



(86) Date de dépôt PCT/PCT Filing Date: 2009/10/08  
(87) Date publication PCT/PCT Publication Date: 2010/05/04  
(45) Date de délivrance/Issue Date: 2013/03/05  
(85) Entrée phase nationale/National Entry: 2009/12/30  
(86) N° demande PCT/PCT Application No.: US 2009/059916  
(30) Priorité/Priority: 2008/11/04 (US12/264,404)

(51) Cl.Int./Int.Cl. *A21D 6/00* (2006.01),  
*A23L 1/10* (2006.01), *A23L 2/38* (2006.01),  
*A23L 2/52* (2006.01)

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CUISEUR EN CONTINU

(54) Title: SOLUBLE OAT OR BARLEY FLOUR AND METHOD OF MAKING UTILIZING A CONTINUOUS COOKER

(57) **Abrégé/Abstract:**

Preparing soluble oat or barley flour in one-step using an extrusion (continuous cooking) process to dextrinize and gelatinize cook the oat or barley flour.



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau(43) International Publication Date  
14 May 2010 (14.05.2010)(10) International Publication Number  
**WO 2010/053651 A1**

## (51) International Patent Classification:

A23L 1/00 (2006.01)      A23L 2/52 (2006.01)  
A23L 1/10 (2006.01)      A23P 1/12 (2006.01)  
A23L 1/164 (2006.01)

## (21) International Application Number:

PCT/US2009/059916

## (22) International Filing Date:

8 October 2009 (08.10.2009)

## (25) Filing Language:

English

## (26) Publication Language:

English

## (30) Priority Data:

12/264,404      4 November 2008 (04.11.2008)      US

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(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, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, 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, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (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, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

## Published:

— with international search report (Art. 21(3))

WO 2010/053651 A1

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(57) Abstract: Preparing soluble oat or barley flour in one-step using an extrusion (continuous cooking) process to dextrinize and gelatinize cook the oat or barley flour.

**SOLUBLE OAT OR BARLEY FLOUR AND METHOD OF MAKING  
UTILIZING A CONTINUOUS COOKER**

**FIELD OF THE INVENTION**

**[0001]** The present invention relates generally to soluble oat or barley flour. More specifically, the present invention relates to methods of making soluble oat or barley flour.

**BACKGROUND**

**[0002]** Oatmeal has for many years been a staple of the human diet due to its health benefits. For example, numerous studies have shown that eating oatmeal on a daily basis can help lower blood cholesterol, reduce risk of heart disease, promote healthy blood flows as well as maintain healthy blood pressure levels. Additionally, oatmeal has high content of complex carbohydrates and fibers, which facilitates slow digestion and stable blood-glucose levels.

**[0003]** With today's hectic lifestyle, consumers are demanding convenience, such as portability and ease of preparation. Consumers desire oatmeal from a variety of food sources including beverages, and convenience foods such as bars, cookies, crackers, smoothies, and the like.

**[0004]** It is desired to prepare a whole oat product that has sufficient soluble fiber to meet the FDA threshold necessary to justify a health claim. For example, a whole oat product must have 0.75 g soluble beta-glucan fiber per serving of food. To prepare an oat beverage that contains at least 0.75 g soluble oat fiber per serving (about 18 g of whole grain oats), highly soluble oat flour must be used. Traditionally, highly soluble flour is prepared using enzymes such as  $\alpha$ -amylase. The enzyme-treated oat flour is then drum or spray dried. This method takes place in at least two steps and is traditionally expensive and produces the soluble oat flour in low rates. For example, a slurry batch is prepared of flour (oat) and water (70-90% moisture content). Enzyme (s) are then added to the slurry and held at optimum enzyme reaction conditions followed by enzyme deactivation process. The slurry is then transferred into either a spray or drum drier. More efficient processes are desired to prepare the oatmeal product.

**[0005]** Likewise, barley has become a desired staple of the human diet for health reasons and suitable means to process and prepare barley containing products is desired.

#### SUMMARY

**[0006]** Aspects of the present invention relate to preparing soluble oat or barley flour in one-step using an extrusion (continuous cooking) process to gelatinize and dextrinize the oat flour.

**[0007]** These and other aspects, along with advantages and features of the present invention herein disclosed, will become apparent through reference to the following description. Furthermore, it is to be understood that the features of the various embodiments described herein are not mutually exclusive and can exist in various combinations and permutations.

**[0007.1]** According to one aspect of the present invention there is provided a method of producing a soluble whole oat or barley flour comprising forming a whole oat or barley flour starting mixture comprising whole oat or barley flour, granulated sugar, and at least one antioxidant; hydrating the starting mixture to a moisture content of 25 to 35 wt% and heating to a temperature of 140 to 160 F; adding the hydrated heated whole oat or barley flour starting mixture in an extruder; gelatinizing and dextrinizing the whole oat or barley flour by mechanical action and heating of the extruder to form extruded pellets; dehydrating the extruded pellets and granulating to form the soluble whole oat or barley flour having a size of 50 to 250 microns.

**[0007.2]** According to a further aspect of the present invention there is provided a method for preparing a beverage containing a soluble whole oat or barley flour comprising: forming a whole oat or barley flour starting mixture comprising whole oat or barley flour, granulated sugar, and at least one antioxidant; hydrating the starting mixture to a moisture content of 25 to 35 wt% and heating to a temperature of 140 to 160 F; adding the hydrated heated whole oat or barley flour starting mixture in an extruder; gelatinizing and dextrinizing the whole oat or barley flour by mechanical action and heating of the extruder to form extruded pellets; dehydrating the extruded pellets and granulating to form the soluble whole oat or barley flour having a size of 50 to 250 microns; and adding the soluble oat flour to a beverage.

**[0007.3]** According to another aspect of the present invention there is provided a method for preparing a food product containing a soluble whole oat or barley flour comprising: forming a whole oat flour starting mixture comprising whole oat or barley flour, granulated sugar, and at least one antioxidant; hydrating the starting mixture to a moisture content of 25 to 35 wt% and heating to a temperature of 140 to 160 F; adding the hydrated heated whole oat or barley flour starting mixture comprising whole oat or barley flour, granulated sugar, and at least one antioxidant in an extruder; gelatinizing and dextrinizing the whole oat or barley flour by mechanical action and heating of the extruder to form extruded pellets; dehydrating the extruded pellets and granulating to form the soluble whole oat or barley flour having a size of 50 to 250 microns; and adding the soluble oat flour to a mixture for a food product.

#### DETAILED DESCRIPTION

**[0008]** The present invention relates to soluble oat or barley flour and a method of producing soluble oat or barley flour using a continuous cooker to gelatinize and dextrinize whole oat or barley flour in one step. The process is easier, less expensive, and less time-consuming than prior art processes.

**[0009]** A starting mixture is prepared containing whole oat or barley flour, granulated sugar, optionally a maltodextrin, and at least one antioxidant.

**[0010]** The whole oat or barley flour is present in an amount of about 50% to about 100% by weight of the total weight of the starting composition. In further aspects, the whole oat or barley flour is present in amounts of about 80 % to about 100% by weight or about 90% to about 95% by weight.

**[0011]** The sugar can be any suitable sugar known to those skilled in the art. Non-limiting examples of sugars include sucrose, fructose, dextrose, other sugars known in the art, and combinations thereof. Typically, the sugar is present in an amount of about 0 to about 15% by weight of the total weight of the starting composition. In further aspects, the sugar is present in amounts of 0 to about 7% by weight.

**[0012]** The maltodextrin may be present in an amount of about 0% to about 15% by weight of the total weight of the starting composition. In further aspects, the maltodextrin is present in amounts of about 3% to about 7% by weight.

**[0013]** The antioxidant may be any suitable antioxidant such as mixed natural tocopherols or artificial antioxidant such as BHT and BHA. The antioxidant is present in an amount from 0.1 % to 2 % by weight. In further aspects, the antioxidant is present in amounts of about 0.25 % to about 0.75 % by weight.

**[0014]** The mixture may be pre-hydrated in a preconditioner prior to extrusion. It is well known in the industry that pre-conditioners can aid in reducing the required mechanical power of the extruder to cook the mixture. The pre-conditioner will give an overall increase in throughput. In the pre-conditioner, water or steam is added to increase the moisture content of the mixture to about 25 to about 35%, more specifically about 28 to about 30%. The mixture's overall temperature is increased to about 140 °F - 160 °F prior to extrusion. The mixture has the characteristics of a uniform free flowing wetted material prior to extrusion.

**[0015]** Starch gelatinization requires water and heat. The gelatinization temperature range for oats is 127 °F to 138 °F (53 – 59 °C). If the moisture is less than about 60% then higher temperatures are required. Typically the extrusion occurs at barrel temperatures between 140 °F and 250 °F. The dough temperatures are approximately 212 °F and 260 °F.

**[0016]** The mixture is fed into the extruder. Any suitable extruder may be used including suitable single screw or twin screw extruders. Typical, but not limiting, screw speeds are 200-300 rpm.

**[0017]** For example, a hydrated mixture at a temperature of about 140 °F - 160 °F is fed into a low-shear cooking extruder. Low-shear cooking extrusion is defined by a moisture range of 20 to 35%, a shear rate range of 20 to 100 s<sup>-1</sup>, mechanical energy input of 0.02 to 0.05 kw-hr/kg and maximum dough temperature less than or equal to 150°C.

Extrusion of Foods by Judson M. Harper CRC Press 1980

**[0018]** Heat may be applied through the extruder barrel wall such as with a jacket around the barrel through which a hot medium like steam, water or oil is circulated, or electric heaters imbedded in the barrel. Heat is also generated within the material by

friction as it moves within the extruder. Shear is controlled by the design of the extruder screw(s) and the screw speed. Viscosity is a function of starch structure, temperature, moisture content, fat content and shear. The shear stresses and heat applied in the extruder to the starches, especially the amylopectin, reduce their average molecular weight.

**[0019]** The extruded dough exits the cooking extruder. As it exits, water immediately evaporates cooling the dough and dropping its moisture content into the 25 to 30% range. The dough is then fed into a second forming extruder where it is further cooled below the boiling point of water, forced through a die opening and cut into pellets. The 25 to 30% moisture pellets are then transported to a pellet drier and de-hydrated to approx 7-10% moisture; specifically 8-9%. The pellets may then be granulated. Granulation specifications can be widened. 50-250 microns. Specifically, targeting 178-250 micron; maximizing 212 microns

**[0020]** The granulated product may be used in beverages such as ready-to-drink beverages, fruit juices, dairy beverages, and carbonated soft drinks, and various food products such as bars, cereals, puddings, smoothies, powdered beverages, cookies, crackers, and the like. The soluble oat flour can also be used to make soft food products such as ice cream and soft yogurt. This list is not all-inclusive and one skilled in the art would recognize that the soluble oat flour may be added to other beverages and food products in accordance with the invention.

**[0021]** A beverage, for example, contains from about 1% to about 25% soluble oat or barley flour and from about 70% to about 95% total water, typically about 75% to about 90%, by weight of the total beverage. The balance can contain sweeteners, flavors, fruits and other materials as desired.

**[0022]** The water should be suitable for use in food. The total water may come in part or in whole from other parts of the drinkable food, especially if milk, juices, or other water containing components are used. For instance, the milk may be dairy (e.g. whole, 2%, 1%, or non-fat) or non-dairy (e.g. soy). The milk may also be produced from powdered milk and water.

**[0023]** The beverage may also include a fruit component. The fruit component can include fruit juice, yogurt containing fruit, fruit puree; fresh fruit, fruit preserves, fruit

sorbet, fruit sherbet, dried fruit powder, and combinations thereof. Typically, the fruit component has particles sufficiently small that the component may be safely swallowed without chewing. The fruit component and/or an added acidulant can be adjusted to obtain a desired pH, for example a pH of less than about 4.6.

[0024] Food products include cereals and ready-to-eat snack bars. A suitable amount of the granulated product is added to the food mixture.

[0025] Additional ingredients may be added to the beverage and food products. Such ingredients can include non grain-based ingredients. For example, flavoring agents, coloring agents, sweeteners, salt, as well as vitamins and minerals can be included. In one embodiment of the invention, flavoring agents such as strawberry, chocolate or cinnamon flavor is added to enhance the taste of product. Other fruit flavoring agent may also be useful to provide different tastes to the food product, for example, strawberry, mango and banana and mixtures thereof. Spices, in particular, cinnamon, can be used. In addition, any desired flavor or flavors can be used. Suitable sweeteners - artificial or natural can be added in the food product to provide a desired sweetness. For example, brown sugar, maple sugar or fruit sugar can be used. The non-grain based food component can be added in the range of about 10 to 75 wt % of the total weight of the product.

[0026] Other optional ingredients, but are not limited to, salt, hydrocolloids, polysaccharides, thickeners, caffeine, dairy, coffee solids, tea solids, herbs, nutraceutical compounds, electrolytes, vitamins, minerals, amino acids, preservatives, alcohol, colorants, emulsifiers, and oils as known in the art.

[0027] The soluble oat or barley flour includes beta glucan soluble fiber, such as beta-1, 3-glucan, beta-1, 6-glucan, or beta-1, 4-glucan or mixtures thereof. In addition to beta glucan naturally present in the oats, beta glucan may also be added as approved by the FDA. In certain embodiments, the oat flour preferably contains at least about 3% to 5% or about 3.7% to 4% beta glucan. In certain embodiments, the oat flour containing liquid product contains 0.1% to about 1.5% beta glucan, or about 0.8% to 1.3% beta glucan. Other amounts of beta glucan are also useful.

WO 2010/053651

PCT/US2009/059916

**[0028]** As described, the present invention provides a healthy drinkable food product which is easy and quick to prepare while convenient to consume on-the-go, making it especially appealing to consumers with today's hectic lifestyle.

**[0029]** Example 1

**[0030]** A flour mix formula for extrusion process

<b>Ingredient</b>	<b>%</b>
Whole oat flour	86.5
Sugar	5
Maltodextrin	5
Mixed tocopherols	0.5
Waxy corn starch	3
<b>Total</b>	<b>100.00</b>

**[0031]** Example 2

**[0032]** A cracker formula is typically made from whole wheat flour or wheat gluten. Instead the formula would be replaced with this hydrolyzed oat flour to improve nutritional benefits (heart health) as well as provide adequate strength to the dough be sheeted and cut into crackers. The formula would include:

Modified corn starch	10.00
Oat flour, Hydrolyzed	48.00
Oat flakes, old fashioned	17.00
Brown sugar, free-flowing	12.00
Malt powder, Briess #10001	4.00
Lecithin, powdered, Centrolex F	2.00
Sodium aluminum phosphate	0.80
Sodium bicarbonate	0.70
Salt, flour	0.60
Corn Oil, with TBHQ, ADM	5.00
<b>Total</b>	<b>100.00</b>

**[0033]** Example 3

**[0034]** A formula for oat ice cream

<b>Ingredient</b>	<b>%</b>
2% Milk	87.0
Oat flour, hydrolyzed	6.5
Sugar	5.4
Cocoa powder	0.8
Flavor	0.2

Modified starch	0.1
<b>Total</b>	<b>100.0</b>

**[0035]** The scope of the claims should not be limited by the preferred embodiments set forth in the examples, but should be given the broadest interpretation consistent with the description as a whole.

**WHAT IS CLAIMED IS:**

1. A method of producing a soluble whole oat or barley flour comprising forming a whole oat or barley flour starting mixture comprising whole oat or barley flour, granulated sugar, and at least one antioxidant;  
hydrating the starting mixture to a moisture content of 25 to 35 wt% and heating to a temperature of 140 to 160 F;  
adding the hydrated heated whole oat or barley flour starting mixture in an extruder;  
gelatinizing and dextrinizing the whole oat or barley flour by mechanical action and heating of the extruder to form to form extruded pellets;  
dehydrating the extruded pellets and granulating to form the soluble whole oat or barley flour having a size of 50 to 250 microns
2. The method of claim 1 wherein the whole oat or barley flour starting mixture further comprises maltodextrin.
3. The method of claim 1 wherein the whole oat flour or barley starting mixture comprises about 50 to about 95 wt% whole oat or barley flour, about 3 to about 15 wt% granulated sugar, 0 to about 15 wt% maltodextrin, and an effective amount of at least one antioxidant.
4. The method of claim 3 wherein the whole oat flour or barley starting mixture comprises about 80 to about 95 wt% whole oat or barley flour.
5. The method of claim 3 wherein the whole oat flour or barley starting mixture comprises about 90 to about 95wt% whole oat or barley flour.
6. The method of claim 1 wherein the extruder is heated to a barrel temperature of about 140°F to about 250°F.

7. The method of claim 1 wherein the extruding occurs at a dough temperature of about 212 °F to about 260 °F.
8. The method of claim 1 wherein the starting mixture is hydrated with water or steam.
9. The method of claim 1 wherein prior to adding the starting mixture to the extruder, heating the mixture to about 140°F to about 250°F.
10. A method for preparing a beverage containing a soluble whole oat or barley flour comprising:
  - forming a whole oat or barley flour starting mixture comprising whole oat or barley flour, granulated sugar, and at least one antioxidant;
  - hydrating the starting mixture to a moisture content of 25 to 35 wt% and heating to a temperature of 140 to 160 F;
  - adding the hydrated heated whole oat or barley flour starting mixture in an extruder;
  - gelatinizing and dextrinizing the whole oat or barley flour by mechanical action and heating of the extruder to form extruded pellets;
  - dehydrating the extruded pellets and granulating to form the soluble whole oat or barley flour having a size of 50 to 250 microns; and
  - adding the soluble oat flour to a beverage.
11. The method of claim 10 wherein the beverage is selected from the group consisting of fruit juices, dairy beverages, and carbonated soft drinks.
12. The method of claim 10 wherein the soluble oat or barley flour is added to provide a beverage having 1 to 25% soluble fiber based on total weight of the beverage.
13. A beverage prepared in accordance with the method of claim 10.

14. A method for preparing a food product containing a soluble whole oat or barley flour comprising:

forming a whole oat flour starting mixture comprising whole oat or barley flour, granulated sugar, and at least one antioxidant;

hydrating the starting mixture to a moisture content of 25 to 35 wt% and heating to a temperature of 140 to 160 F;

adding the hydrated heated whole oat or barley flour starting mixture comprising whole oat or barley flour, granulated sugar, and at least one antioxidant in an extruder;

gelatinizing and dextrinizing the whole oat or barley flour by mechanical action and heating of the extruder to form extruded pellets;

dehydrating the extruded pellets and granulating to form the soluble whole oat or barley flour having a size of 50 to 250 microns; and

adding the soluble oat flour to a mixture for a food product.

15. The method of claim 14 wherein the food product is selected from the group consisting of bars, cereals, puddings, smoothies, ice cream, cookies, and crackers.