <i>before</i> cooking, based on wet solids [g]	BS <i>before</i> cooking, based on DS [g] / [wt%]	BS <i>after</i> cooking, based on DS [g] / [wt%]	CM, based on wet solids [g]	Total soluble fiber in CB [g] / [wt%]	Total insoluble fiber in CB [g] / [wt%]	Total fiber in CB [g] / [wt%]	Total chicory fiber in CB [g] / [wt%]
Glucose syrup (60 DE)	80	0	3.36	2.69 / 15.39	2.69 / 16.80					
Granulated sugar	100	0	1.48	1.48 / 8.50	1.48 / 9.28					
Fructose L92	75	92	9.60	7.20 / 41.25	7.20 / 45.01		6.63 / 16.57			6.63 / 16.57
Frutafit HD	97	90	0.87	0.85 / 4.85	0.85 / 5.29		0.76 / 1.91			0.76 / 1.91
Water	0	0	0.57	3.86 / 22.10	2.40 / 15.00					
Emulsifier (SP 70)	100	0	0.01	0.01 / 0.05	0.01 / 0.05					
Glycerol	75	0	0.70	0.52 / 3.00	0.52 / 3.27					
Fat (Chocofill BR 60)	100	0	0.83	0.83 / 4.74	0.83 / 5.17					
Flavour (caramel)	50	0	0.04	0.02 / 0.12	0.02 / 0.13					
Oat flakes	100	10				17.60		1.76 / 4.40	1.76 / 4.40	
Rice crisps	100	0.5				6.4		0.03 / 0.08	0.03 / 0.08	
Total			17.46	17.46 / 100	16.00 / 100	24.00	7.39 / 18.47	1.79 / 4.48	9.26 / 23.16	7.39 / 18.47

Table 5: recipe Bar 1, iCRF (flour fraction) in binder syrup

Ingredients	DS content [wt%]	Fiber content of DS [wt%]	BS <i>before</i> cooking, based on wet solids [g]	BS <i>before</i> cooking, based on DS [g] / [wt%]	BS <i>after</i> cooking, based on DS [g] / [wt%]	CM, based on wet solids [g]	Total soluble fiber in CB [g] / [wt%]	Total insoluble fiber in CB [g] / [wt%]	Total fiber in CB [g] / [wt%]	Total chicory fiber in CB [g] / [wt%]
Glucose syrup (60 DE)	80	0	4.20	3.36 / 18.99	3.36 / 20.99					
Granulated sugar	100	0	0.71	0.71 / 4.00	0.71 / 4.42					
Fructose L92	75	92	9.73	7.30 / 41.25	7.30 / 45.60		6.71 / 16.78		6.71 / 16.78	6.61 / 16.78
iCRF	95	75	0.88	0.84 / 4.75	0.84 / 5.25			0.63 / 1.58	0.63 / 1.58	0.63 / 1.58
Water	0	0	0.57	4.09 / 23.10	2.40 / 15.00					
Emulsifier (SP 70)	100	0	0.01	0.01 / 0.05	0.01 / 0.06					
Glycerol	75	0	0.71	0.53 / 3.00	0.53 / 3.32					
Fat (Chocofill BR 60)	100	0	0.84	0.84 / 4.74	0.84 / 5.24					
Flavour (caramel)	50	0	0.04	0.02 / 0.12	0.02 / 0.13					
Oat flakes	100	10				17.60		1.76 / 4.40	1.76 / 4.40	
Rice crisps	100	0.5				6.40		0.03 / 0.08	0.03 / 0.08	
Total			17.69	17.69 / 100	16.00 / 100	24.00	6.71 / 16.78	2.42 / 6.05	9.14 / 22.83	7.34 / 18.35

Table 6: recipe Bar 2, iCRF (flour fraction) in binder syrup

Ingredients	DS content [wt%]	Fiber content of DS [wt%]	BS before cooking, based on wet solids [g]	BS before cooking, based on DS [g] / [wt%]	BS after cooking, based on DS [g] / [wt%]	CM, based on wet solids [g]	Total soluble fiber in CB [g] / [wt%]	Total insoluble fiber in CB [g] / [wt%]	Total fiber in CB [g] / [wt%]	Total chicory fiber in CB [g] / [wt%]
Glucose syrup (60 DE)	80	0	4.35	3.48 / 18.99	3.48 / 21.76					
Granulated sugar	100	0	0.37	0.37 / 2.00	0.37 / 2.29					
Fructose L92	75	92	8.98	6.74 / 36.75	6.74 / 42.10		6.20 / 15.49		6.20 / 15.49	6.20 / 15.49
iCRF	95	75	1.65	1.57 / 8.55	1.57 / 9.79			1.18 / 2.94	1.18 / 2.94	1.18 / 2.94
Water	0	0	1.33	4.73 / 25.80	2.40 / 15.00					
Emulsifier (SP 70)	100	0	0.01	0.01 / 0.05	0.01 / 0.06					
Glycerol	75	0	0.73	0.55 / 3.00	0.55 / 3.44					
Fat (Chocofill BR 60)	100	0	0.87	0.87 / 4.74	0.87 / 5.43					
Flavour (caramel)	50	0	0.04	0.02 / 0.12	0.02 / 0.13					
Oat flakes	100	10				17.60		1.76 / 4.40	1.76 / 4.40	
Rice crisps	100	0.5				6.40		0.03 / 0.08	0.03 / 0.08	
Total			18.33	18.33 / 100	16.00 / 100	24.00	6.20 / 15.49	2.97 / 7.42	9.16 / 22.91	7.37 / 18.43

Table 7: recipe Bar 3, iCRF (flour fraction) in cereal mix

Ingredients	DS content [wt%]	Fiber content of DS [wt%]	BS before cooking, based on wet solids [g]	BS before cooking, based on DS [g] / [wt%]	BS after cooking, based on DS [g] / [wt%]	CM, based on wet solids [g]	Total soluble fiber in CB [g] / [wt%]	Total insoluble fiber in CB [g] / [wt%]	Total fiber in CB [g] / [wt%]	Total chicory fiber in CB [g] / [wt%]
Glucose syrup (60 DE)	80	0	6.07	4.86 / 27.39	4.86 / 30.37					
Granulated sugar	100	0	0.89	0.89 / 5.00	0.89 / 5.54					
Fructose L92	75	92	8.60	6.45 / 36.38	6.45 / 40.33		5.94 / 14.84		5.94 / 14.84	5.94 / 14.84
iCRF	95	75				2.16		1.54 / 3.85	1.54 / 3.85	1.54 / 3.85
Water	0	0	0.57	4.14 / 23.33	2.40 / 15.00					
Emulsifier (SP 70)	100	0	0.01	0.01 / 0.05	0.01 / 0.06					
Glycerol	75	0	0.71	0.53 / 3.00	0.53 / 3.33					
Fat (Chocofill BR 60)	100	0	0.84	0.84 / 4.74	0.84 / 5.25					
Flavour (caramel)	50	0	0.04	0.02 / 0.12	0.02 / 0.13					
Oat flakes	100	10				15.44		1.54 / 3.86	1.54 / 3.86	
Rice crisps	100	0.5				6.40		0.03 / 0.08	0.03 / 0.08	
Total			17.74	17.74 / 100	16.00 / 100	24.00	5.94 / 14.84	3.12 / 7.79	9.05 / 22.63	7.48 / 18.69

Table 8: recipe Bar 4, iCRF (flour fraction) in cereal mix

Ingredients	DS content [wt%]	Fiber content of DS [wt%]	BS before cooking, based on wet solids [g]	BS before cooking, based on DS [g] / [wt%]	BS after cooking, based on DS [g] / [wt%]	CM, based on wet solids [g]	Total soluble fiber in CB [g] / [wt%]	Total insoluble fiber in CB [g] / [wt%]	Total fiber in CB [g] / [wt%]	Total chicory fiber in CB [g] / [wt%]
Glucose syrup (60 DE)	80	0	8.45	6.76 / 37.79	6.76 / 42.33					
Fructose syrup F95	75	92	7.24	5.43 / 30.38	5.43 / 33.94		5.00 / 12.49		5.00 / 12.49	5.00 / 12.49
iCRF	95	75				3.60		2.57 / 6.41	2.57 / 6.41	2.57 / 6.41
Water	0	0	0.58	4.28 / 23.93	2.40 / 15.00					
Emulsifier (SP 70)	100	0	0.01	0.01 / 0.05	0.01 / 0.06					
Glycerol	75	0	0.72	0.54 / 3.00	0.54 / 3.35					
Fat (Chocofill BR 60)	100	0	0.85	0.85 / 4.74	0.85 / 5.30					
Flavour (caramel)	50	0	0.04	0.02 / 0.12	0.02 / 0.13					
Oat flakes	100	10				14.00			1.40 / 3.50	
Rice crisps	100	0.5				6.40			0.03 / 0.08	
Total			17.88	17.88 / 100	16.00 / 100	24.00	5.00 / 12.49	4.00 / 9.99	8.99 / 22.48	7.56 / 18.90

Table 9: recipe Bar 5, iCRF (flour fraction) in cereal mix

Ingredients	DS content [wt%]	Fiber content of DS [wt%]	BS before cooking, based on wet solids [g]	BS before cooking, based on DS [g] / [wt%]	BS after cooking, based on DS [g] / [wt%]	CM, based on wet solids [g]	Total soluble fiber in CB [g] / [wt%]	Total insoluble fiber in CB [g] / [wt%]	Total fiber in CB [g] / [wt%]	Total chicory fiber in CB [g] / [wt%]
Glucose syrup (60 DE)	80	0	2.56	2.05 / 11.39	2.05 / 12.79					
Fructose syrup F95	80	0	4.67	3.74 / 20.80	3.74 / 23.35					
Fructose L92	75	92	8.53	6.40 / 35.63	6.40 / 39.99		5.89 / 14.72		5.89 / 14.72	5.89 / 14.72
iCRF	95	75				2.16		1.54 / 3.85	1.54 / 3.85	1.54 / 3.85
Water	0	0	0.58	4.36 / 24.28	2.40 / 15.00					
Emulsifier (SP 70)	100	0	0.01	0.01 / 0.05	0.01 / 0.06					
Glycerol	75	0	0.72	0.54 / 3.00	0.54 / 3.37					
Fat (Chocofill BR 60)	100	0	0.85	0.85 / 4.74	0.85 / 5.32					
Flavour (caramel)	50	0	0.04	0.02 / 0.12	0.02 / 0.13					
Oat flakes	100	10				15.44			1.54 / 3.86	
Rice crisps	100	0.5				6.40			0.03 / 0.08	
Total			17.96	17.96 / 100	16.00 / 100	24.00	5.89 / 14.72	3.11 / 7.79	9.00 / 22.50	7.43 / 18.56

PCT/NL2016/050758

Table 10: recipe Bar 6, iCRF (total fraction) in cereal mix

Ingredients	DS content [wt%]	Fiber content of DS [wt%]	BS before cooking, based on wet solids [g]	BS before cooking, based on DS [g] / [wt%]	BS after cooking, based on DS [g] / [wt%]	CM, based on wet solids [g]	Total soluble fiber in CB [g] / [wt%]	Total insoluble fiber in CB [g] / [wt%]	Total fiber in CB [g] / [wt%]	Total chicory fiber in CB [g] / [wt%]
Glucose syrup (60 DE)	80	0	1.97	1.57 / 8.80	1.57 / 9.83					
Fructose syrup F95	80	0	6.48	5.18 / 28.99	5.18 / 32.39					
Fructose L92	75	92	7.24	5.43 / 30.38	5.43 / 33.94		5.00 / 12.49		5.00 / 12.49	5.00 / 12.49
iCRF	95	75				3.60		2.57 / 6.41	2.57 / 6.41	2.57 / 6.41
Water	0	0	0.58	4.28 / 23.93	2.40 / 15.00					
Emulsifier (SP 70)	100	0	0.01	0.01 / 0.05	0.01 / 0.06					
Glycerol	75	0	0.72	0.54 / 3.00	0.54 / 3.35					
Fat (Chocofill BR 60)	100	0	0.85	0.85 / 4.74	0.85 / 5.30					
Flavour (caramel)	50	0	0.04	0.02 / 0.12	0.02 / 0.13					
Oat flakes	100	10				14.00		1.40 / 3.50	1.40 / 3.50	
Rice crisps	100	0.5				6.40		0.03 / 0.08	0.03 / 0.08	
Total			17.88	17.88 / 100	16.00 / 100	24.00	5.00 / 12.49	4.00 / 9.99	8.99 / 22.48	7.56 / 18.90

Table 11: recipe Bar 7, iCRF (total fraction) in cereal mix

Ingredients	DS content [wt%]	Fiber content of DS [wt%]	BS before cooking, based on wet solids [g]	BS before cooking, based on DS [g] / [wt%]	BS after cooking, based on DS [g] / [wt%]	CM, based on wet solids [g]	Total soluble fiber in CB [g] / [wt%]	Total insoluble fiber in CB [g] / [wt%]	Total fiber in CB [g] / [wt%]	Total chicory fiber in CB [g] / [wt%]
Glucose syrup (60 DE)	80	0	1.97	1.58 / 8.80	1.58 / 9.86					
Fructose syrup F95	80	0	5.78	4.62 / 25.79	4.62 / 28.89					
Fructose L92	75	92	7.26	5.44 / 30.38	5.44 / 34.03		5.01 / 12.52		5.01 / 12.52	5.01 / 12.52
iCRF	95	75				3.60		2.56 / 6.41	2.56 / 6.41	2.56 / 6.41
Water	0	0	0.58	4.32 / 24.13	2.40 / 15.00					
Emulsifier (SP 70)	100	0	0.01	0.01 / 0.05	0.01 / 0.06					
Glycerol	75	0	1.43	1.08 / 6.00	1.08 / 6.72					
Fat (Chocofill BR 60)	100	0	0.85	0.85 / 4.74	0.85 / 5.31					
Flavour (caramel)	50	0	0.04	0.02 / 0.12	0.02 / 0.13					
Oat flakes	100	10				14.00		1.40 / 3.50	1.40 / 3.50	
Rice crisps	100	0.5				6.40		0.03 / 0.08	0.03 / 0.08	
Total			17.92	17.92 / 100	16.00 / 100	24.00	5.01 / 12.52	4.00 / 9.99	9.00 / 22.52	7.57 / 18.94

Table 12: recipe Bar 8, iCRF (medium fraction) in cereal mix

Ingredients	DS content [wt%]	Fiber content of DS [wt%]	BS before cooking, based on wet solids [g]	BS before cooking, based on DS [g] / [wt%]	BS after cooking, based on DS [g] / [wt%]	CM, based on wet solids [g]	Total soluble fiber in CB [g] / [wt%]	Total insoluble fiber in CB [g] / [wt%]	Total fiber in CB [g] / [wt%]	Total chicory fiber in CB [g] / [wt%]
Glucose syrup (60 DE)	80	0	5.38	4.30 / 24.19	4.30 / 26.89					
Granulated sugar	100	0	0.89	0.89 / 5.00	0.89 / 5.56					
Fructose L85	75	85	9.33	7.00 / 39.38	7.00 / 43.77		5.95 / 14.88		5.95 / 14.88	5.95 / 14.88
iCRF	95	75				2.16		1.54 / 3.85	1.54 / 3.85	1.54 / 3.85
Water	0	0	0.58	4.18 / 23.53	2.40 / 15.00					
Emulsifier (SP 70)	100	0	0.01	0.01 / 0.05	0.01 / 0.06					
Glycerol	75	0	0.71	0.53 / 3.00	0.53 / 3.33					
Fat (Chocofill BR 60)	100	0	0.84	0.84 / 4.74	0.84 / 5.27					
Flavour (caramel)	50	0	0.04	0.02 / 0.12	0.02 / 0.13					
Oat flakes	100	10				15.44		1.54 / 3.86	1.54 / 3.86	
Rice crisps	100	0.5				6.40		0.03 / 0.08	0.03 / 0.08	
Total			17.78	17.78 / 100	16.00 / 100	24.00	5.95 / 14.88	3.11 / 7.79	9.06 / 22.67	7.49 / 18.73

Table 13: recipe Bar 9, iCRF (medium fraction) in cereal mix

Ingredients	DS content [wt%]	Fiber content of DS [wt%]	BS before cooking, based on wet solids [g]	BS before cooking, based on DS [g] / [wt%]	BS after cooking, based on DS [g] / [wt%]	CM, based on wet solids [g]	Total soluble fiber in CB [g] / [wt%]	Total insoluble fiber in CB [g] / [wt%]	Total fiber in CB [g] / [wt%]	Total chicory fiber in CB [g] / [wt%]
Glucose syrup (60 DE)	80	0	7.84	6.27 / 34.99	6.27 / 39.19					
Fructose L85	75	85	7.88	5.91 / 33.00	5.91 / 36.96		5.03 / 12.57		5.03 / 12.57	5.03 / 12.57
iCRF	95	75				3.60		2.57 / 6.41	2.57 / 6.41	2.57 / 6.41
Water	0	0	0.58	4.32 / 24.10	2.40 / 15.00					
Emulsifier (SP 70)	100	0	0.01	0.01 / 0.05	0.01 / 0.06					
Glycerol	75	0	0.72	0.54 / 3.00	0.54 / 3.36					
Fat (Chocofill BR 60)	100	0	0.85	0.85 / 4.74	0.85 / 5.31					
Flavour (caramel)	50	0	0.04	0.02 / 0.12	0.02 / 0.13					
Oat flakes	100	10				14.00		1.40 / 3.50	1.40 / 3.50	
Rice crisps	100	0.5				6.40		0.03 / 0.08	0.03 / 0.08	
Total			17.92	17.92 / 100	16.00 / 100	24.00	5.03 / 12.57	4.00 / 9.99	9.02 / 22.56	7.59 / 18.98

Table 14: recipe Bar 10, iCRF (bimodal fraction 1) in cereal mix

Ingredients	DS content [wt%]	Fiber content of DS [wt%]	BS before cooking, based on wet solids [g]	BS before cooking, based on DS [g] / [wt%]	BS after cooking, based on DS [g] / [wt%]	CM, based on wet solids [g]	Total soluble fiber in CB [g] / [wt%]	Total insoluble fiber in CB [g] / [wt%]	Total fiber in CB [g] / [wt%]	Total chicory fiber in CB [g] / [wt%]
Glucose syrup (60 DE)	80	0	5.38	4.30 / 24.19	4.30 / 26.89					
Granulated sugar	100	0	0.89	0.89 / 5.00	0.89 / 5.56					
Fructose L85	75	85	9.33	7.00 / 39.38	7.00 / 43.77		5.95 / 14.88		5.95 / 14.88	5.95 / 14.88
iCRF	95	75				2.16		1.54 / 3.85	1.54 / 3.85	1.54 / 3.85
Water	0	0	0.58	4.18 / 23.53	4.18 / 15.00					
Emulsifier (SP 70)	100	0	0.01	0.01 / 0.05	0.01 / 0.06					
Glycerol	75	0	0.71	0.53 / 3.00	0.53 / 3.33					
Fat (Chocofill BR 60)	100	0	0.84	0.84 / 4.74	0.84 / 5.27					
Flavour (caramel)	50	0	0.04	0.02 / 0.12	0.02 / 0.13					
Oat flakes	100	10				15.44		1.54 / 3.86	1.54 / 3.86	
Rice crisps	100	0.5				6.40		0.03 / 0.08	0.03 / 0.08	
Total			17.78	17.78 / 100	16.00 / 100	24.00	5.95 / 14.88	3.11 / 7.79	9.06 / 22.67	7.49 / 18.73

Table 15: recipe Bar 11, iCRF (bimodal fraction 2) in cereal mix

Ingredients	DS content [wt%]	Fiber content of DS [wt%]	BS before cooking, based on wet solids [g]	BS before cooking, based on DS [g] / [wt%]	BS after cooking, based on DS [g] / [wt%]	CM, based on wet solids [g]	Total soluble fiber in CB [g] / [wt%]	Total insoluble fiber in CB [g] / [wt%]	Total fiber in CB [g] / [wt%]	Total chicory fiber in CB [g] / [wt%]
Glucose syrup (60 DE)	80	0	7.84	6.27 / 34.99	6.27 / 39.19					
Fructose L85	75	85	7.88	5.91 / 33.00	5.91 / 36.96		5.03 / 12.57		5.03 / 12.57	5.03 / 12.57
iCRF	95	75				3.60		2.57 / 6.41	2.57 / 6.41	2.57 / 6.41
Water	0	0	0.58	4.32 / 24.10	2.40 / 15.00					
Emulsifier (SP 70)	100	0	0.01	0.01 / 0.05	0.01 / 0.06					
Glycerol	75	0	0.72	0.54 / 3.00	0.54 / 3.36					
Fat (Chocofill BR 60)	100	0	0.85	0.85 / 4.74	0.85 / 5.31					
Flavour (caramel)	50	0	0.04	0.02 / 0.12	0.02 / 0.13					
Oat flakes	100	10				14.00		1.40 / 3.50	1.40 / 3.50	
Rice crisps	100	0.5				6.40		0.03 / 0.08	0.03 / 0.08	
Total			17.92	17.92 / 100	16.00 / 100	24.00	5.03 / 12.57	4.00 / 9.99	9.03 / 22.56	7.59 / 18.98

CLAIMS

1. Insoluble dietary fiber particles having a particle size of between 30 and 2500 μm and a bimodal particle size distribution, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein said insoluble dietary fiber particles consist of:
 - a) between 3 wt% and 35 wt%, based on the total weight of insoluble dietary fiber particles, of a first fraction of insoluble dietary fiber particles having a particle size of between 30 and 800 μm and a particle size distribution characterized by a D_{10} of 60 μm , a D_{50} of 370 μm and a D_{90} of 680 μm as measured by nest sieving; and
 - b) between 65 wt% and 97 wt%, based on the total weight of insoluble dietary fiber particles, of a second fraction of insoluble dietary fiber particles having a particle size of between 800 and 2500 μm and a particle size distribution characterized by a D_{10} of 1060 μm , a D_{50} of 1580 μm and a D_{90} of 2080 μm as measured by nest sieving.
2. Insoluble dietary fiber particles according to claim 1 wherein the source of the insoluble dietary fiber is chosen from the family of Asteraceae, the family of Alliaceae, the family of Asparagaceae, or the tribe of Triticeae, wherein the source preferably is chicory root.
3. A method for the manufacture of insoluble dietary fiber particles having a particle size of between 30 and 2500 μm according to claim 1 or 2, said method comprising the following consecutive steps:
 - a) washing inulin- and/or fructo-oligosaccharide-containing plant material;
 - b) slicing or mincing said washed plant material to obtain extractable pieces;
 - c) extracting water-soluble components from the pieces obtained in step b);
 - d) drying the extracted pieces obtained in step c) to a water content of less than 10 wt% to obtain insoluble dietary fiber pieces;
 - e) milling the insoluble dietary fiber pieces obtained in step d) to obtain insoluble dietary fiber particles;
 - f) nest sieving the insoluble dietary fiber particles obtained in step e) to obtain a first fraction of insoluble dietary fiber particles having particle sizes between 30 μm and 800 μm and a second fraction of insoluble dietary fiber particles having particle sizes between 800 μm and 2500 μm ;

g) combining between 3 wt% and 35 wt% of the first fraction and between 65 wt% and 97 wt% of the second fraction, preferably combining between 8 wt% and 22 wt% of the first fraction and between 78 wt% and 92 wt% of the second fraction, wherein the weight percentages are based on the weight of the bimodal particle size distribution.

4. Use of:

a) insoluble dietary fiber particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, and having a particle size of between 30 and 2500 μm as measured by nest sieving; and

b) soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof,

said insoluble dietary fiber and soluble dietary fiber originating from the same plant source, in cereal bars.

5. Use according to claim 4, wherein the insoluble dietary fiber particles having a particle size of between 30 and 2500 μm are as defined in claim 1 or 2.

6. Cereal bar comprising a cereal mix and a binding syrup, said cereal bar comprising between 17 wt% and 35 wt%, based on dry solids content, of soluble and insoluble dietary fiber from the same plant source,

wherein the cereal bar comprises between 12 and 20 wt%, based on dry solids content, of soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof, which soluble dietary fiber is contained in the binding syrup, and

wherein the weight percentages are based on the weight of the cereal bar.

7. Cereal bar according to claim 6, wherein the binding syrup comprises said insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 30 and 250 μm as measured by nest sieving, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein the amount of said insoluble dietary fiber particles, based on dry solids content, is between 3 and 13 wt%, based on the weight of the binding syrup.

8. Cereal bar according to claim 6, wherein the cereal mix comprises said insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 30 and 250 μm as measured by nest sieving, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content,
- 5 wherein the amount of said insoluble dietary fiber particles, based on dry solids content, is between 5 and 20 wt%, based on the weight of the cereal mix.
9. Cereal bar according to claim 6, wherein the cereal mix comprises said insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 30 and 2500 μm and a particle size distribution characterized by a D_{10} of 440 μm , a D_{50} of 1250 μm and a D_{90} of 2050 μm as measured by nest sieving, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content,
- 10 wherein the amount of said insoluble dietary fiber particles, based on dry solids content, is between 5 and 20 wt%, based on the weight of the cereal mix.
- 15 10. Cereal bar according to claim 6, wherein the cereal mix comprises said insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 800 and 2500 μm and a particle size distribution characterized by a D_{10} of 1060 μm , a D_{50} of 1580 μm and a D_{90} of 2080 μm as measured by nest sieving, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content,
- 20 wherein the amount of said insoluble dietary fiber particles, based on dry solids content, is between 5 and 20 wt%, based on the weight of the cereal mix.
11. Cereal bar according to claim 6, wherein the cereal mix comprises said insoluble dietary fiber in the form of insoluble dietary fiber particles having a particle size of between 30 and 2500 μm and a bimodal particle size distribution, said particles having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, wherein the amount, based on dry solids content, of said insoluble dietary fiber particles is between 5 and 20 wt%, based on the weight of the cereal mix and wherein said insoluble dietary fiber particles consist of:
- 25 a) between 3 wt% and 35 wt%, based on the total weight of insoluble dietary fiber particles, of a first fraction of insoluble dietary fiber particles having a particle size of between 30 and 800 μm and a particle size distribution characterized by a D_{10} of 60 μm , a D_{50} of 370 μm and a D_{90} of 680 μm as measured by nest sieving; and
- 30

- b) between 65 wt% and 97 wt%, based on the total weight of insoluble dietary fiber particles, of a second fraction of insoluble dietary fiber particles having a particle size of between 800 and 2500 μm and a particle size distribution characterized by a D_{10} of 1060 μm , a D_{50} of 1580 μm and a D_{90} of 2080 μm as measured by nest sieving.

5

12. Cereal bar according to any one of claim 6 to 11 wherein the weight ratio of cereal mix to the binding syrup is from 70:30 to 45:55, preferably from 65:35 to 55:45.

13. Cereal bar according to any one claims 6 to 11, having a weight of between 25 and 60 gram, preferably between 30 and 50 gram.

10

14. Cereal bar according to any one of claims 6 to 13, wherein the source of the insoluble dietary fiber and soluble dietary fiber is chosen from the family of Asteraceae, the family of Alliaceae, the family of Asparagaceae or the tribe of Triticeae, wherein the source preferably is chicory root.

15

15. A method for the manufacture of a cereal bar according to any one of claims 6 to 14, said method comprising the steps of:

a) washing inulin- and/or fructo-oligosaccharide-containing plant material;

20

b) slicing or mincing said washed plant material to obtain extractable pieces;

c) extracting water soluble components from the pieces obtained in step b) to obtain soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof;

d) drying the extracted pieces obtained in step c) to a water content of less than 10 wt% to obtain insoluble dietary fiber pieces;

25

e) milling the insoluble dietary fiber pieces obtained in step d) to obtain insoluble dietary fiber particles;

f) preparing a binding syrup comprising between 12 and 20 wt%, based on dry solids content, of soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof as obtained in step c);

30

g) preparing a cereal mix;

h) adding insoluble dietary fiber particles as obtained in step e) to the cereal mix or to the binding syrup to obtain between 17 wt% and 35 wt%, based on dry solids content, of

insoluble dietary fiber from said plant material and soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof from said plant material;

i) combining the binding syrup and the cereal mix to obtain the cereal bar;

wherein the weight percentages are based on the weight of the cereal bar

5

16. An uncooked binding syrup for a cereal bar, said syrup comprising:

a) 15 - 45 wt%, based on dry solids content, of a mixture of one or more of glucose syrup, fructose syrup, sugar and glycerol;

b) 15 - 30 wt% of water;

10

c) 0.01 - 1 wt% of emulsifier;

d) 1 - 7 wt% of fat;

e) 32 - 47 wt%, based on dry solids content, of soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof;

15

f) insoluble dietary fiber particles in the form of a flour having an insoluble dietary fiber content of between 60 and 80 wt%, based on dry solids content, and having a particle size of between 30 and 250 μm as measured by nest sieving;

wherein the combined amount of said soluble dietary fiber and said insoluble dietary fiber particles is at least 40 wt%, based on dry solids content,

wherein the amount of said insoluble dietary fiber particles is between 2 and 11 wt%, based on dry solids content,

20

wherein the soluble and insoluble dietary fibers originate from the same plant source, and wherein the weight percentages are based on the weight of the binding syrup.

17. Binding syrup according to claim 16 which is cooked to a Brix value of between 84-86.

25

18. Uncooked binding syrup according to claim 16 or binding syrup according to claim 17, wherein the source of the insoluble dietary fiber and soluble dietary fiber is chosen from the family of Asteraceae, the family of Alliaceae, the family of Asparagaceae or the tribe of Triticeae, wherein the source preferably is chicory root.

30

Fig. 1A

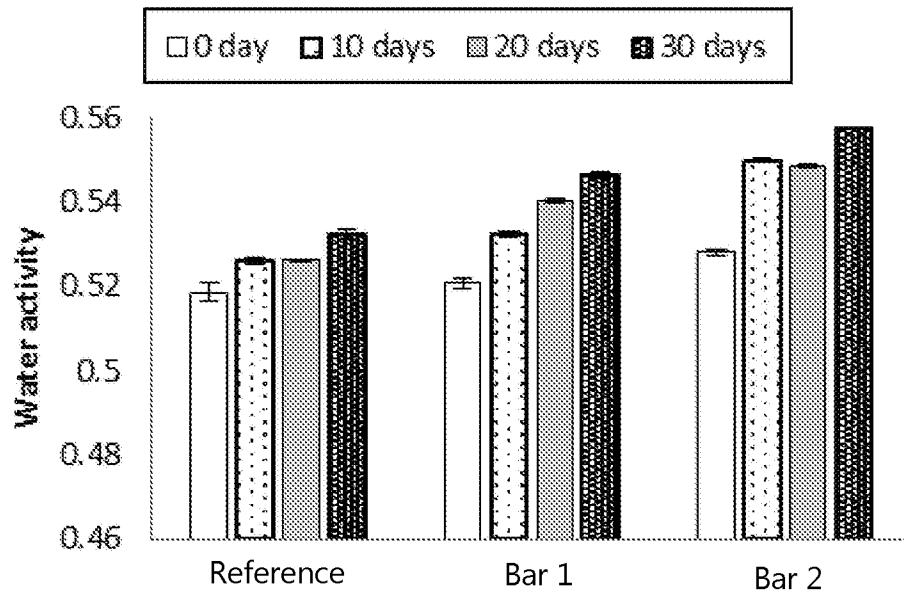


Fig. 1B

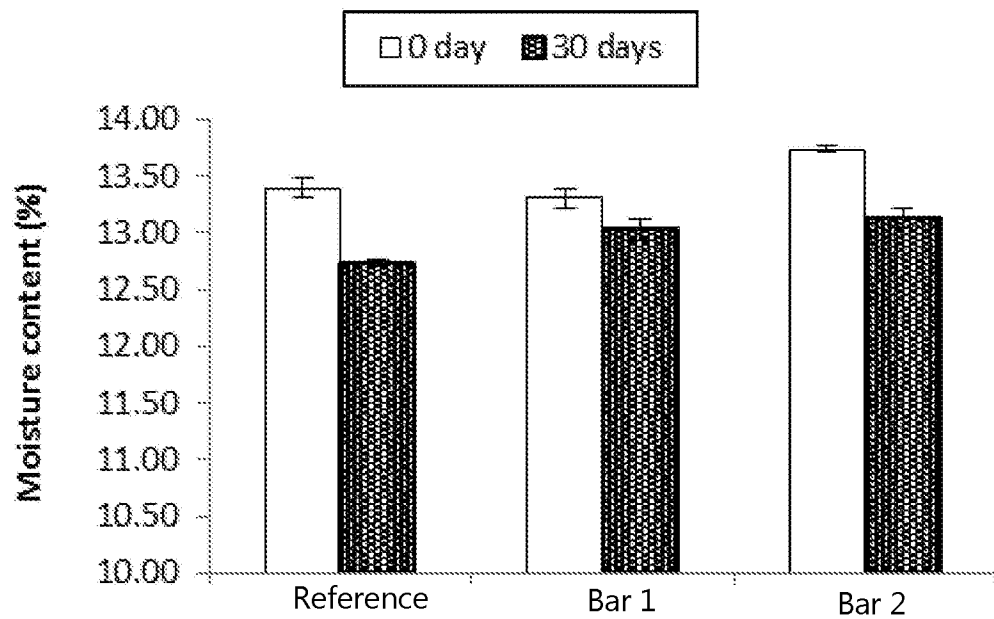


Fig. 1C

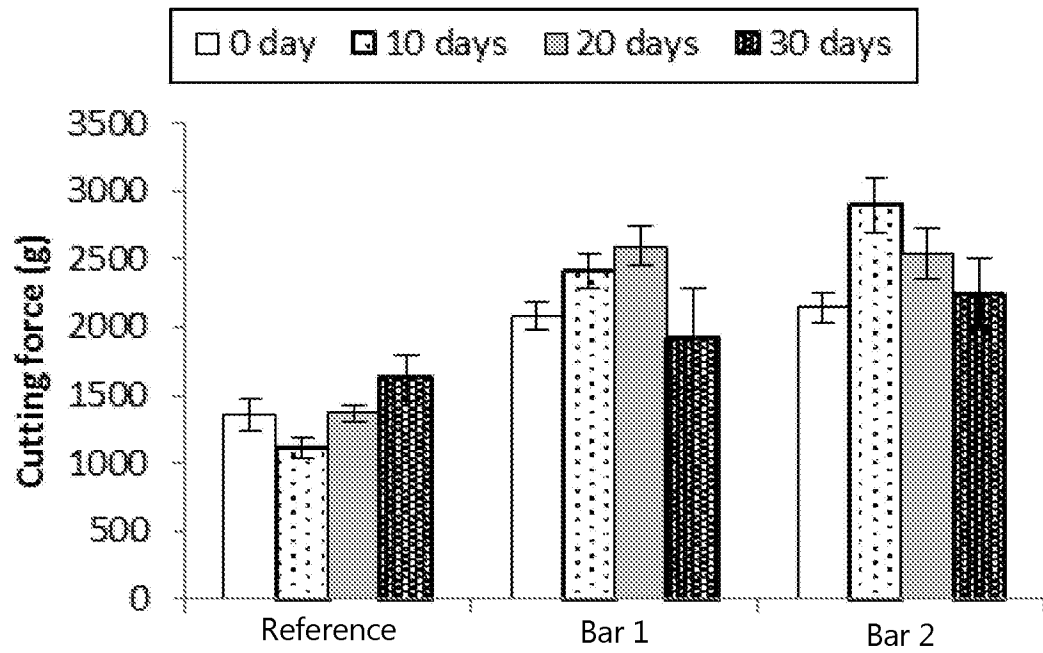


Fig. 1D

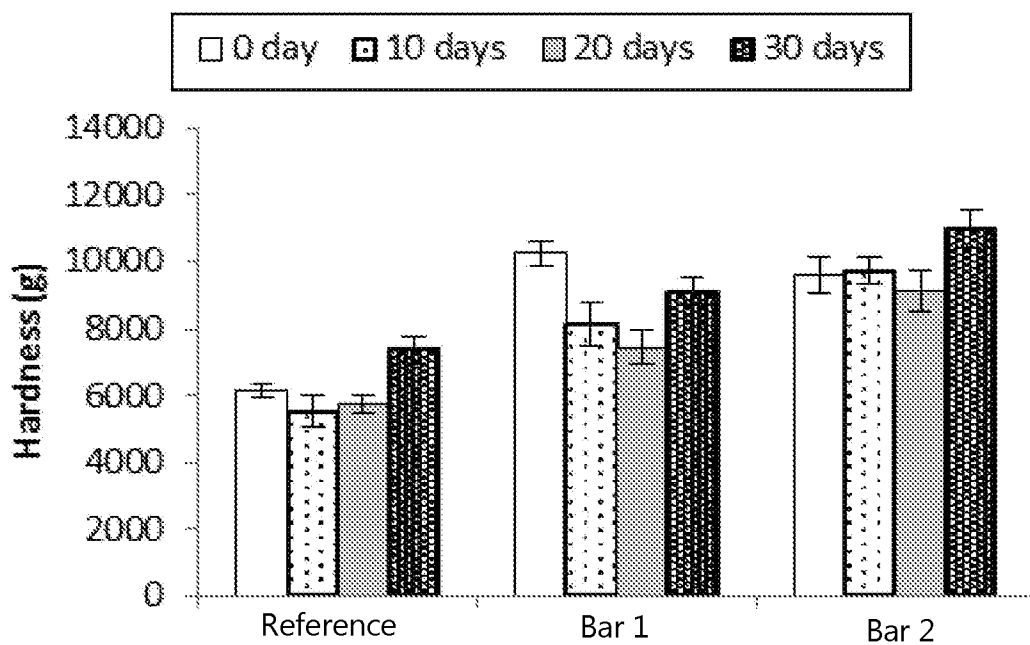


Fig. 1E

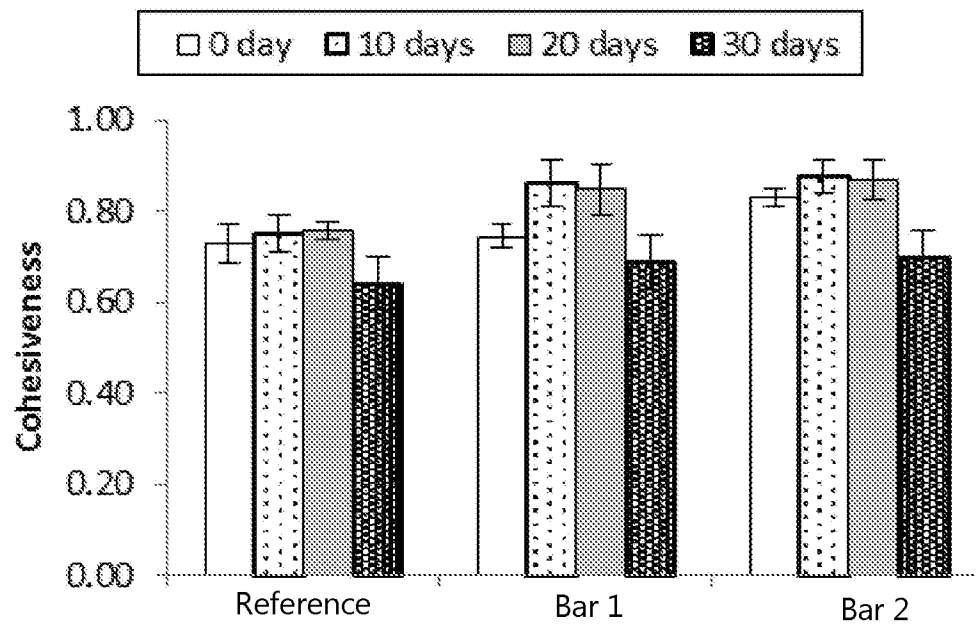
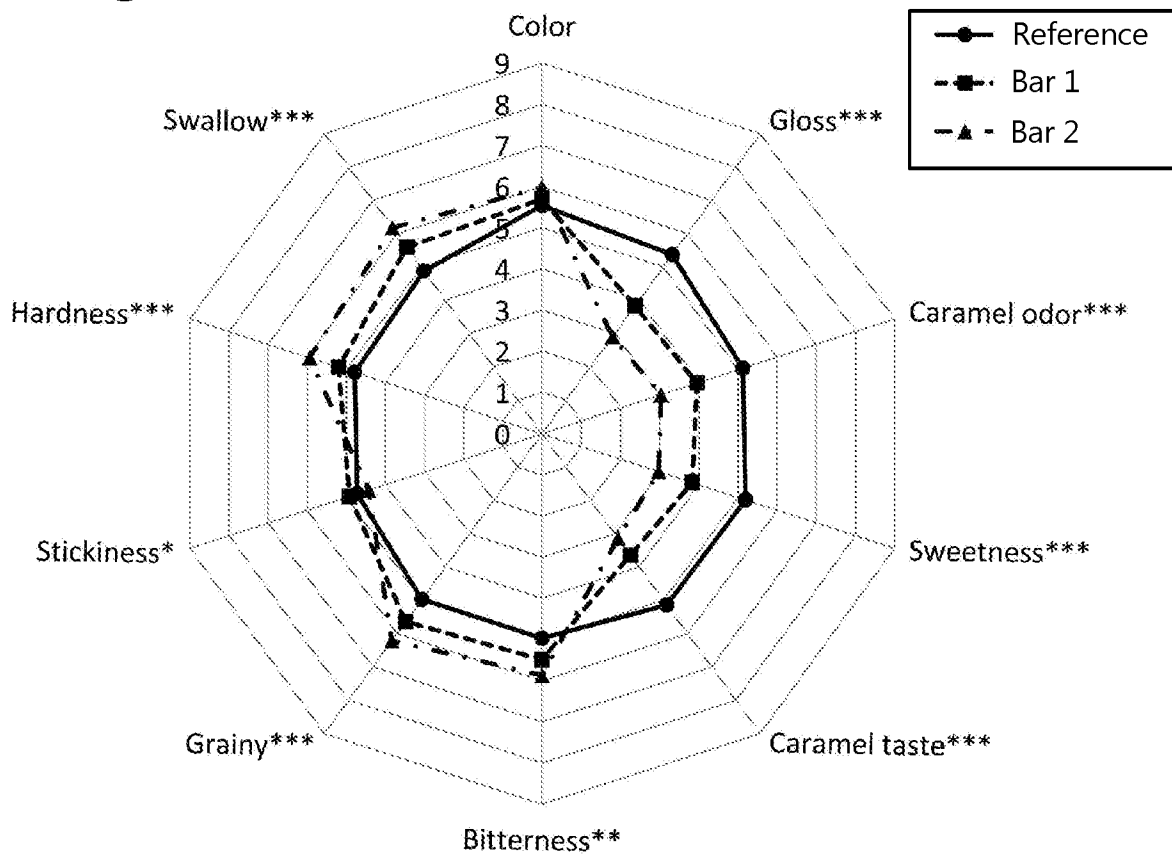


Fig. 2



4/5

Fig. 3

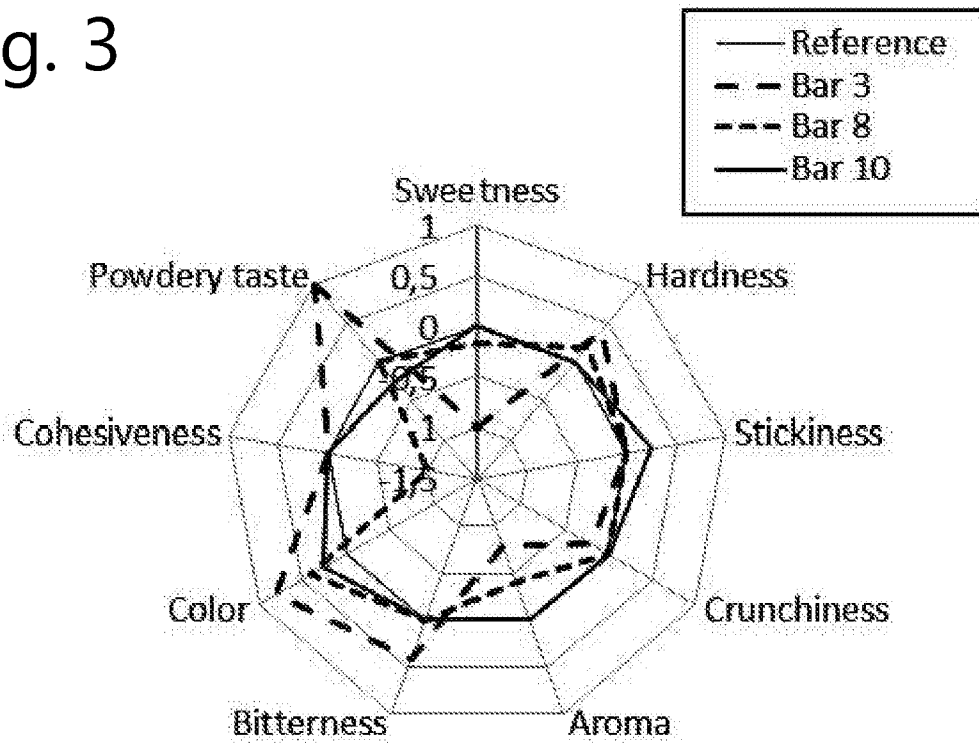


Fig. 4

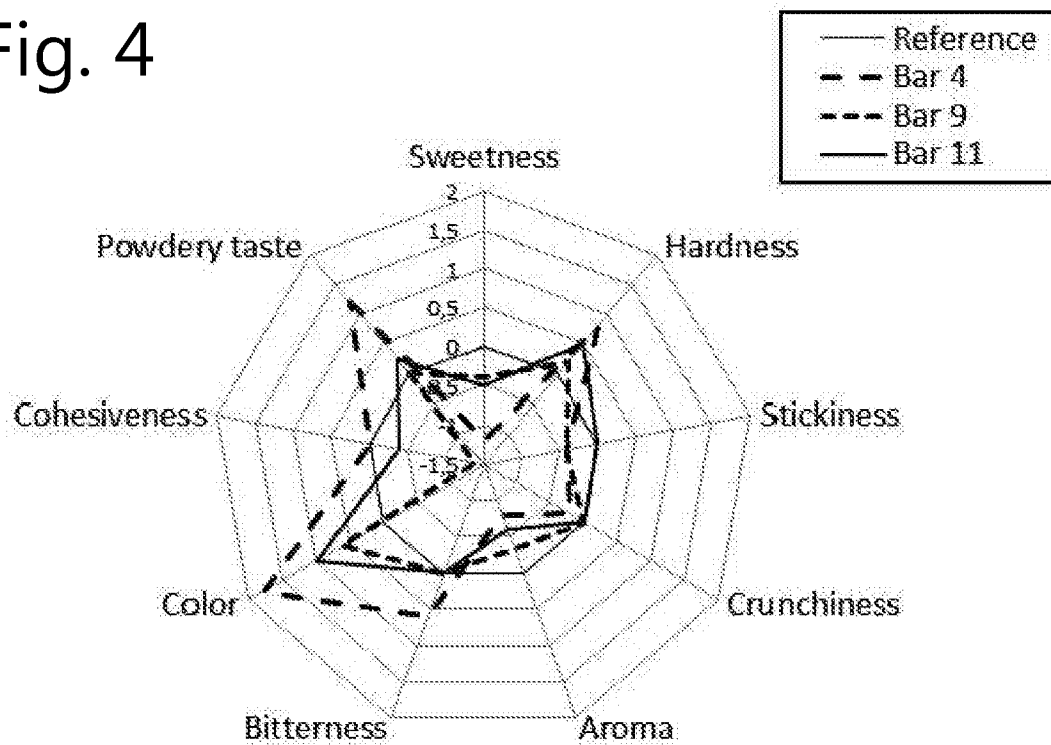


Fig. 5

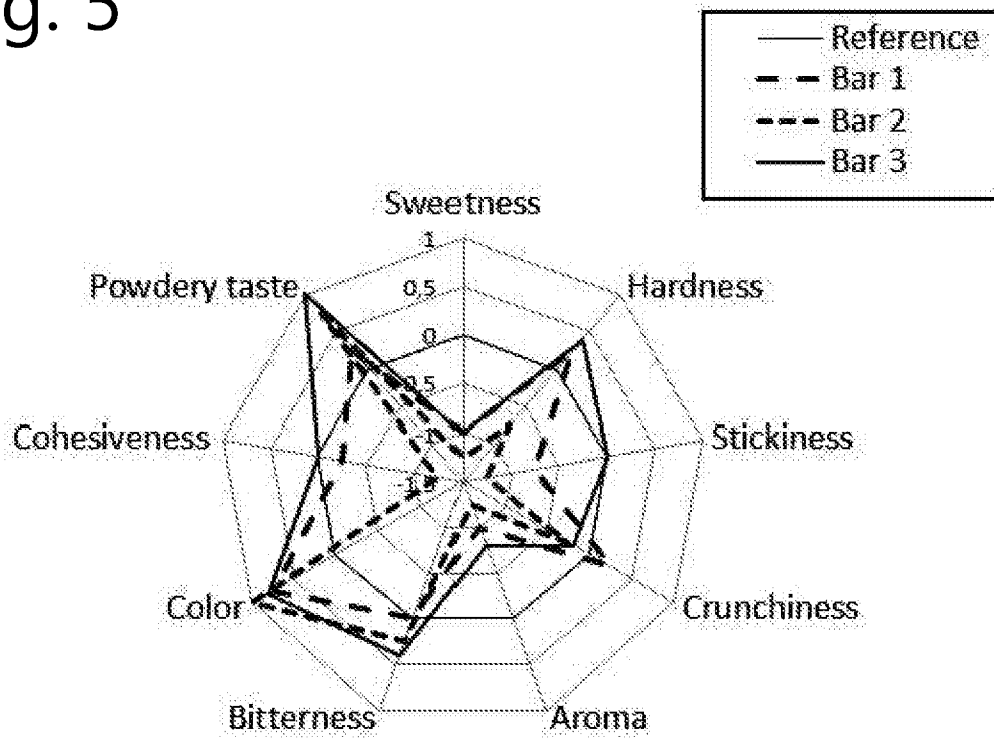
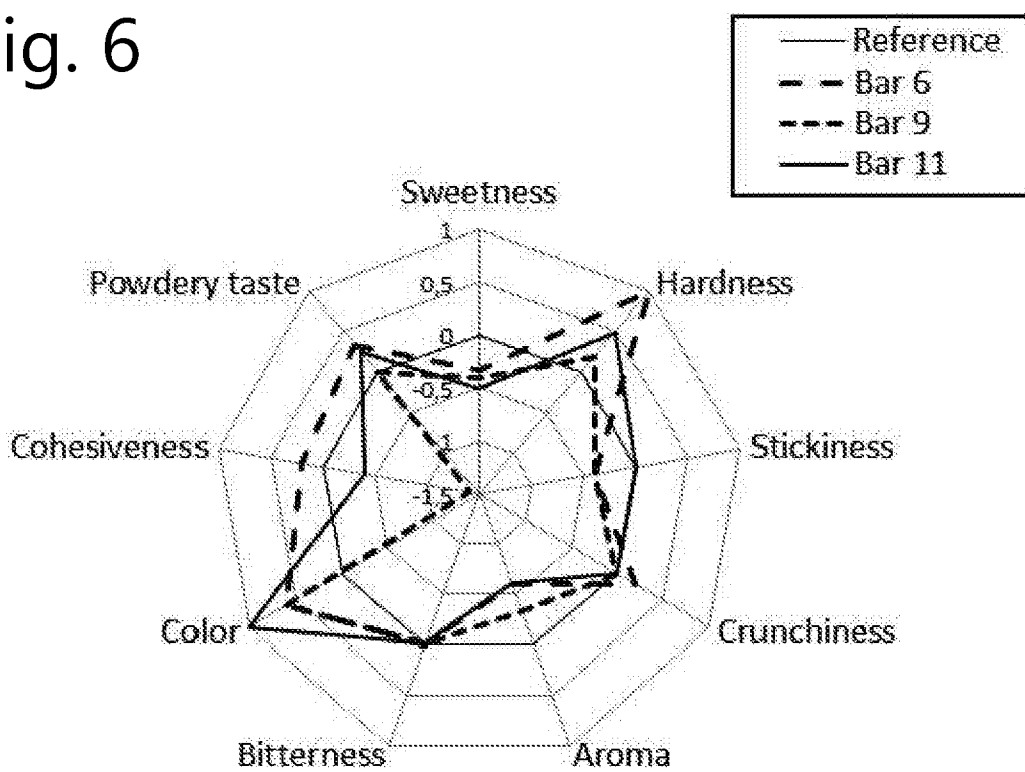


Fig. 6



INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2016/050758

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23L7/126 A23L29/244 A23L33/21 A23L33/22
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A23L

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

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

EPO-Internal, BIOSIS, EMBASE, FSTA, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 03/061405 A1 (WESTHOVE [FR]; ROLLER MARC [FR]; GUILLAUME CHRISTOPHE [BE]) 31 July 2003 (2003-07-31) cited in the application	1-5
Y	abstract examples 3,9	6-15
X	----- US 4 871 574 A (YAMAZAKI HIROSHI [CA] ET AL) 3 October 1989 (1989-10-03) claims 1,3,4,7,9,10,13,14,16,17,22,23; figure 1	3
X	----- US 4 565 705 A (SNIDER H KEITH [US]) 21 January 1986 (1986-01-21) abstract columns 1,2,4 ----- -/-	3



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

10 March 2017

Date of mailing of the international search report

23/03/2017

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

de La Tour, Camille

INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2016/050758

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	I. Massoud Mona ET AL: "Chemical and Technological Studies on Chicory (Cichorium Intybus L) and Its Applications in Some Functional Food", Crop. Processing Res. Dept. Food Technol. Res. Inst. Egypt . 3 Special Foods& Nutrition Dept, Res. Inst. A.R.C.Cairo, 1 January 2009 (2009-01-01), XP055277488, Retrieved from the Internet: URL:not available [retrieved on 2016-06-02] the whole document	3
Y	EP 2 229 822 A2 (CEREAL INGREDIENTS INC [US]) 22 September 2010 (2010-09-22) paragraphs [0005], [0007], [0013], [0014], [0017] - [0020], [0036] claims 1,2,8,13,14,15,16	6-15
Y	US 4 871 557 A (LINSCOTT SUSAN E [US]) 3 October 1989 (1989-10-03) abstract columns 8-10 claims 1,3,5,6,9,10	6-15
Y	ANONYMOUS: "Blueberry cobbler snack bar", GNPD; MINTEL, July 2015 (2015-07), XP002756246, [retrieved on 2015-07-01] the whole document	6-15
A	WO 2009/009720 A1 (KELLOG CO [US]; TREECE THOMAS Z [US]; ORTIZ DEIRDRE E [US]; GHORPADE V) 15 January 2009 (2009-01-15) example 5 claims 1-28	1-15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NL2016/050758

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

1-15
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-5

Insoluble dietary fiber particles, method of manufacture and use thereof.

2. claims: 6-15

Cereal bar comprising a cereal mix and a binding syrup, said cereal bar comprising between 17 wt% and 35 wt%, based on dry solids content, of soluble and insoluble dietary fiber from the same plant source, wherein the cereal bar comprises between 12 and 20 wt%, based on dry solids content, of soluble dietary fiber chosen from fructo-oligosaccharides, inulin or combinations thereof, which soluble dietary fiber is contained in the binding syrup, and wherein the weight percentages are based on the weight of the cereal bar.
Method of manufacture and use thereof.

3. claims: 16-18

a binding syrup

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/NL2016/050758

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 03061405	A1	31-07-2003	FR 2834862 A1 25-07-2003
		WO 03061405 A1	31-07-2003
US 4871574	A	03-10-1989	CA 1324022 C 09-11-1993
		JP H01199554 A	10-08-1989
		US 4871574 A	03-10-1989
US 4565705	A	21-01-1986	NONE
EP 2229822	A2	22-09-2010	AU 2009203213 A1 18-02-2010
		CA 2674782 A1	04-02-2010
		EP 2229822 A2	22-09-2010
		US 2010034926 A1	11-02-2010
US 4871557	A	03-10-1989	JP 2803844 B2 24-09-1998
		JP H0239870 A	08-02-1990
		US 4871557 A	03-10-1989
WO 2009009720	A1	15-01-2009	AU 2008274980 A1 15-01-2009
		EP 2222189 A1	01-09-2010
		US 2009017168 A1	15-01-2009
		WO 2009009720 A1	15-01-2009