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(54) **HEALTHY BISCUIT**

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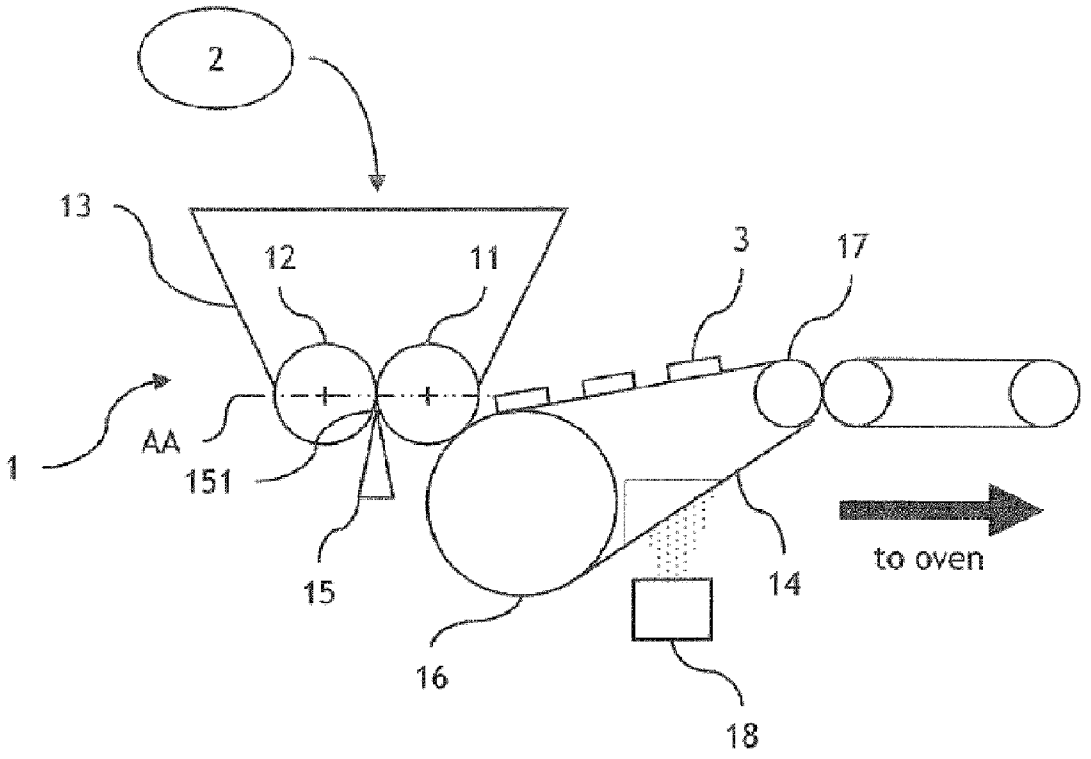
(57) **ABSTRACT**

The disclosure concerns a method for producing a ready-to-eat biscuit comprising at least 29 wt % wholegrain cereal flour, 5 wt % to 22 wt % fat, and at most 30 wt % sugar relative to the total weight of the biscuit, wherein the slowly-digestible-starch-over-total-available-starch ratio of the biscuit is at least 31 wt %, the method comprising: mixing a cereal flour comprising the wholegrain cereal flour with fat and sugar and at most 8 wt % added water relative to the total weight of the dough, to form a dough; moulding the dough into the shape of a biscuit; baking the biscuit; wherein the cereal flour comprises refined cereal flour in an amount of at least 14.5 wt % of the dough and wherein the refined cereal flour has a water absorption under 55% as measured by Brabender® Farinograph® according to NF-ISO-5530-1 norm.



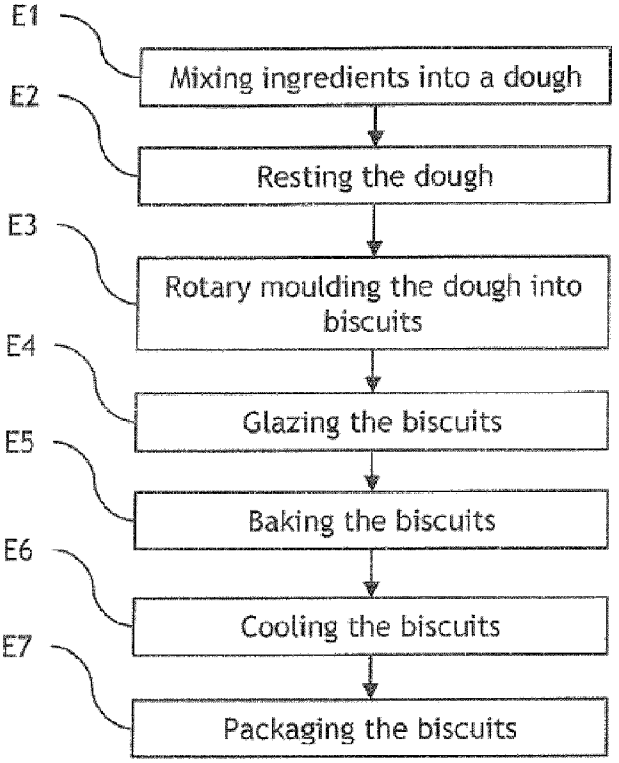

E1
Mixing ingredients into a dough
E2
Resting the dough
E3
Rotary moulding the dough into biscuits
E4
Glazing the biscuits
E5
Baking the biscuits
E6
Cooling the biscuits
E7
Packaging the biscuits

FIG. 1

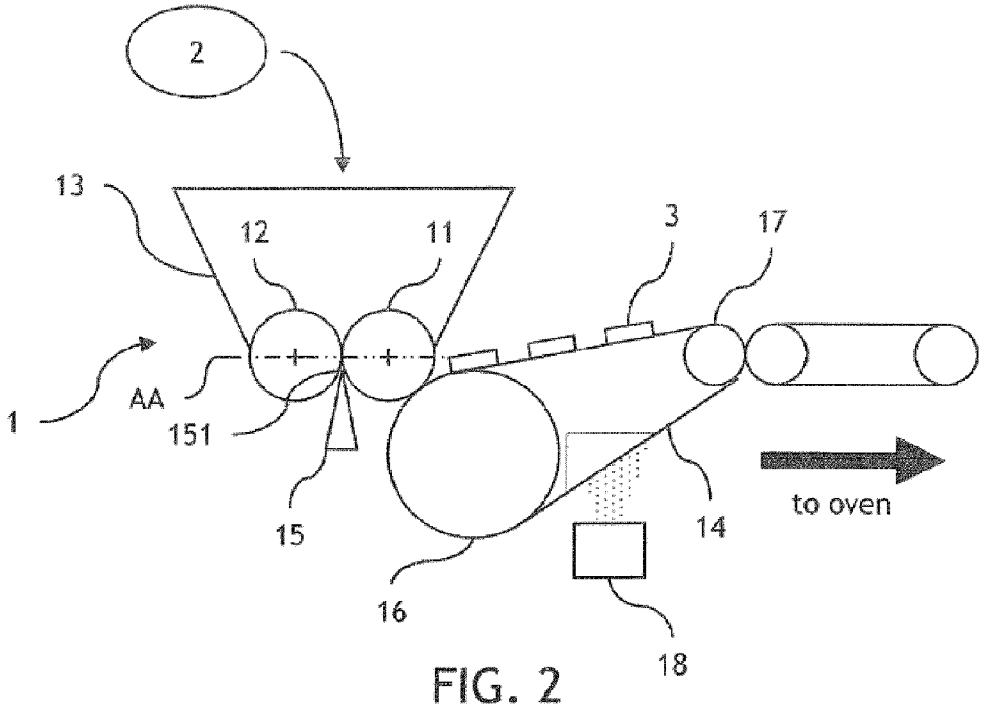

2
13
12
11
3
17
1
AA
151
15
16
14
18
to oven

FIG. 2

HEALTHY BISCUIT

[0001] The present invention relates to biscuits. More specifically, the present disclosure is concerned with a ready-to-eat biscuit having a large amount of slow release energy.

[0002] In the food industry, biscuits are conventionally made from refined flours. With consumers' increasing awareness of healthy foods, there has been increasing demand for food products made from wholegrain flours. This is because the nutritional pattern of wholegrain flours is considered healthier by consumers than that of refined flours.

[0003] Biscuits that provide a slow release of carbohydrates and therefore have a long-lasting energy release, are believed to be beneficial for consumers' health. The starch fraction that is slowly digested (slowly digestible starch or SDS) is responsible for this long-lasting energy release. Products like biscuits comprise a significant amount of slowly digestible starch before baking. However, this amount of slowly digestible starch decreases during the baking process. This is due to the gelatinisation of the SDS during the baking process. The gelatinisation occurs owing to the presence of water in the dough mixture. Gelatinisation refers to the partial melting of the crystalline domains of starch, resulting in increased digestibility. During the heat treatment of moist dough the starch granules first swell, then progressively loose their crystalline structure until they burst, resulting in the leaching out of the polysaccharides contained in the granules (amylose and amylopectin). In highly concentrated systems, such as biscuit doughs, this sequence of event may be limited by the restricted moisture content, but the progressive melting of the crystalline domains still occurs.

[0004] The use of wholegrain flours makes it more difficult to form a processable dough. This is because wholegrain flours, unlike refined flours, comprise bran and germ in addition to endosperm. Bran and germ contain higher amounts of fibres than the endosperm and therefore they have a higher water retention capacity. If the same level of dough hydration is kept, the dough has a more granular consistency and a harder drier texture, which makes it harder to process.

[0005] In order to maintain the same processability for a wholegrain-flour-based dough compared to that of a dough comprising refined flours, it is possible to increase fat content of the dough. Fat enables processing at lower moisture levels by acting as a plasticiser. The fat coats the cereal flours so that the flours retain less water; the less water that is retained, the more water is available to lubricate the dough. Furthermore, the fats also contribute to lubricating the dough. The addition of large amounts of fat is, however, not compatible with the provision of a healthy biscuit.

[0006] It is also known that increasing the sugar content of the dough can result in a more processable dough. This is because sugar also acts as a plasticiser for dough. However, the addition of large amounts of sugar is also not compatible with the provision of a healthy biscuit. Moreover, addition of sugar would increase the rapidly available glucose content since this is composed of the rapidly digestible starch and the glucose units from sugars.

[0007] Another solution would be to include polyols or short-chain soluble fibres, such as fructooligosaccharides, polydextrose, resistant dextrins and the like in the dough. Polyols and short-chain soluble fibres mimic sugar behaviour during processing hence improve the process-ability of the dough. However, these ingredients can raise gastrointestinal tolerance issues.

[0008] Still another solution is to use micronised bran, preferably wheat bran. This has a lower water retention capacity compared to coarse bran. However, biscuits made out from a dough comprising micronised bran do not have the typical appearance of a wholegrain product and do not meet the consumer's expectations. The typical appearance of a wholegrain product is generally a product with visible brownish bran pieces on the surface.

[0009] For improving the poor process-ability of the dough, water can of course be added to the dough. However, water triggers gelatinisation of starch during the baking of the biscuit and this results in an undesirably low slowly digestible starch content in the baked biscuit part. Therefore, the long-lasting energy property can be lost.

[0010] In US 2007/134392 a dough is made from 70 wt % wheat flour, 7 wt % butter, 5 wt % fructose with 28% water content. Using this formulation, US 2007/134392 attempts to obtain a biscuit with a high slowly-digestible-starch content and that can be considered healthy. A starch product is used in the dough that has been at least partially gelatinised or at least partially plasticised with a short-chain amylose. This results in a crystalline structure of the starch product that is slowly digested by the amylase. However, the biscuit of US 2007/134392 fails to fulfil the long-lasting energy criteria.

[0011] Further solutions for maintaining a higher level of slowly digestible starch while keeping a low hydration include the addition of native starch in the dough. However, native starch will give the biscuits a sticky mouth-texture and the biscuits will not seem to melt. Furthermore, this solution decreases the total wholegrain cereal content of the biscuits and is therefore contrary to the aim of providing a healthy biscuit.

[0012] The use of flakes can improve the SDS content. The starch coming from the flakes has less contact with any added water in the dough, and thus does gelatinises to a lesser extent than, for example, the starch in a finely ground flour. Consequently, flake starch is a good candidate for helping maintain a high value of slowly available starch. Flakes also require less hydration than flours. However, using too many flakes is not ideal for biscuits since consumers do not expect to see a high flake content in a biscuit. The texture of these biscuits with too many flakes is overly chewy and parts of the biscuit remain stuck to the teeth. In particular, these biscuits can be denser and have a flaky/sandy texture.

[0013] Consequently, there is a need for an improved biscuit which tackles at least some of the problems associated with the prior art, or at least provide a commercially useful alternative thereto.

[0014] In particular, there is still a need for a method for producing a biscuit meeting the expected nutritional profile in terms of fat and sugar, and which contains a high amount of slowly digestible starch compared to conventional biscuits.

[0015] In particular, the disclosure aims at providing a biscuit which meets the long-lasting energy and the nutritional criteria for a healthy biscuits. Until now, it was not possible to obtain such a biscuit without diminishing palatability and processability.

[0016] In a first aspect, the present disclosure provides a method for producing a ready-to-eat biscuit comprising at least 29 wt % wholegrain cereal flour, 5 wt % to 22 wt % fat, and at most 30 wt % sugar relative to the total weight of the biscuit, wherein the slowly-digestible-starch-over-total-available-starch ratio of the biscuit is at least 31 wt %, the method comprising:

[0017] mixing a cereal flour comprising the wholegrain cereal flour with fat and sugar and with at most 8 wt % added water relative to the total weight of the dough, to form a dough;

[0018] moulding the dough into the shape of a biscuit;

[0019] baking the biscuit;

wherein the cereal flour comprises refined cereal flour in an amount of at least 14.5 wt % of the dough and wherein the refined cereal flour has a water absorption under 55% as measured by Brabender® Farinograph® according to NF-ISO-5530-1 norm.

[0020] The present disclosure will now be further described. In the following passages different aspects of the disclosure are defined in more detail. Each aspect so defined may be combined with any other aspect or aspects unless clearly indicated to the contrary. In particular, any feature indicated as being preferred or advantageous may be combined with any other feature or features indicated as being preferred or advantageous.

[0021] Biscuits are baked, edible, cereal-based products. They typically have a low moisture and a crispy texture. They are typically small, and leavened with baking powder, baking soda, or sometimes yeast. They are typically sweet. They can contain inclusions and fillings. The biscuits are ready-to-eat in the sense that they a complete and final product suitable for sale and consumption.

[0022] The ready-to-eat biscuit has a slowly-digestible-starch-over-total-available-starch ratio (SDS/(SDS+RDS)) of at least 31 wt %, preferably at least 35 wt %, more preferably at least 38 wt %, still more preferably at least 40 wt %. The highest ratio will preferably be at most 80 wt % for digestibility. Total available starch comprises slowly digestible starch (SDS) and rapidly digestible starch (RDS). The difference between total available starch and total starch is that total available starch does not comprise resistant starch that cannot be digested, i.e. that escapes digestion in the small intestine.

[0023] It is believed that slowly digestible starch gives a higher health benefit than rapidly digestible starch. Indeed, rapidly digestible starch is rapidly broken down into glucose during digestion and thus rapidly made available to the body. Therefore, the blood glucose level rapidly increases. This can trigger insulin delivery leading to some storage in adipose tissues. Consequently, energy can only be provided for a shorter time. On the contrary, slowly digestible starch is slowly assimilated by the body. Consequently, energy can be provided for a longer time.

[0024] SDS or slowly available glucose (SAG) can be characterised through the slowly available glucose (SAG) measurement by Englyst method ("Rapidly Available Glucose in Foods: an In Vitro Measurement that Reflects the Glycaemic Response", Englyst et al., Am. J. Clin. Nutr., 1996 (3), 69(3), 448-454; "Glycaemic Index of Cereal Products Explained by Their Content of Rapidly and Slowly Available Glucose", Englyst et al., Br. J. Nutr., 2003(3), 89(3), 329-340; "Measurement of Rapidly Available Glucose (RAG) in Plant Foods: a Potential In Vitro Predictor of the Glycaemic Response", Englyst et al., Br. J. Nutr., 1996(3), 75(3), 327-337). SAG refers to the amount of glucose (from sugar and starch, including maltodextrins) likely to be available for slow absorption in the human small intestine. In the present case of the disclosure, the SDS content equals the SAG content since there is no other SAG source than starch, i.e. SDS. Rapidly available glucose (RAG) refers to the amount of glucose likely to be available for rapid absorption in the human small intestine.

[0025] In Englyst method, biscuit samples are prepared by manually and roughly grinding one or more biscuits. The biscuit samples are then subjected to an enzymatic digestion by incubation in presence of invertase, pancreatic alpha-amylase and amyloglucosidase under standardised conditions. Parameters such as pH, temperature (37° C.), viscosity and mechanical mixing are adjusted to mimic the gastrointestinal conditions. After an enzymatic digestion time of 20 min, glucose is measured and is labelled RAG. After an enzymatic digestion time of 120 min, glucose is again measured and is labelled available glucose (AG). SAG is obtained by subtracting RAG to AG (SAG=AG−RAG), thus, SAG corresponds to the glucose fraction released between the 20^{th} and the 120^{th} minute. Free glucose (FG), including the glucose released from sucrose, is obtained by separate analysis. RDS is then obtained as the subtraction of FG from RAG (RDS=RAG−FG).

[0026] Preferably, the ready-to-eat biscuit has at least 15 g SAG/100 g biscuit. Such a biscuit complies with the long-lasting energy criteria, i.e. SAG value over 15 g/100 g biscuit or slowly-digestible-starch-over-total-available-starch ratio of at least 31% with respect to the total weight of the biscuit. Preferably, the ready-to-eat biscuit has a SAG content of at least 16.5 g/100 g biscuit, more preferably at least 18.0 g/100 g biscuit, still more preferably at least 21.0 g/100 g biscuit. The highest SAG will preferably at most 50.0 g/100 g.

[0027] The biscuit is formed from a dough which comprises a cereal flour, fat, sugar and added water. The cereal flour comprises at least 29 wt % wholegrain cereal flour and comprises at least 14.5 wt % refined cereal flour with a water absorbance of under 55%.

[0028] The dough comprises added water in an amount of at most 8 wt % relative to the total weight of the dough. That is, the added water forms 8 wt % of the total dough before baking. This water is substantially removed from the biscuit during baking. Added water does not include the water that is already present in some of the ingredients (such as the about 12 wt % of cereal flour that is water). At least some of the water present in these ingredients is also removed from the biscuit during baking. Hence, the wt % of cereal flour in the dough and in the final biscuit is substantially the same, due to this loss of moisture. Components without a moisture content (such as fat) will form a larger wt % of the biscuit than of the dough.

[0029] The dough comprises at most 8 wt % added water, preferably from 3 to 8 wt %, and more preferably from 4 to 7 wt % and most preferably from 5 to 6 wt %. As noted above, the term "added water" means water that is added in addition to the other ingredients. Thus, "added water" does not include water contained in any other ingredients such as cereal flour (typically around 10-15 wt %), flakes or bran and germs. For syrups of sugars, short chain soluble fibres, polyols and the like, the water present in the syrup is considered as part of the added water,

[0030] The rheology of a biscuit dough as discussed herein and having a water content of from 3 to 8 wt % is quite characteristic. The dough typically does not have a "continuous" structure like a bread/pizza dough, and is instead more like a collection of disconnected particles. When the dough has a water content of less than 3 wt % no dough can be formed. At such low hydration levels the dough behaves more

like a granular material (similar to sand). The dough texture resembles that of shortbread or crumble dough and exhibits a very limited cohesion. Such doughs are also much harder upon compression than more hydrated doughs. Thus, the dough workability is diminished and it cannot be processed by rotary moulding. With higher amounts of added water than 8 wt %, the dough machinability increases but the extent of starch hydrolysis on baking is increased and the SDS decreases.

[0031] The term "wholegrain cereal flour(s)" as used herein means flour produced directly or indirectly from cereal whole grains comprising endosperm, bran and germ. The wholegrain flour can also be preferably reconstituted from separate endosperm (for example refined flour), bran and germ respectively in ratios that give to the reconstituted wholegrain flour the same composition as wholegrain flour directly produced from grains that still retain bran and germ.

[0032] "Wholegrain cereal flour" should be distinguished from "refined cereal flour" which refers to flour made from cereal endosperm only. The biscuit obtainable by the method of the disclosure comprises at least 29 wt % wholegrain cereal flour, preferably at least 30 wt %, more preferably at least 31 wt %. Preferably, the biscuit comprises at most 70 wt % wholegrain cereal flour, more preferably at most 60 wt %, still more preferably at most 50 wt %. These amounts are calculated from the total weight of the wholegrain cereal flour over the weight of the final biscuit. When the amount of wholegrain cereal flour is over 70 wt %, it becomes very difficult to process the dough.

[0033] The wholegrain cereal flour preferably comprises at least two different types of wholegrain cereal flours. These types of wholegrain cereal flours preferably selected from wholegrain wheat flour, wholegrain barley flour, wholegrain rye flour, wholegrain spelt flour, wholegrain oat flour, wholegrain rice flour, wholegrain maize flour, wholegrain millet flour, wholegrain sorghum flour, wholegrain teff flour, wholegrain triticale flour, and pseudocereal flour such as amaranth flour and quinoa flour, and mixtures thereof. Preferably, the wholegrain cereal flours is selected from wholegrain wheat flour, wholegrain barley flour, wholegrain rye flour, wholegrain spelt flour, wholegrain oat flour and mixtures thereof. More preferably, they are selected from wholegrain wheat flour, wholegrain barley flour, wholegrain rye flour, wholegrain spelt flour and mixtures thereof.

[0034] In one embodiment, the wholegrain cereal flour comprises wholegrain wheat flour. The wholegrain wheat flour can be a reconstituted wholegrain wheat flour obtained from a mixture of refined wheat flour, wheat bran and wheat germ. Preferably, the refined wheat flour is the same as the refined wheat flour with a water absorption under 55% as measured by Brabender® Farinograph® used in this method. In this latter case, a part of this refined wheat flour is used to reconstitute the wholegrain wheat flour, however this part will be included in the refined wheat flour content of the dough and, at the same time, part of the wholegrain cereal flour content. Consequently, it will be included in the at least 14.5 wt % of refined wheat flour, preferably at least 29 wt %, necessary for having a processable dough. Preferably, the other wholegrain cereal flour(s) are chosen amongst wholegrain barley flour, wholegrain rye flour, wholegrain spelt flour and mixture thereof.

[0035] In one preferred embodiment, the wholegrain cereal flour comprises at most 80 wt % wholegrain wheat flour over the total weight of the wholegrain cereal flour, preferably at most 60 wt %, more preferably at most 50 wt % and still more preferably at most 32 wt %.

[0036] In a still preferred embodiment, the wholegrain cereal flour comprises four different types of wholegrain cereal flour: wholegrain barley flour, wholegrain rye flour, wholegrain spelt flour and wholegrain wheat flour.

[0037] Preferably, the wholegrain cereal flour is a multicereal flour, i.e. at least 20 wt % of the wholegrain cereal flour is not wholegrain wheat flour, preferably at least 40 wt %, more preferably at least 50 wt % and still more preferably at least 68 wt %.

[0038] When types of wholegrain cereal flour other than wholegrain wheat flour are used it is harder to obtain a final biscuit with the adequate SDS/(SDS+RDS) value over 31 wt %. This is because some types of wholegrain cereal flour such as rye, barley and spelt contain less SDS than wholegrain wheat flour.

[0039] The biscuit comprises a refined cereal flour. Preferably the refined cereal flour is selected from soft wheat flour, wheat flour with low damaged starch, and thermally treated wheat flour and mixtures thereof. Using these kinds of flour makes it possible to limit starch gelatinisation during baking. Indeed, in these flours, starch is less damaged than conventional refined wheat flour. Starch gelatinisation enables starch to be more easily digestible and thus reduces the slowly-digestible-starch content in the final product.

[0040] Soft wheat flours and hard wheat flours are both wheat flour types produced from *Triticum aestivum*. Soft wheat flours should not be confused with flours produced from *Triticum aestivum* only and hard wheat flours with flours produced from *Triticum durum*. The terms "soft" and "hard" refer to the hardness of the grains of *Triticum aestivum* used to make the flour and not to the species of wheat. The hardness of the grains is due to the density of endosperm cells. Soft wheat endosperm has a lower density, which corresponds to weaker starch and protein bonds. Consequently soft wheat grains can be crushed into finer particles than hard wheat grains and resulting in less damaged starch.

[0041] Soft wheat flours may be obtained from the milling of soft wheat, for example those commercialised under the name Crousty, Alteo, Epson (both from Syngenta) or Arkeos (from Limagrain), etc. The use of softer flours, which absorb less water, allows for the use of a wider range of added water than for harder flours. That is, even if up to 8 wt % water is used, the flour generally absorbs less of the water and the starch content is consequently less gelatinised during baking. Moreover, since less water is absorbed, there is more free water available to lubricate the dough and a processable dough can be produced even with a reduced amount of added water (around 3-4 wt %). In one embodiment, when using a soft flour, the dough may comprise up to 10 wt % added water.

[0042] Wheat flour with low damaged starch that means a flour with a content of damaged starch lower than 5.5% of the flour weight. Damaged starch content is the percentage of the starch granules that is physically damaged during the milling operation. It is measured by AACC 76-31.01 method.

[0043] Examples of thermally treated wheat flours are wheat flours treated with a number of heating and cooling cycles or annealed. Annealing is a hydrothermal treatment that changes the physicochemical properties of starches by improving crystal growth and by facilitating interactions between starch chains.

[0044] The refined wheat flour is preferably made of specifically selected milling fractions so that the flour has a very low water absorption under 55% as measured by Brabender® Farinograph® according to NF-ISO-5530-1 norm. Preferably, the selected milling fractions have a small particle size, i.e. the percentage of fine particles less than 40 μm is above 50%. Selecting milling fractions can be assisted by granulometry analysis (by laser granulometry or mesh diameter) during milling. The use of these tests is well known in the art of baking and described below.

[0045] The refined cereal flour with a water absorption under 55% as measured by Brabender® Farinograph® according to NF-ISO-5530-1 norm, preferably under 52%, represents at least 14.5 wt % of the dough, preferably at least 29 wt %. Preferably, the refined cereal flour represents at most 40 wt %, preferably at most 35 wt % of the dough.

[0046] The measure by Brabender® Farinograph® is normalised under NF-ISO-5530-1. Water absorption is defined in this norm as the quantity of water per 100 g of flour at 14 wt % water content needed to have a dough with a maximal consistency of 500 UF. Consistency is the resistance, expressed in arbitrary units (farinographic units UF), of a dough during kneading inside the Farinograph®, at a constant speed specified in the norm. First, water content of the flour is measured. Then, water is added to the flour, quantity of water being calculated so that consistency of the dough is close to 500 UF (480 UF to 520 UF). Flour and water are kneaded together and measures are recorded for two dough troughs. From these measures and the volume of water added to the flour to form the dough, water absorption is obtained.

[0047] Use of this type of flour gives the advantage that less water is needed to form the dough and thus limits gelatinisation of starch. As a consequence, a healthy biscuit is obtained.

[0048] Techniques for measuring water content are well known in the art. The water content of the flour, dough and final biscuits can be measured using the AAC 44-15.02 International Method (Moisture-air oven methods), revised 1999.

[0049] The term "fat" or "fats" means any lipid source, vegetable or animal source that is edible and can be used to make the biscuit. Examples of such fat are palm oil, rapeseed oil or other vegetable oils, butter from animal source. Preferably, the ready-to-eat biscuit has 5 wt % to 22 wt % fat, more preferably 9 wt % to 18 wt % fat, still more preferably 15 wt % to 17.5 wt %

[0050] As defined herein, "sugar" or "sugars" means the dry matter of any mono- and disaccharides, whatever the source and also by extension all the dry matter of the glucose syrup, also called glucose—fructose syrup or fructose-glucose syrup. Among monosaccharides there are fructose, galactose, glucose, mannose and mixtures thereof. Among disaccharides, there is saccharose, but saccharose may be partly or totally replaced with another disaccharide, such as lactose or maltose. Glucose syrup contains mono and disaccharides, but also some longer chains of polymerized dextrose. The biscuit obtainable with the method of the disclosure comprises at most 30 wt % sugar, and preferably at most 28 wt % sugar over the total weight of the biscuit, still more preferably at most 25 wt %. For the avoidance of doubt, when considering the amount of sugar added to a mixture in the form of a glucose syrup or other sugar suspension, only the dry weight of sugar should be considered. The water content of the syrup or suspension should be considered as part of the added water as described herein.

[0051] The most preferred amount of sugar present in the biscuit is at least 12 wt %. This is for both sensory impact and technical reasons. Without wishing to be bound by theory, it is speculated that below 12 wt % sugars the machinability of the dough is affected. In general in the dough a continuous phase is formed by the added water enriched by the soluble ingredients that are able to dissolve. Because the sugar is able to dissolve in the water it effectively increases the effective volume of the water present (1 g of sugar dissolved in 1 ml of water gives a total volume of 1.6 ml). Hence, the presence of at least 12 wt % sugars decreases the requirement to include further added water and, hence, by allowing for less water, increases the SDS value of the final biscuit.

[0052] A "Healthy biscuit" means a biscuit or a cookie with a cereal content over 50 wt % of ingredients with respect to the final product, with at least 29 wt % of wholegrain cereal flour with respect to the final product. A healthy biscuit or cookie may also comprises sugar that makes up to at most 27.5% of the total caloric value of the final product, fat that makes up to at most 35% of the total caloric value of the final product, and available carbohydrate at least 55% of the total caloric value of the final product.

[0053] The biscuit may further comprise from about 19 to about 50 wt % of further ingredients, including wholegrain cereal flakes, non-refined, non-wholegrain flour and additional ingredients, such as, emulsifiers, leavening agents, vitamins, minerals, salt, flavourings and milk or dairy ingredients, and combinations thereof. These additional ingredients are discussed in more detail below.

[0054] The biscuit may further comprise at most 34.5 wt % wholegrain cereal flakes, preferably at most 19 wt %, preferably at most 16 wt %, more preferably at most 11 wt %, still more preferably at most 9 wt %, for example wholegrain oat flakes or malted wholegrain rye flakes. An excess of flakes, i.e. over 19 wt %, will give the biscuit an unexpected appearance, i.e. the appearance of a granola biscuit and a denser product that can discourage potential consumers. When flakes are present, preferably they comprise at least about 0.9 wt % of the biscuit, since lesser amounts may not be discernable in the final product.

[0055] More generally, the biscuit part of the ready-to-eat layered cookie may comprise visible pieces of cereal whole grains. The preferred flakes are oat flakes and malted rye flakes due to the sensory impact on consumers. This also helps to increase the wholegrain content of the dough recipe without compromising on the palatability of the final biscuits. The most preferred flakes are baby oat flakes since their appearance is advantageous for the consumer and they contribute additional SDS to the biscuit that is less readily hydrolysed during baking. They remain more intact than large flakes during processing.

[0056] By way of example, some ranges of the content of different flakes are set out in the table below:

Ingredient type	Minimum % in biscuit formula	Maximum % in biscuit formula
Wheat flakes	0.9	9
Malted rye flakes	0.9	19
Baby oat flakes	3	18
Oat flakes	3	9
Barley flakes	0.9	3

[0057] The ready-to-eat biscuit can still comprise additional cereal bran and/or cereal germ. In case there are additional cereal bran and cereal germ, the bran and the germ come from different cereals chosen amongst: wheat, barley, rye, spelt, oat or a mixture thereof.

[0058] Other ingredients that can be mixed with the cereal flour and water for forming the dough are: emulsifier, leavening agents.

[0059] Emulsifier can be soybean lecithin, diacetyl tartaric ester of monyglyceride, sodium stearoyl lactylate.

[0060] Leavening agent can be ammonium bicarbonate, sodium bicarbonate, sodium pyrophosphate acid or a mixture thereof.

[0061] Other ingredients can also be vitamins or minerals such as vitamin B1, vitamin E, vitamin PP, iron and magnesium and a mixture thereof.

[0062] Still other ingredients can be salt, flavouring agents, cocoa powder, solid pieces, milk and dairy derivatives, honey.

[0063] Flavouring agents can be in powder form or liquid form.

[0064] Solid pieces may be chocolate drops, fruit pieces, nuts like hazelnut (preferably hazelnut pieces), extruded cereal, etc. Solid pieces doe not include cereal flakes. Solid pieces bring texture and flavour without increasing SAG content. The biscuit preferably comprises 4 wt % to 15 wt % solid pieces, preferably 7 wt % to 13 wt %.

[0065] Chocolate drops are pieces of solid chocolate. "Chocolate" is understood as meaning either "dark chocolate", "milk chocolate" or "white chocolate". Preferably, chocolate drops are dark chocolate pieces containing at least 35 wt % of cocoa liquor (US legislation), more preferably 35 wt % of cocoa solids (European Union legislation), still more preferably at least 40 wt %.

[0066] Within the scope of the disclosure, "fruit pieces" means pieces of any sweet, edible part of a plant that resembles fruit, for example raisin, fig, prune, orange, cranberry, blueberry, raspberry, strawberry, apricot, blackcurrant, redcurrant, peach, pear, kiwi, banana, apple, lemon, pineapple, tomato. These pieces of fruit are either dried or processed. This wording does not include nuts.

[0067] Milk and dairy derivatives can be fresh milk, milk powder, sweet whey powder, milk proteins, whey proteins, etc.

[0068] The biscuit may also comprise polyols or short-chain soluble fibres. These act in a similar way to sugars in improving the machinability of the dough without increasing the hydrolysis of the starch present in the biscuits. The use of polyols or short-chain soluble fibres allow for the provision of a sugar-free or reduced sugar biscuit. Preferably, the ingredients comprise less than 20%, preferably less than 10 wt %, preferably less than 5% of polyols or short-chain soluble fibres for gastrointestinal tolerance issues and for clean labelling. Similarly as for sugars, only the dry weight of polyols or short-chain soluble fibres should be considered. If a biscuit comprises more than 10 wt % polyols then it is considered to have laxative properties and must be labelled accordingly. Most preferably, the ingredients do not comprise polyols or short-chain soluble fibres. In one embodiment, the biscuits comprise at least 0.1 wt % polyols or short-chain soluble fibres. In one embodiment, the ingredients do not comprise guar gum or other viscous soluble fibers such as pectins, xanthan gum, *psyllium*, or glucomannan.

[0069] Due to the water loss of water naturally present in cereal flours on baking, the wt % values for the cereal content of the dough are substantially the same as the wt % values for the final biscuit.

[0070] In one embodiment, the method for producing a biscuit according to the present disclosure comprises:

[0071] mixing E**1** a cereal flour comprising at least two different types of wholegrain cereal flours with at most 8 wt % added water relative to the total weight of the dough, with fat and sugar for forming a dough **2**;

[0072] P moulding, preferably rotary moulding, E**3** the dough **2** into the shape of a biscuit **3**;

[0073] baking E**5** the biscuit **3**;

wherein the cereal flour comprises refined cereal flour, preferably refined wheat flour, the refined cereal flour representing at least 14.5 wt % of the dough, preferably at least 29 wt %, with a water absorption under 55% as measured by Brabender® Farinograph® according to NF-ISO-5530-1 norm, preferably under 52%.

[0074] Mixing E**1** is preferably carried out in a horizontal mixer with double jacket. Mixing phases are adjusted so that water content is controlled. Preferably, the temperature of the dough is 15° C. to 35° C., more preferably 15° C. to 30° C. during mixing.

[0075] With conventional rotary moulding apparatuses, it is difficult and sometime not possible to process such granular dough. Therefore, a new specific rotary moulder was designed for the rotary moulding step. Nevertheless, other moulding techniques may be used, although these are less preferred.

[0076] This specific rotary moulder **1** (as illustrated in FIG. **2**) comprises:

[0077] a moulding cylinder **11** and a grooved cylinder **12** for shaping the dough **2** into the biscuit **3**; and, optionally,

[0078] a hopper **13** playing the role of a funnel to help feed the moulding and grooved cylinders **11**, **12**; and/or

[0079] a demoulding belt **14** for demoulding the biscuit **3**.

[0080] The moulding cylinder **11** has mould cavities for receiving the dough **2**. The mould cavities will give the dough **2** the shape of the biscuits **3**. The grooved cylinder **12** preferably comprises grooves of 5 to 15 mm, preferably 10 mm±50% to allow sufficient stickiness of the dough without crushing inclusions like flakes and solid pieces, and during operation presses the dough **2** that is received inside the mould cavities of the moulding cylinder **11** so that the dough completely filled the mould cavities and take the shape thereof. The grooved cylinder **12** preferably is mounted on a horizontal axis and can be adjusted thereon to vary the compression force applied to the dough **2**. High compression should be used since the dough **2** lacks continuity, thus, cohesive dough pieces would be demouldable and transferrable from the demoulding belt **14** to the oven belt that drives the uncooked biscuit **3** into the oven for baking.

[0081] The difference of speed between the grooved cylinder **12** and the moulding cylinder **11** is preferably maintained less than 10% so that the formation of the biscuit **3** is not impaired. Indeed, a higher differential between both rotation speed of the moulding cylinder **11** and the grooved cylinder **12** will induce a shear stress on the dough that will not be able to be pressed onto the mould cavities but will rather be spread and less packed between the circumferential faces of the moulding cylinder **11** and the grooved cylinder **12**.

[0082] The level of dough **2** in the hopper **13** can be preferably controlled so that it is minimal and that the moulding and grooved cylinders **11**, **12** are nearly visible. The aim is to prevent the dough from compacting and thus, ensure regular feeding of the moulding cylinder along the width of the belt. The dough has to be the least packed as possible.

[0083] A cutter **15**, with its tip **151** under the axis line AA of the moulding and grooved cylinders **11**, **12**, preferably cuts the dough **2** at the top of the mould cavities. The cutter **15** determines the quantity of dough **2** to remain inside the mould cavities, and makes it possible to adjust the weight of the dough pieces therein. Each dough piece forming an uncooked biscuit preferably weighs 0.5 gram to 40 grams, more preferably 1 to 35 grams, still more preferably 1 to 30 grams.

[0084] The demoulding belt **14**, preferably made from cotton and/or polyamide, has weft with suitable dimension for extracting dough pieces drier than conventional dough, i.e. granular dough. The demoulding belt **14** is preferably mounted on at least two cylinders **16**, **17**, one of which, generally a rubber cylinder **16**, presses the moulding cylinder **11**. Upon pressure of the rubber cylinder **16** onto the moulding cylinder **11**, the dough pieces lying inside the mould cavities adhere to the demoulding belt **14** and are transported towards the oven for baking.

[0085] The rotary moulder **1** may further comprise a humidifier **18** for the demoulding belt **14**, for example the humidifier **18** is a steaming device or a water-spraying device.

[0086] This rotary moulder **1** can be used for producing other type of biscuits, such as biscuits from a granular dough comprising at least cereal flour and water. A granular dough means a non-cohesive or non-continuous dough like shortbread dough or crumble dough.

[0087] The resting time of the resting step E**2** of the dough **2** before forming should be limited to avoid high drying of the dough **2**, which would require the addition of further water and thus would impede SAG content by triggering starch gelatinisation.

[0088] Before baking E**5**, the biscuits **3** can be glazed so that they gain a shiny appearance. Therefore, the method can comprise an optional additional step of glazing E**4** the shaped biscuit **3**. The biscuit **3** can be glazed with an aqueous glazing, preferably comprising milk powder and/or icing sugar and/or buffering agent such as sodium bicarbonate, sodium hydroxide. Preferably, the glazing E**4** comprises skimmed milk powder. Still preferably, the glazing preferably comprises starchy icing sugar, i.e. sucrose natural sweetener characterised by its fine granulometry obtained by milling crystal sugar and added with starch as an anti-agglomerating agent.

[0089] Baking E**5** is preferably carried out until the moisture content of the baked biscuit (final product) is 0.5 wt % to 5.0 wt %, for example by gentle baking (i.e. baking temperature is below 110° C. inside the biscuit during the first third time of the baking—if baking time is 7 min, during 2 min 20 s.—and preferably below 100° C.).

[0090] After baking, the baked biscuits are cooled down E**6** on an open belt, i.e. a belt that is not covered, a cooling tunnel is preferably not used because there is a too much temperature differential between the input and the output, what causes checking (failure) in the biscuit. The biscuits are then packaged E**7**, for example biscuits are packaged into wrappers containing 50 g of biscuits and the wrappers are gathered in a packet that is designed to contain 6, 8 or 12 wrappers. Preferably, the biscuits can be packaged in wrappers so that one wrapper contains one serving.

[0091] The water content of the final biscuit is preferably less than 3 wt % and preferably between 1 and 2 wt % of the final biscuit following baking.

[0092] The low water content helps to provide a long-term shelf stable product. For example, the present biscuits and sandwich-biscuits may be kept at 20-25° C. for up to one year while remaining edible. Shelf-life studies based on sensory expert panel evaluation have been conducted. It was found that the full sensory profile was maintained for up to 7 months to one year depending on the ingredients. Nevertheless, the edibility of the biscuits extended at least up to the one year mark.

[0093] The disclosure also concerns a ready-to-eat biscuit obtainable by the method described above. Preferably, the biscuit further comprises at least 30 wt % total starch over the total weight of the biscuit.

[0094] The disclosure further concerns a cookie comprising a biscuit part and a filling part, the biscuit part including at least one biscuit as described above. This cookie can be a filling over biscuit type biscuit, the biscuit being produced with the method described above and the filling being layered on the biscuit before or after baking.

[0095] This cookie can still be a sandwich cookie, i.e. a cookie wherein a layer of filling lies between two layers of biscuits, the biscuits being distinct. The biscuits are produced with the method described above. The sandwich cookie is most commonly assembled after baking the biscuits.

[0096] The filling part of the cookie can still be at least partly enclosed by the biscuit part. In this latter case, the biscuit part builds a continuous biscuit and comprises a cavity therein for receiving the filling part. The cookie can still be formed in more than one step, with the biscuit part formed with its cavity therein and the filling part being injected into the cavity before or after baking the biscuit part.

[0097] The disclosure will now be described in relation to the figures, provided by way of non-limiting example, in which:

[0098] FIG. **1** is a flowchart showing the different steps of the preferred embodiment of method of the disclosure; and

[0099] FIG. **2** is a schematic representation of a rotary moulder as used for the method of the disclosure.

[0100] As a key to FIG. **1**:

[0101] E**1**: Mixing the ingredients

[0102] E**2**: Resting the dough

[0103] E**3**: Rotary moulding the dough into biscuits

[0104] E**4**: Glazing the biscuits

[0105] E**5**: Baking the biscuits

[0106] E**6**: Cooling the biscuits

[0107] E**7**: Packaging the biscuits

[0108] The disclosure will now be described in relation to the following non-limiting examples.

EXAMPLE 1

[0109] A plain Cocoa biscuit was prepared. The biscuit has the following composition (in percentage of the final biscuit):

dough ingredients	115.41 wt %
glazing ingredients	1.69 wt %
water removal	−17.10 wt %
total	100 wt %

[0110] More particularly, biscuits are produced from dough formed with the following recipes:

Ingredient	Wt % in dough	Wt % in Biscuit
Refined soft wheat flour	29.4	29.2
Wheat bran and germ	3.0	3.1
Whole grain spelt flour	0.91	0.90
Whole grain rye flour	2.9	2.9
Whole grain barley flour	5.6	5.5
Whole grain oat flakes	7.7	7.8
SUGARS	16.5	19.0
FAT	10.2	11.8
ADDED WATER	7.6	2.0
Cocoa powder	3.0	3.3
Chocolate drop	11.3	13.0
Flavouring powder	0.27	0.31
Emulsifier	0.33	0.38
Salt	0.25	0.29
Leavening agents	0.80	0.18
Vitamin and mineral lend	0.16	0.18
Total	100.0	100.0
Relative total wt % after baking	86.8	

(amounts are expressed in percentage with respect to the weight of, respectively, final biscuit and unbaked dough)

[0111] Wholegrain wheat flour is reconstituted from:

	final biscuit	unbaked dough
refined soft wheat flour	16.87 wt %	14.62 wt %
wheat bran and germ	3.45 wt %	2.99 wt %
total wholegrain wheat flour	20.32 wt %	17.61 wt %.

[0112] The water absorption measured by Brabender® Farinograph® of the refined wheat flour is 52%.

[0113] The ingredients of the dough are mixed together in a horizontal mixer until the dough gets a homogenised consistency. Then the dough is rested for 30 minutes. After resting, the dough is fed into the hopper of the rotary moulder for forming the biscuits. The dough is fed so that the moulding and grooved cylinders of the rotary moulder are nearly visible. The speed differential of the moulding and grooved cylinder is kept below 10%. The biscuits are then glazed with a glazing that comprises (in weight percentage of the final biscuit):

water	1.48 wt %
skimmed milk powder	0.169 wt %
starchy icing sugar	0.0425 wt %.

[0114] After glazing the biscuits are driven to the oven for baking for about 7 min. During baking the temperature of the dough remains under 160° C. At the end of baking the water content is about 2.0 wt %.

[0115] When the biscuits are taken out from the oven, they are allowed to cool down on open belts until the temperature of the biscuits is below 30° C.

[0116] The biscuit comprises 57.15 wt % cereal ingredients, more in particular 31.19 wt % wholegrain cereal flour representing 64.55% of the total cereal flour. The biscuit has 17.1 wt % fat and 27.1 wt % sugar. Fat represents 35% of the total caloric value of the biscuit, while carbohydrate represents 58% and more precisely, sugar represents 24%. The biscuit has a SDS/(RDS+SDS) ratio of 40.75% and 16.3 g SAG/100 g biscuit. The biscuit has a starch content of 36.5 wt %.

EXAMPLE 2

[0117] The biscuit has the following composition (in percentage of the final biscuit):

dough ingredients	112.46 wt %
glazing ingredients	1.69 wt %
water removal	−14.15 wt %
total	100 wt %

[0118] More particularly, biscuits are produced from dough formed with the following recipes:

Ingredient	Wt % in dough	Wt % in Biscuit
Refined soft wheat flour	32.3	31.1
Wheat bran and germ	3.1	3.1
Whole grain spelt flour	0.89	0.86
Whole grain rye flour	3.1	3.0
Whole grain barley flour	4.4	4.2
Whole grain oat flakes	9.5	9.5
SUGARS	16.6	18.6
FAT	12.2	13.6
ADDED WATER	4.5	1.5
Honey (dry)	4.5	4.9
Chocolate drop	7.7	8.6
Flavouring powder	0.29	0.32
Emulsifier	0.15	0.17
Salt	0.26	0.29
Leavening agents	0.44	0.10
Vitamin and mineral lend	0.15	0.17
Total	100.00	100.00
Relative total wt % after baking	89.3	

(amounts are expressed in percentage with respect to the weight of, respectively, final biscuit and unbaked dough).

[0119] Wholegrain wheat flour is reconstituted from:

	final biscuit	unbaked dough
refined soft wheat flour	16.83 wt %	14.97 wt %
wheat bran and germ	3.45 wt %	3.07 wt %
total wholegrain wheat flour	20.28 wt %	18.04 wt %.

[0120] The water absorption value measured by Brabender® Farinograph® of the refined wheat flour is 53%.

[0121] The ingredients of the dough are mixed together in a horizontal mixer until the dough gets a homogenised consistency. Then the dough is rested. After resting, the dough is fed into the hopper of the rotary moulder for forming the biscuits.

[0122] The dough is fed so that the moulding and grooved cylinders of the rotary moulder are nearly visible. The speed differential of the moulding and grooved cylinder is kept below 10%. The biscuits are then glazed with a glazing that comprises (in weight percentage of the final biscuit):

water	1.47 wt %
skimmed milk powder	0.170 wt %
starchy icing sugar	0.040 wt %.

[0123] After glazing the biscuits are driven to the oven for baking for about 7 min. During baking the temperature of the dough remains under 160° C. and the water content decreases until it reaches about 1.5 wt %.

[0124] When the biscuits are taken out from the oven, they are allowed to cool down on open belts until the temperature of the biscuits is below 30° C.

[0125] The biscuit comprises 56.4 wt % cereal ingredients, more in particular 29.66 wt % wholegrain cereal flour representing 60.34% of the total cereal flour. The biscuit has 17.24 wt % fat and 24.56 wt % sugar. Fat represents 34% of the total caloric value of the biscuit, while carbohydrate represents 60% and more precisely, sugar represents 22%. The biscuit has a SDS/(RDS+SDS) ratio of 44.18% and 18.6 g SAG/100 g biscuit. The biscuit has a starch content of 38.1 wt %.

[0126] Unless otherwise stated, the percentage values recited herein are by weight and, where appropriate, by weight of the final biscuit.

[0127] Although preferred embodiments of the disclosure have been described herein in detail, it will be understood by those skilled in the art that variations may be made thereto without departing from the scope of the disclosure or of the appended claims.

We claim:

1. A method for producing a ready-to-eat biscuit comprising at least 29 wt % wholegrain cereal flour, 5 wt % to 22 wt % fat, and at most 30 wt % sugar relative to the total weight of the biscuit, wherein the slowly-digestible-starch-over-total-available-starch ratio of the biscuit is at least 31 wt %, the method comprising:

mixing a cereal flour comprising the wholegrain cereal flour with fat and sugar and at most 8 wt % added water relative to the total weight of the dough, to form a dough;

moulding the dough into the shape of a biscuit;

baking the biscuit;

wherein the cereal flour comprises refined cereal flour in an amount of at least 14.5 wt % of the dough and wherein the refined cereal flour has a water absorption under 55% as measured by Brabender® Farinograph® according to NF-ISO-5530-1 norm.

2. The method of claim **1**, wherein the biscuit has a slowly available glucose value of at least 15.0 g/100 g of biscuit.

3. The method of claim **1**, wherein the wholegrain cereal flour comprise at least two different types of wholegrain cereal flour.

4. The method of claim **1**, wherein the refined cereal flour is a refined wheat flour.

5. The method according to claim **4**, wherein the refined wheat flour is selected from soft wheat flour, wheat flour with low damaged starch and thermally treated wheat flour, including combinations of two or more thereof.

6. The method of claim **1**, wherein the moulding is rotary moulding.

7. The method of any claim **6**, wherein rotary moulding is performed with a rotary moulder comprising:

(i) a moulding cylinder and a grooved cylinder for shaping the dough into the biscuit, the moulding cylinder receiving the dough and the grooved cylinder with grooves of 5 to 15 mm, preferably 10 mm, pressing the dough in the moulding cylinder; and, optionally

(ii) a hopper playing the role of a funnel for feeding the moulding and grooved cylinders; and/or

(iii) a demoulding belt for demoulding the biscuit;

wherein the difference of speed between the grooved cylinder and the moulding cylinder is preferably maintained under 10%.

8. The method of claim **7**, wherein the rotary moulder further comprises a humidifier for the demoulding belt.

9. A ready-to-eat biscuit obtainable by the method of claim **1**, the ready-to-eat biscuit comprising at least 29 wt % wholegrain cereal flours, 5 wt % to 22 wt % fat, and at most 30 wt % sugar over the total weight of the biscuit, wherein the slowly-digestible-starch-over-total-available-starch ratio of the biscuit is at least 31 wt %.

10. The biscuit of claim **9**, further comprising at least 30 wt % total starch over the total weight of the biscuit.

11. The biscuit of claim **9**, wherein the wholegrain cereal flour comprises at least two different types of wholegrain cereal flours.

12. The biscuit according to claim **9**, wherein the wholegrain cereal flour comprises wholegrain wheat flour and at least one wholegrain cereal flour selected from wholegrain barley flour, wholegrain rye flour, wholegrain spelt flour and wholegrain oat flour, including combinations of two or more thereof.

13. The biscuit of claim **12**, wherein the wholegrain wheat flour represents at most 80 wt % of the wholegrain cereal flour.

14. The biscuit of claim **11**, wherein the wholegrain cereal flour comprises wholegrain barley flour, wholegrain rye flour, wholegrain spelt flour and wholegrain wheat flour.

15. The biscuit of claim **9**, wherein the biscuit further comprises wholegrain cereal flakes and wherein the amount of wholegrain cereal flakes is preferably at most 11 wt % relative to the total weight of the biscuit.

16. The biscuit of claim **9**, comprising 9 wt % to 18 wt % fat relative to the total weight of the biscuit; and/or at most 27 wt % sugar relative to the total weight of the biscuit.

17. A cookie comprising a filling part and a biscuit part including at least one biscuit according to claim **9**.

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