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AREPAS Y TORTILLAS MEDIANTE UNA PRECOCCION ENZIMATICA

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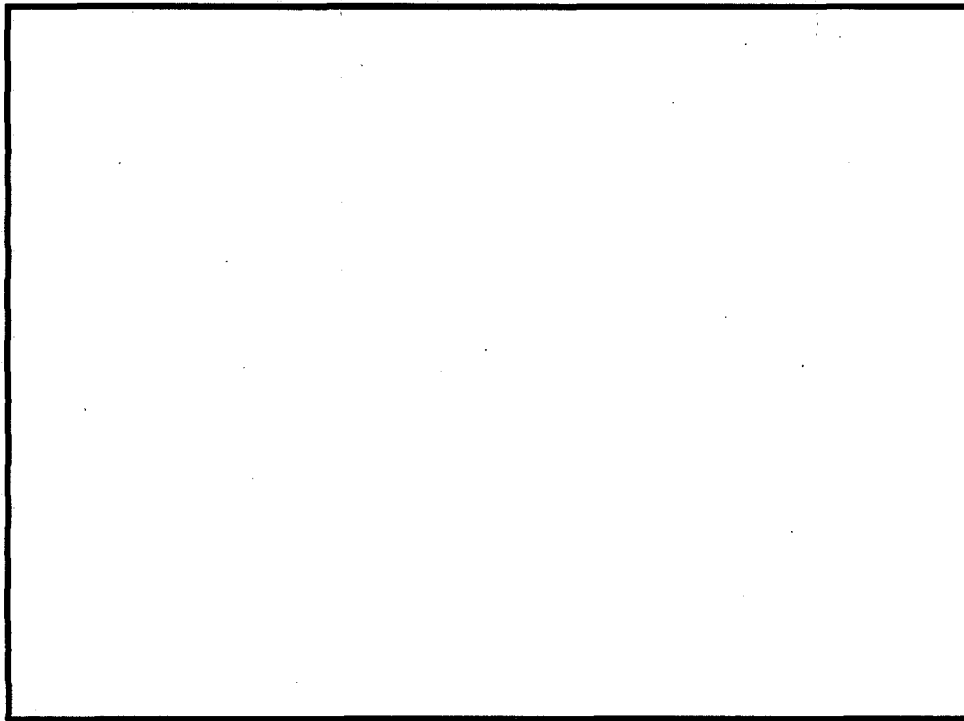
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ANEXOS

- ☒ Comprobante de pago de la tasa de presentación de la solicitud. \$422.000
- ☐ Documento que acredita la existencia y representación legal cuando el solicitante sea persona jurídica.
- ☒ Poderes, si fuere el caso. **Fotocopia autenticada**
- ☐ Documento de cesión del inventor al solicitante o a su causante.
- ☐ Declaraciones
- ☒ Copia de la solicitud internacional. (Resumen, descripción, reivindicaciones, dibujos)
- ☒ Traducción de la solicitud internacional al castellano. (Resumen, descripción, reivindicaciones, dibujos)
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- ☐ De ser el caso, certificado de depósito del material biológico.
- ☐ Arte final 12x12.
- ☐ De ser el caso, información sobre otras solicitudes de patente o títulos obtenidos en el extranjero por el mismo titular o su causante, relacionadas parcial o totalmente con la invención de esta solicitud.
- ☒ Otros: Tarjeta de propietarios.

11 FIGURA CARACTERÍSTICA:



12 Solicito la concesión de la patente.

NOMBRE: HECTOR GOMEZ MEJIA

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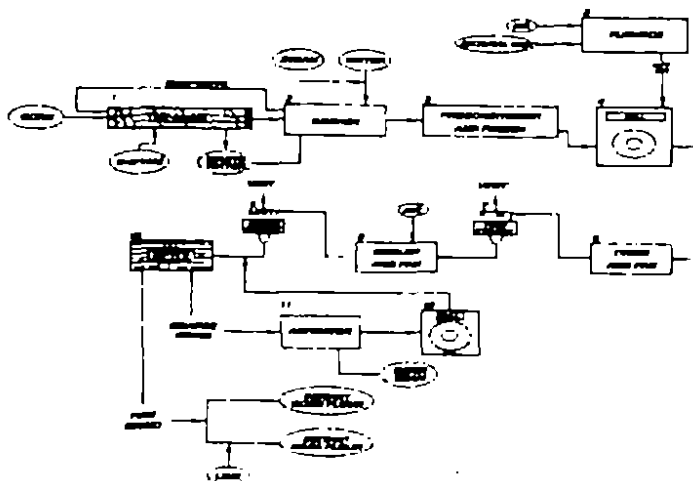
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(54) Title: **CONTINUOUS PRODUCTION OF AN INSTANT CORN FLOUR FOR AREPA AND TORTILLA, USING AN ENZYMATIC PRECOOKING**



(57) Abstract: Precooking and partially-debranned corn flour is produced in a continuous process. First, the cleaned corn kernel is precooked with at a near neutral-pH with heated water and a xylanase in a precooker (1) to effect a partial bran hydrolysis. The precooked corn kernel is then passed to a washer (2) where it is washed with steam-heater water. After the moisture content of the precooked washed corn kernel is stabilized using a preconditioner (3), the preconditioned kernel is fed to a mill (4) and a dryer (6) to produce a controlled gelatinization in the ground kernel. The ground kernel is then cooled and further dried in a cooler (8) with ambient air. The cooled ground corn is fed to a sifter where a fine fraction is separated and recovered from a coarser fraction, which is also segregated to partially isolate a bran fraction for animal feed or integral flour. The coarser fraction is remilled and served to produce an instant corn flour for arepa. The fine fraction is admixed with lime to obtain a masa flour for tortilla.

CONTINUOUS PRODUCTION OF AN INSTANT CORN FLOUR FOR AREPA AND TORTILLA, USING AN ENZYMATIC PRECOOKING

BACKGROUND OF INVENTION

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1. Field of the invention

The present invention relates to a method of low-temperature and near neutral-pH precooking for the production of corn flour and, more particularly, to one that achieves continuous partial hydrolysis of the corn insoluble fiber and avoids excessive
10 pregelatinization with a xylanase as a processing aid during the manufacture of an instant corn flour for the elaboration of arepa and tortilla and derivatives.

2. Description of Related Art

The production of high-quality masa flour can be produced by conventional techniques only if the food-grade dent corn has the following characteristics: uniformity in
15 kernel size and hardness, low number of stress-cracks and kernel damage and ease of pericarp removal during the lime-water cooking process. The mature kernel has four separable components, on a dry weight basis: tip cap (0.8-1.1%), pericarp or bran (5.1-5.7%), endosperm (81.1-83.5%), and germ (10.2-11.9%). In dry or wet-milling processes the bran includes the pericarp, tip cap, aleurone layer and adhering pieces of starchy endosperm as
20 well. Nixtamalized corn flour (NCF) is produced by the steps of alkaline cooking of corn, washing, milling the nixtamal and drying to give corn masa flour. This flour is sieved and blended for different product applications and it is usually supplemented with additives before packaging for commercial table or packaged-tortilla and snack production. Although the pericarp or bran is partially removed during the alkaline-cooking and washing process
25 stages, there is still fiber left from the corn kernel (Montemayor and Rubio, 1983, U.S. Patent 4,513,018). Whole Nixtamalized corn flour or masa flour can contain from 7-9% of total dietary fiber or bran with 6-8% mainly consisting of insoluble fiber on a dry basis (Sustain, 1997).

The cell walls or non-starch polysaccharides (NSP) are the major corn dietary
30 fiber components and are composed of hemicellulose (heteroxylan or pentosan and β -glucan:

4.4-6.2%), cellulose (2.5-3.3%) and some lignin (0.2%). According to Watson (1987: Tables IV and VII), the corn pericarp makes up 5-6% of the kernel dry weight. This pericarp also contains 90% insoluble fiber (67% hemicellulose and 23% cellulose) and only 0.6% soluble-fiber (soluble-arabinoxylan and β -glucan). It is estimated that dietary fiber in both pericarp or
5 bran (4.9%) and endosperm (2.6%) make up 80% of the total dietary fiber. The corn insoluble fiber is mainly found in the pericarp and endosperm (aleurone and starchy) which make up 68% of the total dietary fiber (9.5% in a dry-weight basis).

Unlike corn endosperm, in which soluble fiber amounts to 12% of the total fiber (4.1%), in whole wheat, soluble fiber represents 22% of total fiber (about 20% of the
10 flour water-uptake is bound to the soluble pentosan fraction). Arabinoxylan is a complex polymer (20,000-170,000 Daltons) with a linear backbone of (1,4)- β -xylopyranosyl units to which substituents are attached through O2 and O3 atoms of the xylosyl residues (mainly, α -L-arabinofuranosyl). This polymer is apparently linked to the cellulose skeleton in the corn cell wall by ester linkage cross-bonding through ferulic and diferulic acid (Watson, 1987).
15 However, heteroxylan insolubility in corn bran might be due to protein-polysaccharide linkages and a highly branched structure (23% of the xylan backbone does not bear side-chains) as opposed to wheat bran (Saulnier et al., 1995).

During alkali-cooking and/or steeping, there are chemical and physical changes such as nutrient losses along with partial pericarp or bran removal, degradation of the
20 endosperm periphery with starch gelatinization/swelling and protein denaturation in the precooked corn kernel. The most important nutritional modifications are: an increase in the calcium level with improvement in the Ca to P ratio, a decrease in insoluble dietary fiber and zein-protein, a reduction in thiamin and riboflavin, an improvement of the leucine to isoleucine ratio reducing the requirement for niacin, and leaching the aflatoxins into the
25 wastewater (Sustain, 1997).

The known cooking methods (batch or continuous) have been proposed as the critical variables (Sahai et al., 2001) which determine soluble-solid loss (1% to 1.6% COD) in
limewater residue for anaerobic biodegradation (Alvarez and Ramirez, 1995). Dry solid matter (1.5%-2.5%) includes an average of 50-60% dietary fiber, 15-20% ash, 15% starch, 5-
30 10% protein and 5% fat. Bryant et al., (1997) showed an optimum change in starch behavior at a lime level similar to the corn masa industry where starch gelatinization indicators

(enzyme digestion, water retention capacity, starch solubility and DSC-peak temperature = 69° to 75°C) are increased with lime addition of 0 to 0.4%, peaking at 0.2%. They also found a peak-viscosity temperature reduction upon the addition of lime up to 0.5%, indicating faster granule swelling that requires less thermal energy. Corn pericarp nixtamalization (Martinez et al., 2001) has a first-order stage associated with a fast dissolution of hot-water soluble fractions as starch and pectin, and alkali-soluble fat. A second stage is due to a slow alkaline-hydrolysis of the hemicellulose-cellulose-lignin structure with a higher hemicellulose loss proportional to alkaline-pH concentrations.

Arabinoxylan degrading enzymes include xylanases (1,4- β -D-xylan *xylanohydrolase*, EC 3.2.1.8) and β -xylosidases (1,4- β -D-xylan *xylohydrolase*, EC 3.2.1.37). The former endozyme randomly hydrolyze the insoluble and soluble xylan backbone (EC 3.2.1.8) whereas the latter exozyme hydrolyze xylose from the non-reducing end of the xylose-polymer (EC 3.2.1.37). Xylose is not usually the major product and it is typically produced after xylobiose and xylotriose (smallest oligomer). Virtually all xylanases are endo-acting as determined by chromatography or their kinetic properties (substrate and product formation), molecular weight and pH (basic or acidic) or its DNA sequence (crystal structure). They can be structurally classified into two major families or isoenzymes (F or 10 and G or 11) of glycosyl hydrolases (Jeffries, 1996). F10 xylanases are larger, with some cellulase activity and produce low DP oligosaccharides (less specific); F11 are more specific for xylan and with lower molecular weight (i.e., *B. Circulans* and *T. harzianum*).

In addition, the Enzyme Technical Association (ETA, 1999; FDA, 1998) classified as carbohydrases the following hemicellulases (trivial name): a) endoenzymes (EC 3.2.1.32=*1,3- β -xylanohydrolase*, 78=*mannanohydrolase* and 99=*arabinohydrolase*) and b) exoenzymes only attack branches on the xylose-polymer (pentosan), producing xylo-oligomers (EC 3.2.1.55= *α -L-arabinofuranosidase*, *glucuronic-acid glycosilase* and *ferulic-acid esterase*).

Currently recognized endoenzymes (xylanases) and exoenzymes produced from *A. niger* (EC 3.2.1.8 and 37,55), *A. oryzae* (EC 3.2.1.8 or 32), *B.subtilis* (EC 3.2.1.99), and *Trichoderma longibrachiatum* (formerly *reesei*: EC 3.2.1.8) are Generally Recognized As Safe (GRAS; 21 CFR 182, 184 and 186) and require no further approval from the U.S. Food and Drug Administration or Recognized As Safe (RAS in Europe: Mathewson, 1998).

However, direct and indirect food additives (i.e., packaging materials) are regulated in 21 CFR 172 and 174-178 as well. Secondary direct additives, a sub-class of direct additives, are primarily Processing Aids which are used to accomplish a technical effect during food processing but are not intended to serve a technical or as a functional additive in the finished food. They are also regulated in 21 CFR 173 (Partial List of Enzyme Preparations that are used in foods). Finally, all GRAS Substances produced through recombinant-DNA which were widely consumed prior to 1958, and which have been modified and commercially introduced after 1958 must comply with regulatory requirements proposed in 21 CFR 170.3 (GRAS Notice).

The benefits of using a commercial xylanase (endoenzyme) in cereal flours instead of a non-specific hemicellulase (endo/exoenzyme) preparation are a reduction in side activities (cellulase, beta-glucanase, protease and amylase) and a reduction of dough-stickiness. Arabinoxylan degrading enzymes with well defined endo-acting and exo-acting activities have become commercially available, for food and feed, from the following companies: Amano, Danisco-Cultor, EDC/EB, Genencor, Gist-Brocades, Iogen, Novo, Primalco, Rhodia and Rohm.

Suggested applications for commercial xylanases (endopentosanases) and hemicellulases (pentosanases) mentioned in the literature include: 1) improving the watering of spent grains and energy reduction during grain drying; 2) facilitation of dough formulation with less water, reduction of stickiness in noodle and pasta production; 3) reduction in the water content when formulating grains for flaking, puffing or extrusion; 4) retarding staling or hardening in bread; 5) relaxing dough for cookie and cracker production and use of sticky cereal flours in new product formulations; 6) increase in bran removal when added to tempering water; and 7) reducing both steeping time and starchy fiber in corn wet milling.

A moderate exoxylanase addition decreases water uptake in wheat dough, whereas using an endoxylanase increases water binding and soluble-xylans as well for a high-moisture bread product. On the contrary, if starch gelatinization is to be minimized, a higher endo-enzyme addition is desirable and hydrolysis of the soluble fraction releases water for low-moisture cookie or cracker products (EPA Patent 0/338787). Therefore, a suitable level of xylanase results in desirable dough softening without causing stickiness, thereby improving machinability during forming and baking operations.

Haarasilta et al. (U.S. Patent 4,990,343) and Tanaka et al. (U.S. Patent 5,698,245) have proposed that the use of hemicellulase and pentosanase (Cultor and Amano) causes decomposition of wheat insoluble fiber for bread volume increase. Van Der Wouw et al. (U.S. Patent 6,066,356) also reported the use of recombinant-DNA endo-arabinoxylanase (Gist Brocades) breaks down the water-insoluble-solids (~1.5%) from degermed maize and increases their in-vitro digestion (13%-19%) for animal feed or in wheat flour for improving bread volume (~9%).

A pilot process (WO Patent 00/45647) for the preparation of a modified masa foodstuff used a reducing agent (metabisulfite) or an enzyme as a processing aid (disulfide isomerase or thiol-protease/Danisco) with masa or corn prior to nixtamalization such that the native protein is modified. Sahai and Jackson (2001) disclosed a similar process where whole-kernel corn was steeped and digested with a food-grade commercial alkaline-protease (<0.10%: 50°C-60°C; pH>10) which altered zein structure similarly to alkali-cooking with a partial gelatinization (~20%-40%).

A novel transgenic thermostable-reductase enzyme was cloned in corn (high-protein) mainly to enhance extractability and recovery of starch and protein important in flaking grit production and in masa production. Reduction of protein disulphide bonds alters the nature of corn flour (as a wheat substitute from high-protein corn) when steeping the corn grain between 45°C and 95°C instead of using sulfites. The critical steeping is required to soften the kernel and then to loosen starch granules from the complicated matrix of proteins and cell wall material that makes up the corn endosperm (WO. Patent 01/98509).

Tortilla is the main edible corn product in North and Central America. It is a flat, round, unleavened and baked thin pancake (flat-cornbread) made from fresh masa or corn dough prepared from industrial nixtamalized corn flour (masa flour). It might be mentioned that tortilla, when manually or mechanically elaborated and without additives of any kind, has a maximum shelf life of 12 to 15 hours at room temperature. Afterwards they are spoiled by microorganisms and become hard or stale (starch retrogradation) due to a physicochemical change in the starch constituent of either stored or reheated tortilla. It is known that tortillas when kept under conditions in which no moisture is lost (plastic package), nevertheless become inflexible with time and break or crumble easily when bent.

In northern South America, particularly in Colombia and Venezuela, hard endosperm corn is processed with dry milling technology without wastewater and it is further converted into a precooked, degermed and debranned flour for traditional corn foods. Its consumption is mainly in the form of "arepa", which is a flat or ovoid-shaped, unleavened, and baked thick pancake made from instant corn flour. In other South American countries, corn meal and corn flour are used for different bakery and pancake mixes as well as snack foods.

Properly processed industrial corn or masa flour simplifies the production of tortilla products, because the customer eliminates management techniques required for wastewater treatment, securing, handling and processing corn into masa for tortillas and snacks. However an instant corn flour might have the following quality and cost disadvantages: high cost, lack of flavor and poor texture in tortilla products or snacks prepared from masa flour.

Corn processors can generate added value from their industrial operations in one of three approaches: developing new products from new hybrids, increasing the yield of traditional products from corn, and improving process efficiency at a lower unit cost. In the past, this has been done by methods and using an apparatus in which the grain is cooked and/or steeped in a lime-water solution such as those disclosed in U.S. Patents Nos. 2,584,893, 2,704,257, 3,194,664, and 4,513,018. These prior art methods for the industrial production of corn dough or masa flour involve accelerated cooking and steeping times with large amounts of solids losses (~1.5-2.5%) in the liquid waste. In addition, essential nutrients such as vitamins and some amino acids are lost, depending on the severity of the cooking, washing and drying operations.

Many and varied methods for the production of instant corn flour for food products involving reduced amounts of water with low-temperature cooking and short-time processing for a high yield of the end product have been developed, as reflected by the following U.S. Patent Nos: 4,594,260, 5,176,931, 5,532,013, and 6,387,437. In this connection, reference is made to the following U.S. Patent Nos: 4,594,260, 5,176,931, 5,532,013, and 6,265,013 also requiring a low-temperature drying. On the contrary, U.S. Patent Nos: 4,513,018, 5,447,742, 5,558,898, 6,068,873, 6,322,836, and 6,344,228 used a high-temperature dehydration or cooking in place of a low-temperature cooking.

Having in mind the disadvantages of the prior art methods, several studies not only have used a low-temperature precooking with minimum wastewater, but also separate corn fractions as reflected by the following U.S. Patent Nos: 4,594,260, 5,532,013, 6,025,011, 6,068,873, 6,265,013, and 6,326,045.

5 A few applications for enzymatic steeping were also tested to convert a traditional masa processing with reduced wastewater into a novel biochemical process (WO Patent 00/45647 and Sahai et al., 2001) Although the above described prior art methods are capable of protease precooking or steeping whole corn for either modified masa or masa flour processing, a continuous industrial application using xylanase instead as a processing aid was
10 still unavailable in the market at the time of the invention.

SUMMARY AND OBJECTS OF THE INVENTION

Accordingly, it is an object of this invention to provide a complete departure
15 from the prior art accelerated precooking methods of thermal, mechanical, chemical and enzymatic or biochemical processing of whole corn in order to control starchy endosperm gelatinization without using chemicals during production of an instant corn flour for arepa and tortilla.

It is another object of this invention to use low-temperature cooking with a
20 microbial xylanase solution for a partial hydrolysis of corn bran heteroxylans during the continuous production of precooked corn flour.

Another object is to use an industrial method and apparatus involving a low-temperature, near neutral-pH precooking which not only solubilize corn cell-walls along with a slower water diffusion effecting a controlled starch granule swelling, but also results in a
25 reduced corn solid loss.

The above and other objects and advantages of the invention are achieved by a new continuous process applied to the production of precooked corn flour or instant corn flour for arepa and tortilla, embodiments of which include a short-time corn precooking followed by a low-temperature and near neutral-pH precooking with a xylanase as a
30 processing aid so as to effect a partial hydrolysis of insoluble fiber and decreased gelatinization, reduced washing and corn solid loss of precooked kernel, stabilization of the

moisture content to a desired optimum level for grinding, milling and drying the preconditioned kernel to produce a uniform partial gelatinization, cooling and drying the dry-ground particle, separating and recovering the fine grind so produced from the coarser grind while the latter is further aspirated to partially remove a bran fraction for feed or integral flour, remilling the isolated coarser grind and further sieving it to obtain an instant corn flour for arepa, and admixing only a fine flour with lime to produce masa flour for tortilla and derivatives thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more fully understood from the description, which follows, and from the appended drawing in which the sole drawing figure depicts an embodiment of this invention in a block-type flowchart illustrating the continuous and industrial process using a low-temperature and near neutral-pH precooking with a xylanase as a processing aid.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1, there is depicted, in flowchart form, an embodiment of the present invention. It includes a pre-cooker 1; a washer 2; a preconditioner 3 with a feeder; a primary mill 4; a furnace 5; a dryer 6 with a fan; a first cyclone separator 7; a cooler 8 with an associated fan; a second cyclone separator 9; a sifter 10; an aspirator system 11; and a secondary mill 12.

The pre-cooker 1, whose design is known per se, is fed with cleaned corn and a hot steep-water (70°C to 85°C) recycled from the washer 2 to form an aqueous suspension (corn to water ratio of about 1:1 to 1:1.5). The corn kernel is parboiled in order to loosen their bran cell walls and partially hydrated from a range of 9%-12% to a range of about 24%-27% for a period of about 15 to about 20 minutes. Next, a microbial xylanase solution is continuously added as a food processing aid into the pre-cooker at a low-temperature range of about 50°C to 70°C for another period of 15 to 75 minutes. This allows the enzymatically precooked kernel to be produced at moisture contents of between 32% and 34%, while the pH is maintained at a near neutral-pH of about 6.0 to about 7.0 with the addition of a 10%

xylanase solution to supply a 0.03% to 0.07% by weight processing aid (based on corn). By controlling the steam heating along with the kernel residence time, it is possible to precook the corn at a temperature of about 50°C to 85°C for a total period of 30 to about 95 minutes in order to soften their bran layers.

5 Wastewater loss in the precooker is replaced with recycled steam-heated water from the washer 2, which is regulated to maintain the solid content of the solution from about 0.8% to about 1.1%. The industrial pre-cooker performs a partial hydrolysis of corn bran that promotes a fast water diffusion through the pericarp and tip cap layers, and later on a slow penetration via the endosperm and germ cell-walls increasing starch granule swelling. This
10 low-temperature precooking (<70°C) further controls the insoluble fiber solubilization (from about 0.4% to about 0.6% water-extractable solids, based on corn kernel), thus permitting a 60% reduction in soluble solids concentration as compared to the traditional alkali cooking (1%-1.6%). The partially precooked corn suspension is then passed to a washer 2 where it is sprayed with steam-heated water at a temperature of about 70° to 85°C during 30 to 60
15 seconds, which also serves to increase water absorption and wash off soluble solids with denatured xylanase as wastewater.

The washed corn is thereafter passed to a preconditioner 3, where the enzymatically precooked kernel is equilibrated to obtain a residual moisture content of about 33% to about 38% for about 30 to about 150 minutes.

20 Thereafter, the preconditioned corn is fed through a feeder, whose design is known per se, to a primary mill 4 such that the premilled corn and hot air coming from a furnace 5, is mixed and partially cooked by an industrial dryer 6 whose design is known per se. The premilled kernel is thereby flash dried at a high-temperature from 190°C to about 230°C for a short time of 5 sec to about 30 sec. Its starchy endosperm is partially gelatinized
25 or precooked to yield a moisture content of 16% to about 18% depending on the granulation being produced.

Moisture laden-hot air (110°C to 120°C, and 11% to 13% moisture) is extracted with a first cyclone separator 7 so that further moisture extraction may take place by impelling the drier material through a cooler 8 with an associated fan, thus further decreasing
30 the moisture content from 16-18% to about 9-12% (similar to incoming corn).

After further extraction of moisture laden-warm air (95°C to 100°C) with a second cyclone separator 9, the precooked dry particle is directed to a sifter 10 where the fine fraction is separated (under 20 to 60 mesh) as instant corn flour and the coarser fraction is further separated.

5 The latter coarse fraction is further separated in the aspirator system 11 wherein two fractions are obtained, a light-bran fraction which is isolated as feed or for integral flour with a moisture content between 9% to 12% (representing from about 3%-5% to about 6%-9% of the total weight of incoming corn), and a heavy coarser fraction that is remilled in a secondary mill 12. The milled product from secondary mill 12 is recycled to the
10 sifter 10 for further sieving and producing a homogeneous corn flour for arepa. If desired, the arepa flour can be admixed with lime (0.3% based on precooked flour) to produce a masa flour for making tortilla or snack foods.

 For use in arepa manufacture, the instant corn flour is preferably rehydrated by mixing with warm water from a 1:1.3 to about 1:1.4 weight ratio to form a corn dough (55%
15 to 60% final moisture) for arepa elaboration.

 For use in tortilla manufacture, the masa flour made from the present method can be rehydrated with water from a 1:1.0 to about 1:1.3 weight ratio for a masa dough (50% to 55% final moisture) used in tortilla or corn-based foods.

 In this method, the novel enzymatic precooking results in a 45% to 55%
20 reduction in wastewater corn solid, with correspondingly lower sewage and energy costs, as compared to the industrial methods (1.5%-2.5%). Furthermore, the enzymatic precooking of the invention allows a 50% reduction in lime use if an instant masa flour were produced to improve new flavors in corn-based foods as tostadas and snacks. The low-temperature precooking (50°C-70°C) at near neutral-pH (6-7) using a xylanase (0.03%-0.07%) not only
25 aids in depolymerization of the cell-wall heteroxylans but also improves its bran removal. It also dissolves endosperm and germ cell walls facilitating a simultaneous water diffusion with a reduced gelatinization and denaturation without using a low-lime (Sahai and Jackson, 2001, U.S. Patent Nos: 6,344,228 and 6,387,437) or a low-sulfite concentration (U.S. Patent 6,322,836).

30 There is furthermore a potential in corn flour yield from 89% to 91% of the total weight of enzymatically pre-cooked corn as compared to the commercial alkali-cooking

15 ~~55~~

process, which yields 88%. Whereas the instant corn flour produced by the novel method may thus comprise a higher than 90% average yield of flour per kilogram of corn, the debranned and degermed flour produced by a typical arepa process obtains only a 65% to 70% yield, or a 80% to 85% yield for an integral arepa flour (U. S. patent 6,326,045).

5 Still further, the low-temperature and enzymatically precooked corn flour produced by the present method has a higher nutritional value as compared to the conventional methods, with more dietary fiber and fat contents than the commercial arepa or degermed corn flours (INCAP, 1961).

10 From the foregoing, it will be apparent that it is possible to manufacture a precooked and partially-debranned corn flour for arepa and masa flour with a novel enzymatic process which is efficient because of partial hydrolysis of cell-walls or solubilization of the endosperm periphery with starch pregelatinization and protein denaturation in the precooked corn kernel, wherein some of the nutrient losses that would have been present but for the features of this invention is prevented. The following table gives
15 a typical nutrient average composition of Precooked flours for corn foods and traditional arepa (Cuevas, 1985):

Nutritional profile (g/100 g): <u>Precooked Corn Flours</u>			
<u>Nutrient</u>	<u>Limed-corn</u>	<u>Corn</u>	<u>Arepa</u>
<i>Water</i>	11.0	11.0	11.0
<i>Protein</i>	8.1	8.1	7.0
<i>Fat</i>	2.6	2.6	0.7
<i>Ash:</i>	1.5	1.3	0.3
<i>Calcium</i>	0.16	0.01	0.01
<i>Dietary fiber:</i>	7.0	7.0	3.0
<i>Crude fiber</i>	1.5	1.5	0.5
<i>Starch</i>	70.0	70.0	78.0
Total Calories	350	350	370

It is to be understood that the embodiments of this invention herein illustrated and described in detail, are by way of illustration and not of limitation. Other changes and
5 modifications are possible and will present themselves to those skilled in the prior art and by the spirit of the appended claims.

We claim:

1. A biochemical process for the continuous production of precooked and partially debranned corn flour for arepa and tortilla, comprising the steps of:

precooking cleaned corn kernel with water heated from a downstream washer
5 to form a suspension of corn and water, having a corn to water ratio between 1:1 and 1:1.5,
precooking the corn kernel at a near neutral-pH with a solution comprising at least one xylanase, to effect a partial hydrolysis of insoluble heteroxylans or cell-walls during precooking,

washing said precooked kernel to remove soluble solids and denatured
10 xylanase, stabilizing a moisture content of said enzymatically precooked corn kernel,

milling said precooked washed corn kernel and drying said milled corn kernel for further pregelatinization,

cooling and further drying said milled and dried corn kernel with ambient air,

sifting said cooled milled corn to obtain a fine fraction, under 20 to 60 mesh to
15 produce a corn flour with fine particle size, and a coarse fraction,

aspirating said sifted coarse fraction to remove a corn bran for feed or integral flour.

2. The method of claim 1 wherein said low-temperature precooking uses a xylanase in an amount from 0.03% to about 0.07% by weight of the corn kernel.

20 3. The method according to claim 1 wherein said corn bran is a light fraction, representing a minimum yield from 3% to about 6% of the total weight of corn kernel.

4. The method of claim 1, wherein wastewater produced by the enzymatic precooking step comprises a corn solids reduction in a range of 45% to about 55%.

25 5. The method in accordance with claim 1, further comprising rehydrating said corn flour by mixing with warm water from a 1:1.3 to about 1:1.4 weight ratio to form a corn dough.

6. The method in accordance with claim 1, further comprising a step of treating said corn flour with lime to produce a masa flour.

30 7. The method according to claim 6, further comprising a step of rehydrating said masa flour with water from a 1:1 to about 1:1.3 weight ratio to form a masa dough.

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8. The method of claim 5, wherein the corn dough has a final moisture content between 55% and 60% used in arepa preparation.

9. The method of claim 7, wherein the masa dough has a moisture in a range of 50% to 55% used in tortilla or corn-based foods.

5 10. The method of claim 1, wherein the hot water used in the precooking step is recycled from a downstream washer.

11. The method of claim 1, wherein the at least one xylanase is selected from microbially derived enzymes recognized as GRAS substances and processing aids.

10 12. The method of claim 1, wherein the low-temperature precooking step is performed up to the denaturing temperature of said xylanase.

13. The method of claim 1, wherein in the milling and drying step, the drying is performed with a high temperature-short time drier.

14. The method of claim 1, further comprising remilling the aspirated coarse fraction.

15 15. The method of claim 14, wherein the remilled coarser fraction is recycled to the sifting step.

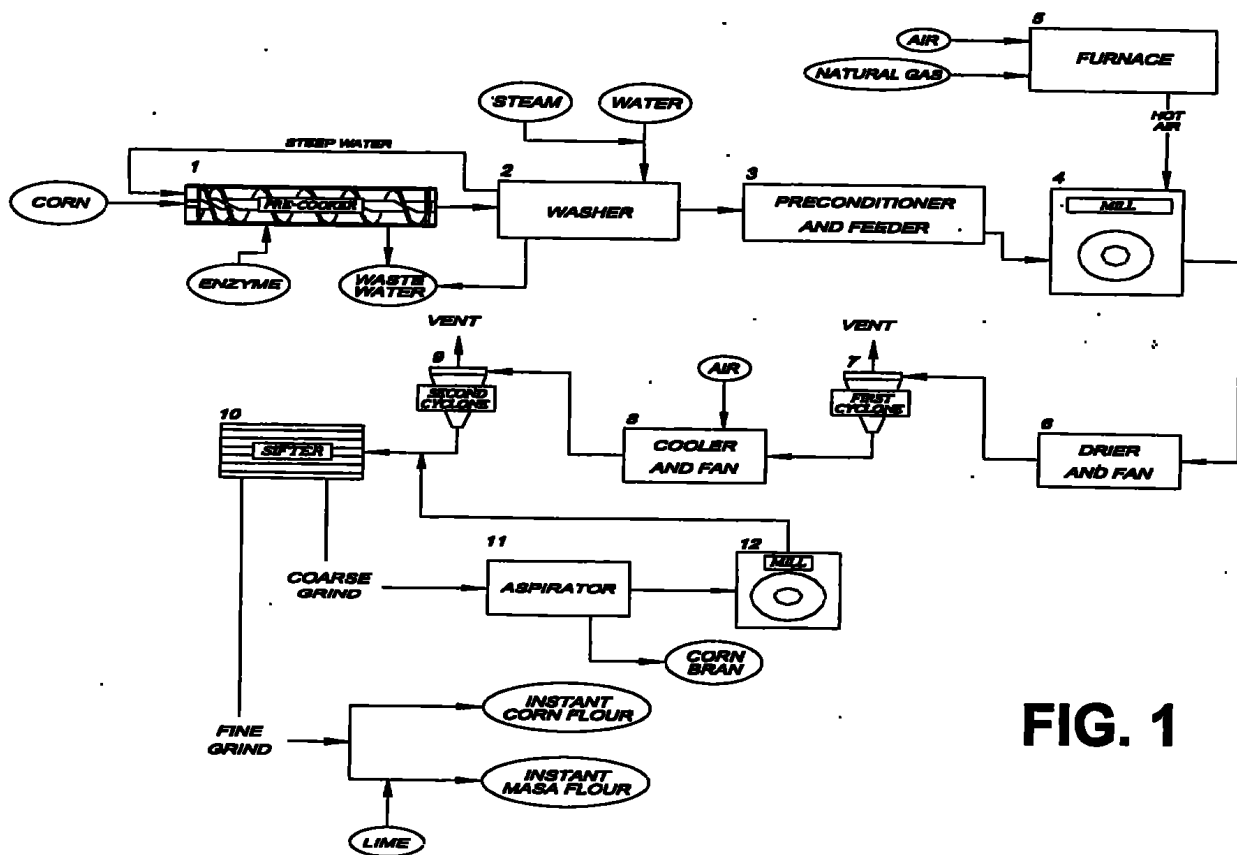


FIG. 1

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(54) Título: PRODUCCIÓN CONTINUADA DE UNA HARINA DE MAÍZ INSTANTÁNEA PARA AREPAS Y TORTILLAS MEDIANTE UNA PRECOCCIÓN ENZIMÁTICA

(Extracto) Se produce harina de maíz precocida a la cual se le retiró parcialmente el salvado en un proceso continuo. Primero se debe precocer el grano de maíz limpio con un pH prácticamente neutro con agua caliente y una xilanasa en una unidad de precocido (1) para efectuar una hidrólisis parcial del salvado. Luego el grano de maíz precocido pasa a una lavadora (2) donde se lava con agua de un calentador a vapor. Una vez se estabiliza el contenido de humedad del grano de maíz precocido y lavado empleando un preacondicionador (3), se alimenta un molino con el grano acondicionado (4) y un secador (6) para producir una gelatinización controlada del grano molido. Posteriormente el grano molido se enfría y se continua secando en un enfriador (8) con aire del ambiente. Se alimenta un tamizador con el maíz molido y frío donde una fina fracción se separa y se recupera de una fracción más gruesa, la cual también se agrega para aislar parcialmente una fracción de salvado para alimento de consumo animal o para la harina integral. La fracción más gruesa se vuelve a moler y sirve para producir una harina de maíz instantánea para arepas. La fracción fina se mezcla con cal para obtener una harina para masa de tortillas.

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PRODUCCIÓN CONTINUADA DE UNA HARINA DE MAÍZ INSTANTÁNEA PARA AREPAS Y TORTILLAS MEDIANTE UNA PRECOCIÓN ENZIMÁTICA

ANTECEDENTES DE LA INVENCION

1. Campo de la Invención

La presente invención se relaciona con un método de precocción a temperatura baja y con un pH cerca a neutro para la producción de harina de maíz, y más particularmente, a uno que permite la hidrólisis parcial de la fibra insoluble del maíz y que evita una excesiva pregelatinización con una xilanasas como una ayuda para el procesamiento durante la manufactura de una harina de maíz instantánea para la preparación de arepas y tortillas y sus derivados.

2. Descripción del Arte Relacionado

La producción de harina para masa de óptima calidad se puede lograr por medio de unas técnicas convencionales únicamente si el maíz dentado para alimento tiene las siguientes características: uniformidad del tamaño del grano y de su dureza, número bajo de fisuras por estrés y daños en el grano y el pericarpio se debe poder retirar fácilmente durante el proceso de cocción en agua con cal. El grano maduro tiene cuatro componentes separables, sobre una base de peso en seco: sombrerete de la punta (0.8 - 1.1%), pericarpio o salvado (5.1 - 5.7%), endosperma (81.1 - 83.5%) y germen (10.2 - 11.9%). En unos procesos de molienda secos o húmedos, el salvado incluye el pericarpio, el sombrerete de la punta, la capa aleurona y también las piezas adhesivas del endosperma almidonado. La harina de maíz nixtamalizado (NCF) se produce siguiendo los pasos de una cocción alcalina del maíz, lavado, molienda del nixtamal y secado para obtener harina de maíz para masa. Esta harina se cierne y se mezcla para aplicaciones en diferentes productos, y por lo general se le agregan aditivos antes de ser empacada para su comercialización de productos de mesa o para tortillas empacadas y para golosinas. Aunque el pericarpio o el

salvado se retiran parcialmente durante las etapas de cocción alcalina y del proceso de lavado, aún queda fibra del grano de maíz (Montemayor y Rubio, 1983, Patente de Estados Unidos 4,513,018). La harina entera de maíz nixtamalizada o la harina para masa puede contener de 7 - 9% de fibra dietaria total o de salvado con 6 - 8% compuesto principalmente por fibra insoluble sobre una base seca (Sustain, 1997).

Las paredes celulares o los polisacáridos desprovistos de almidón (NSP) son los principales componentes dietarios de fibra del maíz y están compuestos por hemicelulosa (heteroxilano o pentosano y β -glucan: (4.4 - 6.2%), celulosa (2.5 - 3.3%) y algo de lignina (0.2%). De acuerdo con Watson (1987: Tablas IV y VII), el pericarpio del maíz conforma hasta 5 - 6% del peso del grano seco. Igualmente este pericarpio contiene 90% de fibra insoluble (67% de hemicelulosa y 23% de celulosa) y solamente 0.6% de fibra soluble (arabinoxilano soluble y β -glucan). Se estima que la fibra dietaria tanto en el pericarpio o el salvado (4.9%) como en el endosperma (2.6%) conforman hasta el 80% de la fibra dietaria total. La fibra insoluble del maíz se encuentra principalmente en el pericarpio y en el endosperma (aleurona y almidón) que conforman el 68% de la fibra dietaria total (9.5% sobre una base de peso en seco).

A diferencia del endosperma del maíz, cuya fibra soluble asciende a 12% del total de la fibra (4.1%), en el trigo entero la fibra soluble representa el 22% de la fibra total (alrededor de 20% de la absorción de agua de la harina se enlaza a la fracción soluble del pentosano). El arabinoxilano es un polímero complejo (20,000 - 170,000 Daltons) con una columna lineal de unidades (1,4)- β -xilopiranosilo a las cuales se adhieren los radicales mediante átomos de O2 y O3 de los residuos de xilosilo (principalmente, α -L-arabinofuranosilo). Aparentemente este polímero está enlazado al esqueleto de la celulosa en la pared celular del maíz mediante un enlace en cruz del éster por medio del ácido ferúlico y diferúlico (Watson, 1987). Sin embargo, la insolubilidad del heteroxilano en el salvado de maíz se puede deber a unos enlaces de proteína - polisacárido y a una estructura sumamente ramificada (23% de la columna de xilano no tiene cadenas

laterales) en contraposición al salvado de trigo (Saulnier y colaboradores, 1995).

Durante la cocción alcalina y / o el remojo, se presentan unos cambios químicos y físicos como la pérdida de nutrientes junto con la extracción parcial del pericarpio o salvado, la degradación de la periferia del endosperma con la gelatinización / el esponjamiento del almidón, y la desnaturalización de la proteína en el grano de maíz precocido. Las modificaciones nutricionales más importantes son: un aumento del nivel de calcio con un mejoramiento de la proporción de Ca a P, una reducción de la fibra dietaria insoluble y la proteína zeína, una disminución de la tiamina y de la riboflavina, una mejora de la proporción de leucina a la isoleucina reduciendo el requerimiento de niacina y la lixiviación de las aflotoxinas en las aguas residuales (Sustain, 1997).

Los métodos de cocción conocidos (por lotes o continuo) se propusieron como las variables críticas (Sahai y colaboradores, 2001) que determinan las pérdidas de sólidos solubles (1% a 1.6% COD) en los residuos del agua con cal para una biodegradación anaeróbica (Álvarez y Ramírez, 1995). El material sólido seco (1.5% - 2.5%) incluye un promedio de 50% - 60% de fibra dietaria, 15 - 20% de ceniza, 15% de almidón, 5 - 10% de proteína y 5% de grasa. Bryant y colaboradores (1997) mostró un cambio óptimo en el comportamiento del almidón al nivel de la cal similar a la industria del maíz para masa donde los indicadores de gelatinización del almidón (digestión de enzimas, capacidad de retención de agua, solubilidad del almidón y temperaturas pico de DSC = 69° a 75°C) aumentan con la adición de cal de 0 a 0.4% alcanzando un pico en 0.2%. Igualmente notaron una reducción de temperatura pico - viscosidad cuando se agregó cal hasta de un 0.5% indicando un esponjamiento más rápido del gránulo lo cual requiere menos energía térmica. La nixtamalización del pericarpio del maíz (Martínez y colaboradores, 2001) tiene una etapa de primer orden asociado con una rápida disolución de las fracciones solubles en agua caliente como el almidón y la pectina, una grasa alcalino soluble. Una segunda etapa se debe a una lenta hidrólisis alcalina de la estructura

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hemicelulosa – celulosa – lignina con una mayor pérdida de hemicelulosa proporcional a las concentraciones del pH alcalino.

Las enzimas que degradan el arabinoxilano incluyen xilanasas (1,4-β-D-xilano *xilanohidrolasa*, EC 3.2.1.8) y β-xilosidasas (1,4-β-D-xilano *xilohidrolasas*, EC 3.2.1.37). La primera enzima hidroliza la columna xilano soluble e insoluble en forma aleatoria (EC 3.2.1.8), mientras que la segunda enzima hidroliza la xilosa del extremo donde no se reduce el polímero xilosa (EC 3.2.1.37). Por lo general, la xilosa no es el principal producto y usualmente se produce después de la xilobiosa y la xilotriosa (oligómero más pequeño). Virtualmente todas las xilanasas endoactúan como se determina en una cromatografía o en sus propiedades cinéticas (substrato y formación de producto), peso molecular y pH (ácido o alcalino) o su secuencia de ADN (estructura cristalina). Estructuralmente se pueden clasificar en dos grandes familias o isoenzimas (F o 10 y G u 11) de hidrolasas de glicosilo (Jeffries, 1996). Las xilanasas F10 son más grandes, tienen alguna actividad celulasa y producen oligosacáridos de DP bajo (menos específicos); los F11 son más específicos para xilano y tienen un peso molecular más bajo (es decir, *B. Circulans* y *T. harzianum*).

Adicionalmente, la Asociación Técnica de Enzimas (ETA, 1999; FDA, 1998) clasificó las siguientes hemicelulasas como carbohidrasas (nombre trivial): a) endoenzimas (EC 3.2.1.32=1,3-β-xilanohidrolasa, 78=mananohidrolasa y 99=arabinohidrolasa) y b) exoenzimas únicamente atacan ramas en el polímero xilosa (pentosano), produciendo xilooligómeros (EC 3.2.1.55=α-L-arabinofuranosidasa, ácido glucurónico glicosilasa y ácido ferúlico esterasa).

Las endoenzimas actualmente reconocidas (xilanasas) y las exoenzimas producidas de *A. niger* (EC 3.2.1.8 y 37,55), *A. oryzae* (EC 3.2.1.8 o 32), *B. subtilis* (EC 3.2.1.99) y *Trichoderma longibrachiatum* (anteriormente *reseei*: EC 3.2.1.8) se Reconocen Generalmente Como Seguras (GRAS; 21 CFR 182, 184 y 186) y no requieren más aprobación de la administración de Alimentos y Medicamentos de los Estados Unidos o Reconocidos como Seguros (RAS en Europa: Mathewson, 1998).

Sin embargo, los aditivos directos e indirectos para alimentos (es decir, los materiales de empaque) también se regulan en 21 CFR 172 y 174-178. Los aditivos secundarios directos, una sub-clase de los aditivos directos, son esencialmente Ayudas de Procesamiento que se emplean para obtener un efecto técnico durante el procesamiento de alimentos pero su finalidad no es la de actuar como un aditivo técnico o funcional en el alimento final. También se regulan en 21 CFR 173 (Lista Parcial de Preparaciones de Enzimas que se emplean en los alimentos). Finalmente, todas las Sustancias GRAS producidas mediante ADN recombinante ampliamente consumidos antes de 1958 que se han modificado y se introdujeron comercialmente después de 1958, deben cumplir con los requisitos propuestos en 21 CFR 170.3 (Notificación GRAS).

Los beneficios de utilizar una xilanasa comercial (endoenzima) en harinas de cereal en vez de una preparación hemicelulosa no específica (endo / exoenzima) son una reducción de las actividades laterales (celulasa, beta-glucanasa, proteasa y amilasa) y una reducción de viscosidad de la masa. Las enzimas que degradan el arabinoxilano con unas actividades de endo-actuación y exo-actuación ya se encuentran disponibles en el comercio, para alimentos y alimento de consumo animal, en las siguientes compañías: Amano, Danisco-Cultor, EDC / EB, Genencor, Gist-Brocades, Iogen, Novo, Primalco, Roída y Rohm.

Unas aplicaciones sugeridas para las xilanasas comerciales (endopentosanasas) y hemicelulasas (pentosanasas) mencionadas en la literatura incluyen: 1) mejorar el riego de los granos empleados y una reducción de energía durante el secado de los granos; 2) facilitar la formulación de la masa con menos agua, reducción de viscosidad en la producción de fideos y pasta; 3) reducir el contenido de agua cuando se formulan granos para hojuelas, soplado o extrusión; 4) retardar el envejecimiento o el endurecimiento del pan; 5) dejar reposar la masa para producir pastelitos y galletas y el uso de harinas viscosas de cereal en nuevas formulaciones de productos; 6) aumentar la extracción del salvado

cuando se agrega a agua de atemperación y 7) reducir tanto el tiempo de remojo como la fibra de almidón en la molienda de maíz mojado.

Una adición moderada de exoxilanas reduce la absorción de agua en la masa húmeda, mientras que el uso de una endoxilanas aumenta la adhesión de agua y los xilanos solubles, también para un producto de pan con alto contenido de agua. Por el contrario, si se va a minimizar la gelatinización del almidón, es deseable una mayor adición de endoenzima y la hidrólisis de la fracción soluble libera el agua para productos como pastelitos y galletas con bajo contenido de humedad (patente EPA 0/338787). Por lo tanto, un nivel adecuado de xilanas resulta en una masa deseable más suave sin causar viscosidad, mejorando así la posibilidad de pasarla por una máquina durante las operaciones de formación y de cocción.

Haarasilta y colaboradores (Patente de Estados Unidos 4,990,343) y Tanaka y colaboradores (Patente de Estados Unidos 5,698,245) propusieron que la utilización de hemicelulasa y pentosanasa (Cultor y Amano) causa la descomposición de la fibra insoluble en agua en el trigo para aumentar el volumen del pan. Van Der Wouw y colaboradores (Patente de Estados Unidos 6,066,356) también reportó el uso de ADN recombinante endo-arabinoxilanas (Gist Brocades) degrada los sólidos insolubles en agua (~1.5%) del maíz desprovisto de germen y aumenta su digestión in vitro (13% - 19%) para alimento de consumo animal o en la harina de trigo para mejorar el volumen del pan (~9%).

Un proceso piloto (Patente WO 00/45647) para la preparación de una masa modificada de alimento para consumo animal empleó un agente de reducción (metabisulfito) o una enzima como una ayuda de procesamiento (difulsido isomerasa o tiol-proteasa/Danisco) con masa o maíz antes de la nixtamalización de manera que se modifica la proteína nativa. Sahai y Jackson (2001) divulgaron un proceso similar donde se remojó el grano entero de maíz y se digirió con una proteasa alcalina comercial de grado alimento (<0.10%: 50°C - 60°C; pH>10) que alteró la estructura zeína en forma similar a la cocción con un alcalino con una gelatinización parcial (~20% - 40%).

Se clonó una enzima transgénica novedosa termoestable – reductasa en maíz (alta proteína) esencialmente para mejorar la posibilidad de extracción y recuperación del almidón y la proteína importante en la producción de granos en hojuelas y en la producción de masa. La reducción de los enlaces de proteína disulfida altera la naturaleza de la harina de maíz (como un sustituto de trigo del maíz con alto contenido de proteínas) cuando se remoja el grano de maíz entre 45°C y 95°C en vez de emplear sulfitos. El remojo crítico es necesario para ablandar el grano y luego soltar los gránulos de almidón de la complicada matriz de la proteína y del material de la pared celular que conforman el endosperma del maíz (Patente WO 01/98509).

La tortilla es el principal producto comestible de maíz en América del Norte y en Centroamérica. Es una torta plana, circular, sin levadura y cocida (pan de maíz plano) fabricada a partir de una masa fresca o una masa de maíz preparada a partir de harina de maíz nixtamalizada (harina de masa). Se puede mencionar que la tortilla, cuando se prepara en forma manual o mecánica y sin aditivos de ninguna naturaleza, tiene una vida útil máxima de 12 a 15 horas a temperatura ambiente. Posteriormente los microorganismos los dañan y se endurecen o envejecen (retrogradación del almidón) debido a un cambio fisicoquímico en el constituyente del almidón de una tortilla almacenada o recalentada. Se sabe que cuando se guardan las tortillas bajo condiciones donde no se experimenta una pérdida de humedad (empaquete plástico), de todas formas se vuelven inflexibles con el tiempo y se parten o desmoronan fácilmente cuando se doblan.

En el norte de América del Sur, especialmente en Colombia y Venezuela, el endosperma duro del maíz se procesa por medio de una tecnología de molienda en seco sin aguas residuales y además se convierte en una harina precocida, desprovista de germen y salvado para alimentos tradicionales de maíz. Su consumo es principalmente en forma de arepa, que es una torta plana y gruesa de forma ovoide, sin levadura y asada fabricada a partir de harina de maíz instantánea. En otros países en Sur

América, el alimento de maíz y la harina de maíz se utilizan para diferentes mezclas en pastelería al igual que para golosinas.

Una harina de maíz procesada industrialmente en forma correcta o la harina para masa simplifica la producción de productos de tortillas, puesto que el cliente elimina las técnicas de manejo requeridas para el tratamiento de aguas residuales, aseguramiento, manejo y procesamiento de maíz para fabricar masa para tortillas y golosinas. Sin embargo, una harina de maíz instantánea puede tener las siguientes desventajas en cuanto a calidad y costo: alto costo, insípido y una textura deficiente de los productos de tortillas o golosinas fabricados a partir de la harina para masa.

Los procesadores de maíz pueden generar valor agregado en sus operaciones industriales en uno de tres enfoques: desarrollar nuevos productos a partir de híbridos nuevos, aumentar el rendimiento de los productos tradicionales a base de maíz y mejorar la eficiencia del proceso a un costo unitario inferior. En el pasado esto se lograba mediante métodos y empleando un aparato donde se cocinaba el grano y / o se remojava en una solución de agua con cal como aquellos descritos en las Patentes de Estados Unidos Nos. 2,584,893; 2,704,257; 3,194,664 y 4,513,018. Estos métodos del arte previo para la producción industrial de masa de maíz o harina para masa implican una cocción acelerada y unos tiempos de remojo con grandes pérdidas de sólidos (~1.5 - 2.5%) en el desperdicio líquido. Además se pierden los nutrientes esenciales como las vitaminas y algunos aminoácidos, dependiendo de la severidad de las operaciones de cocción, lavado y secado.

Se han desarrollado muchos y variados métodos para la producción de harina de maíz instantánea con cantidades reducidas de agua y cocción a baja temperatura y un tiempo de procesamiento corto para un alto rendimiento del producto final, como se refleja en las siguientes Patentes de Estados Unidos Nos. 4,594,260; 5,176,931; 5,532,013 y 6,387,437. Al respecto se hace referencia a las siguientes Patentes de Estados Unidos Nos. 4,594,260; 5,176,931; 5,532,013 y 6,265,013 que también requieren un secado a baja temperatura. Por el contrario, las Patentes de Estados Unidos

Nos. 4,513,018; 5,447,742; 5,558,898; 6,068,873; 6,322,836 y 6,344,228 utilizaron una deshidratación a alta temperatura o una cocción en vez de una cocción a baja temperatura.

Teniendo en cuenta las desventajas de los métodos del arte previo, varios estudios han empleado no solo una precocción a baja temperatura con un mínimo de aguas residuales, sino también unas fracciones de maíz separadas como se refleja en las siguientes Patentes de Estados Unidos Nos. 4,594,260; 5,532,013; 6,025,011; 6,068,873; 6,265,013 y 6,326,045.

También se efectuaron unos ensayos con unas pocas aplicaciones para el remojo enzimático con el fin de convertir el procesamiento tradicional de la masa con una reducción de aguas residuales en un novedoso proceso bioquímico (Patente WO 00/45647 y Sahai y colaboradores, 2001). Aunque los métodos del arte previo descritos arriba son capaces de efectuar una precocción de proteasas o el remojo del maíz entero bien sea para la masa modificada o para el procesamiento de harina para masa, todavía no se encontraba disponible en el mercado una aplicación industrial continua empleando xilanasas como una ayuda en el procesamiento en el momento de la invención.

RESUMEN Y OBJETIVOS DE LA INVENCION

Por lo tanto, un objetivo de la invención es partir completamente de los métodos de precocción acelerada del arte previo para el procesamiento térmico, mecánico, químico y enzimático o bioquímico del maíz entero para controlar la gelatinización del endosperma de almidón sin utilizar químicos durante la producción de harina de maíz para arepas y tortillas.

Otro objetivo de esta invención es como emplear una cocción a baja temperatura con una solución microbiana de xilanasas para una hidrólisis parcial de los heteroxilanos del salvado de maíz durante la producción continua de harina de maíz precocida.

Otro objetivo es emplear un método y un aparato industrial que utiliza una temperatura baja, una precocción con un pH cercano a neutro

que no solamente solubiliza las paredes celulares del maíz junto con una difusión de agua más baja permitiendo un esponjamiento controlado del gránulo de almidón, sino que también resulta en una menor pérdida de sólidos del maíz.

Los objetivos anteriores y otros objetivos y ventajas de la invención se alcanzan mediante un proceso continuo aplicado a la producción de harina de maíz precocida o harina de maíz instantánea para arepas y tortillas, cuyas incorporaciones incluyen un periodo corto de precocido seguido por un precocido a baja temperatura y con un pH cercano a neutro con una xilanasa como una ayuda de procesamiento con el fin de efectuar una hidrólisis parcial de la fibra insoluble y una menor gelatinización, una reducción del lavado y una disminución de los sólidos del maíz de los granos precocidos, la estabilización del contenido de humedad hasta llegar a un nivel óptimo deseado para la trituración, molienda y secado del grano preacondicionado para producir una gelatinización parcial y uniforme, el enfriamiento y el secado de las partículas secas molidas, separando y recuperando el producto finamente molido producido en esta forma del producto molido más grueso, y este último se aspira posteriormente para retirar parcialmente una fracción de salvado para alimento de consumo animal o harina integral, volviendo a moler el producto molido aislado más grueso y luego pasándolo por un tamiz para obtener una harina de maíz instantánea para arepas y agregando solamente una harina fina con cal para producir harina para masa para tortillas y derivados de las mismas.

BREVE DESCRIPCIÓN DE LOS DIBUJOS

La invención se comprenderá más fácilmente a partir de la descripción que sigue, del dibujo adjunto donde el único dibujo representa una incorporación de esta invención en una tabla de flujo de tipo bloque ilustrando el proceso continuo e industrial empleando una precocción a baja temperatura y con un pH cercano a neutro con una xilanasa como ayuda de procesamiento.

DESCRIPCIÓN DETALLADA DE LAS INCORPORACIONES PREFERIDAS

Haciendo referencia primero a la Figura 1, se representa, en forma de tabla de flujo, una incorporación de la presente invención. Incluye una unidad de precocido 1; una lavadora 2, un preacondicionador 3 con una alimentador, un primer molino 4, un horno 5, un secador con ventilador, un primer separador de ciclón 7, un enfriador 8 con su respectivo ventilador, un segundo separador de ciclón 9, un tamizador 10, un sistema de aspirado 11 y un segundo molino 12.

La unidad de precocido 1, cuyo diseño se conoce por sí, se alimenta con maíz limpio y agua caliente para remojo (70°C a 85°C) reciclado de la lavadora 2 para formar una suspensión acuosa (proporción de maíz a agua de alrededor de 1:1 a 1:1.5). El grano de maíz se sancocha con el fin de ablandar las paredes celulares del salvado y se hidrata parcialmente en un rango entre 9% - 12% a un rango de alrededor de 24% - 27% durante un periodo de unos 15 a 20 minutos. Luego se añade en forma continua una solución microbiana de xilanasa como una ayuda en el procesamiento de alimentos al dispositivo de precocido a baja temperatura en el rango de alrededor de 50°C a 70°C durante otro periodo de unos 15 a 75 minutos. Esto permite la producción del grano precocido enzimáticamente con un contenido de humedad de entre 32% y 34% mientras que el pH se mantiene lo más cerca posible a neutro, de alrededor de 6.0 a alrededor de 7.0 con la adición de un 10% de solución de xilanasa para agregar un 0.03% a 0.07% por peso de ayuda para el procesamiento (con base en el maíz). Al controlar el calentamiento con vapor junto con el tiempo de residencia del grano, es posible precocer el maíz a una temperatura de alrededor de 50°C a 85°C por un periodo total de 30 a alrededor de 95 minutos con el fin de ablandar sus capas de salvado.

La pérdida de agua residual en la unidad de precocido se reemplaza con agua reciclada calentada a vapor de la lavadora 2, que se regula para

mantener el contenido sólido de la solución de alrededor de 0.8% a alrededor de 1.1%. La unidad de precocido industrial efectúa una hidrólisis parcial del salvado de maíz que promueve una rápida difusión del agua a través del pericarpio y de las capas de los sombreretes de la punta, y posteriormente por una penetración lenta vía el endosperma y las paredes celulares del germen aumentando el esponjamiento de los gránulos de almidón. Esta precocción a temperatura baja ($<70^{\circ}\text{C}$) controla además la solubilización de las fibras insolubles (de alrededor de 0.4% a alrededor de 0.6% de sólidos extraíbles por agua, con base en el grano de maíz), permitiendo así una reducción del 60% de la concentración de sólidos solubles cuando se compara con la cocción alcalina tradicional (1% - 1.6%). La suspensión de maíz parcialmente cocida se pasa luego a una lavadora 2 donde se asperja con agua calentada a vapor a una temperatura de alrededor de 70°C a 85°C durante 30 a 60 segundos, lo cual también sirve para aumentar la absorción de agua y a lavar los sólidos solubles y las aguas residuales corresponden a xilanasas desnaturalizadas.

Posteriormente el maíz lavado se pasa a un preacondicionador 3 donde el grano precocido enzimáticamente se equilibra para obtener un contenido de humedad residual de alrededor de 33% a alrededor de 38% durante unos 30 a unos 150 minutos.

Luego el maíz preacondicionado se alimenta mediante un dispositivo alimentador, cuyo diseño se conoce por sí, a un primer molino 4 de manera que el maíz premolido y el aire caliente que proviene de un horno 5 se mezcla y cocina parcialmente con un secador industrial 6 cuyo diseño se conoce por sí. El grano premolido se seca instantáneamente a alta temperatura de 190°C a alrededor de 230°C durante un periodo corto de 5 segundos hasta alrededor de 30 segundos. Su endosperma de almidón se gelatiniza parcialmente o se precoce para obtener un contenido de humedad de 16% hasta alrededor de 18% dependiendo de la granulación que se está produciendo.

Se extrae el aire caliente cargado de humedad (110°C a 120°C y 11% a 13% de humedad) con un primer separador de ciclón 7 de manera que la

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extracción posterior de humedad se pueda llevar a cabo impulsando el material más seco a través de un enfriador 8 con su respectivo ventilador, reduciendo en esta forma el contenido de humedad aún más de 16 - 18% a alrededor de 9 - 12% (similar al maíz de entrada).

Después de otra extracción de aire caliente cargado de humedad (95°C a 100°C) con un segundo separador de ciclón 9, la partícula precocida seca se lleva a un tamizador 10 donde la fracción fina se separa (bajo una malla de 20 a 60) como harina de maíz instantánea y la fracción más gruesa se vuelve a separar.

Esta última fracción gruesa se vuelve a separar en el sistema de aspirado 11 donde se obtienen dos fracciones, una fracción de salvado ligero que se aísla como alimento para consumo animal o para harina integral con un contenido de humedad entre 9% y 12% (representando de alrededor de 3% - 5% a alrededor de 6% - 9% del peso total del maíz de entrada), y una fracción más gruesa y pesada que se vuelve a moler en un segundo molino 12. El producto molido del segundo molino 12 se recicla al tamizador 10 para volver a cernirlo y produce una harina de maíz homogénea para arepas. Si se desea, la harina de maíz se puede mezclar con cal (0.3% con base en la harina precocida) para producir una harina para masa de tortilla o golosinas.

Para el uso en la manufactura de arepas, preferiblemente se rehidrata la harina de maíz instantánea mezclándola con agua caliente a una proporción por peso de 1:1.3 a alrededor de 1:1.4 para formar una masa de maíz (con una humedad final de 55% a 60%) para la preparación de arepas.

Para el uso en la manufactura de tortillas, la harina para masa fabricada mediante el presente método se puede rehidratar con agua a una proporción por peso de 1:1.0 a alrededor de 1:1.3 para una masa (con una humedad final de 50% a 55%) empleada en tortillas o en alimentos a base de maíz.

En este método, la precocción enzimática novedosa resulta en una reducción de sólidos de maíz en las aguas residuales de 45% a 55%, por lo cual se reduce los costos de alcantarillado y energía, cuando se compara con

los métodos industriales (1.5% - 2.5%). Adicionalmente, la precocción enzimática de la invención permite una reducción de 50% en el uso de cal si se produjera una harina para masa instantánea para mejorar nuevos sabores en alimentos a base de maíz como tostadas y golosinas. La precocción a baja temperatura (50°C – 70°C) con un pH cercano a neutro (6 - 7) utilizando una xilanasa (0.03% - 0.07%) no solamente ayuda a la despolimerización de los hetoxilanos de las paredes celulares sino que también mejora la extracción del salvado. Igualmente disuelve el endosperma y las paredes celulares del germen facilitando una difusión de agua simultánea con una gelatinización reducida y una desnaturalización sin emplear una cantidad baja de cal (Sahai y Jackson, 2001, Patente de Estados Unidos Nos. 6,344,228 y 6,387,437) o una baja concentración de sulfito (Patente de Estados Unidos 6,322,836).

Existe además un potencial rendimiento de la harina de maíz de 89% a 91% del peso total del maíz precocido enzimáticamente cuando se compara con el proceso de cocción comercial alcalino con un rendimiento de 88%. Mientras que la harina de maíz instantánea producida por el método novedoso puede comprender por lo tanto un rendimiento promedio superior al 90% de harina por kilogramo de maíz, la harina desprovista de salvado y desprovista de germen producida por un proceso típico para arepas únicamente alcanza un rendimiento de 65% a 70% o un rendimiento de 80% a 85% para una arepa de harina integral (Patente de Estados Unidos 6,326,045).

Y adicionalmente, la harina de maíz precocida a baja temperatura y enzimáticamente producida por el presente método tiene un valor nutricional mayor cuando se compara con los métodos convencionales, con mayor fibra dietaria y contenido de grasa que la arepa comercial o las harinas de maíz desprovistas de germen (INCAP, 1961).

De lo anterior será aparente que es posible fabricar una harina de maíz precocida y parcialmente desprovista de salvado para arepas y harina para masa con un novedoso proceso enzimático que es eficiente porque la hidrólisis parcial de las paredes celulares o la solubilización de la periferia

del endosperma con una pregelatinización del almidón y la desnaturalización de la proteína en el grano de maíz precocido, donde algunas pérdidas de nutrientes que hubieran estado presentes se previene por las características de esta invención. La siguiente tabla muestra la composición promedio de nutrientes de harinas precocidas para alimentos a base de maíz y la arepa tradicional (Cuevas, 1985).

Perfil nutricional (g/100g) <u>Harinas de Maíz Precocidas</u>			
<u>Nutriente</u>	<u>Maíz con cal</u>	<u>Maíz</u>	<u>Arepa</u>
<i>Agua</i>	11.0	11.0	11.0
<i>Proteína</i>	8.1	8.1	7.0
<i>Grasa</i>	2.6	2.6	0.7
<i>Ceniza</i>	1.5	1.3	0.3
<i>Calcio</i>	0.16	0.01	0.01
<i>Fibra dietaria</i>	7.0	7.0	3.0
<i>Fibra cruda</i>	1.5	1.5	0.5
<i>Almidón</i>	70.0	70.0	78.0
<i>Total calorías</i>	350	350	370

Se deberá entender que las incorporaciones de esta invención aquí ilustradas y descritas en detalle son a modo de ilustración y no de limitación. Otros cambios y modificaciones son posibles y se presentarán ante aquellos con destreza en el arte previo y por el espíritu de las reivindicaciones adjuntas.

Nosotros reivindicamos:

1. Un proceso bioquímico para la producción continua de una harina de maíz precocida y parcialmente desprovista de salvado para arepas y tortillas, que comprende los pasos de:

Precocer los granos de maíz limpios con agua calentada de una lavadora corriente abajo para formar una suspensión de maíz y agua, con una proporción de maíz a agua entre 1:1 y 1:1.5,

Precocer los granos de maíz limpios a un pH cercano a neutro con una solución que comprende por lo menos una xilanasa, para efectuar una hidrólisis parcial de heteroxilanos insolubles o paredes celulares durante el precocido,

Lavar los citados granos precocidos para extraer los sólidos solubles y la xilanasa desnaturalizada, estabilizar el contenido de humedad de los citados granos de maíz precocidos enzimáticamente,

Moler los citados granos de maíz precocidos y secar los citados granos molidos para una posterior pregelatinización,

Enfriar y secar aún más los citados granos de maíz secos y molidos con aire del ambiente,

Cernir el citado maíz frío para obtener una fracción fina, bajo una malla de 20 a 60 para producir harina de maíz con un tamaño de partícula fino y una fracción gruesa,

Aspirar la citada fracción gruesa cernida para extraer el salvado de maíz para alimento de consumo animal o harina integral.

2. El método de la reivindicación 1, donde la citada precocción a temperatura baja utiliza una xilanasa en una cantidad de 0.03% a alrededor de 0.07% por peso de los granos de maíz.

3. El método de conformidad con la reivindicación 1, donde el citado salvado del maíz es una fracción ligera, representando un rendimiento mínimo de 3% a alrededor de 6% del peso total de los granos de maíz.

4. El método de la reivindicación 1, donde el agua residual producida por el paso de la cocción enzimática comprende la reducción de los sólidos de maíz en un rango de 45% a alrededor de 55%.

5. El método de conformidad con la reivindicación 1, que comprende además de rehidratación de la citada harina de maíz revolviéndola con agua tibia a una proporción por peso de 1:1.3 a alrededor de 1:1.4 para formar una masa de maíz.

6. El método de conformidad con la reivindicación 1, que comprende además un paso de tratar la citada harina de maíz con cal para producir una harina para masa.

7. El método de conformidad con la reivindicación 6, que comprende además un paso de rehidratar la citada harina para masa con agua a una proporción por peso de 1:1 a alrededor de 1:1.3 para formar una masa.

8. El método de la reivindicación 5, donde la masa de maíz tiene un contenido de humedad final entre 55% y 60% empleada en la preparación de arepas.

9. El método de la reivindicación 7, donde la masa tiene una humedad en el rango de 50% a 55% empleada en tortillas o en alimentos a base de maíz.

10. El método de la reivindicación 1, donde el agua caliente empleada en el paso de precocido se recicla de una lavadora corriente abajo.

11. El método de la reivindicación 1, donde por lo menos una xilanasa se selecciona entre enzimas derivadas en forma microbiológica reconocidas como Sustancias GRAS y ayudas de procesamiento.



12. El método de la reivindicación 1, donde el paso de precocción a baja temperatura se efectúa hasta la temperatura de desnaturalización de la citada xilanasa.

13. El método de la reivindicación 1, donde en el paso de molienda y secado, el secado se efectúa con un secador de alta temperatura y durante un corto tiempo.

14. El método de la reivindicación 1, que comprende además volver a moler la fracción gruesa aspirada.

15. El método de la reivindicación 14 donde la fracción más gruesa que se volvió a moler se recicla en el paso de cernido.

PATENT COOPERATION TREATY

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PCT NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

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1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices)(Article 39(1))(see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/US

Mall Stop PCT, Attn: IPEA/US
Commissioner for Patents
P.O. Box 1430
Alexandria, Virginia 22313-1430

Facsimile No. (703) 305-3230

Authorized officer

Examined George C. Young

Telephone No. (571) 272-1412

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 9002-1008-1	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US03/18292	International filing date (day/month/year) 11 June 2003 (11.06.2003)	Priority date (day/month/year) 30 August 2002 (30.08.2002)
International Patent Classification (IPC) or national classification and IPC IPC(7): A23L 1/00 and US Cl.: 426/508, 463, 464, 622, 626		
Applicant BARRERA, ROBERTO GONZALEZ		
1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36. 2. This REPORT consists of a total of <u>3</u> sheets, including this cover sheet. ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT). These annexes consist of a total of <u>0</u> sheets. 3. This report contains indications relating to the following items: I ☒ Basis of the report II ☐ Priority III ☐ Non-establishment of report with regard to novelty, inventive step and industrial applicability IV ☐ Lack of unity of invention V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement VI ☐ Certain documents cited VII ☐ Certain defects in the international application VIII ☐ Certain observations on the international application		
Date of submission of the demand 24 November 2003 (24.11.2003)	Date of completion of this report 20 February 2004 (20.02.2004)	
Name and mailing address of the IPEA/US Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer Examiner George C. Yeung Telephone No. (571) 272-1412	

Form PCT/IPEA/409 (cover sheet)(July 1998)

I. Basis of the report

1. With regard to the elements of the international application:*

- ☒ the international application as originally filed.
- ☒ the description:
 pages 1-12 _____ as originally filed
 pages NONE _____, filed with the demand
 pages NONE _____, filed with the letter of _____.
- ☒ the claims:
 pages 13 and 14 _____, as originally filed
 pages NONE _____, as amended (together with any statement) under Article 19
 pages NONE _____, filed with the demand
 pages NONE _____, filed with the letter of _____.
- ☒ the drawings:
 pages 1/1 _____, as originally filed
 pages NONE _____, filed with the demand
 pages NONE _____, filed with the letter of _____.
- ☐ the sequence listing part of the description:
 pages NONE _____, as originally filed
 pages NONE _____, filed with the demand
 pages NONE _____, filed with the letter of _____.

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in printed form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

- ☒ the description, pages NONE
- ☒ the claims, Nos. NONE
- ☒ the drawings, sheets/fig NONE

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US03/18292

V. Reasoned statement under Rule 66.2(a)(II) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. STATEMENT

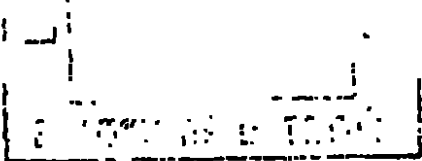
Novelty (N)	Claims <u>1-15</u>	YES
	Claims <u>NONE</u>	NO
Inventive Step (IS)	Claims <u>1-15</u>	YES
	Claims <u>NONE</u>	NO
Industrial Applicability (IA)	Claims <u>1-15</u>	YES
	Claims <u>NONE</u>	NO

2. CITATIONS AND EXPLANATIONS

Claims 1-15 meet the criteria set out in PCT Article 33(2)-(4), because the prior art does not teach or fairly suggest the present process for the continuous production of precooked and partially debranned corn flour for arepa and tortilla, wherein the process comprises the steps of precooking cleaned corn kernel with water heated from a downstream washer to form a suspension of corn and water, having a corn to water ratio between 1:1 and 1:1.5; precooking the corn kernel at a near neutral-pH with a solution comprising at least one xylanase, to effect a partial hydrolysis of insoluble heteroxylans or cell-walls during precooking; washing the precooked kernel to remove soluble solids and denatured xylanase, stabilizing a moisture content of the enzymatically precooked corn kernel; milling the precooked washed corn kernel and drying the milled corn kernel for further pregelatinization; cooling and further drying the milled and dried corn kernel with ambient air, sifting the cooled milled corn to obtain a fine fraction, under 20 to 60 mesh to produce a corn flour with fine particle size, and a coarse fraction; and aspirating the sifted coarse fraction to remove a corn bran for feed or integral flour.

NEW CITATIONS

NONE



TRATADO DE COOPERACIÓN EN MATERIA DE PATENTES

Remitente

OFICINA ENCARGADA DEL EXAMEN PRELIMINAR INTERNACIONAL

A:

ERIC JENSEN
C/O YOUNG & THOMPSON
745 S. 23rd STREET
ARLINGTON, VIRGINIA 22202

PCT

COMUNICACIÓN SOBRE EL ENVÍO DEL
INFORME DE EXAMEN PRELIMINAR
INTERNACIONAL
(PCT Regla 71.1)

		Fecha de envío (Día/Mes/Año)	18 MAR 2004
No. de Expediente del Solicitante o Apoderado 9002-1008-1		COMUNICACIÓN IMPORTANTE	
No. de Solicitud Internacional PCT/US03/18292	Fecha Internacional de Presentación (día/mes/año) 11 de junio de 2003 (11.06.2003)	Fecha de Prioridad (día/mes/año) 30 de agosto de 2002 (30.08.2002)	
Solicitante BARRERA, ROBERTO GONZALEZ			

1. Se comunica al solicitante que la oficina encargada del Examen Preliminar Internacional le envía con el presente el informe de examen preliminar internacional, elaborado para la solicitud internacional, en caso dado con los anexos correspondientes.

2.

Una copia del informe, en caso dado con los anexos correspondientes se hace llegar a la Oficina Internacional para su envío posterior a todas las oficinas seleccionadas.

3. A solicitud de una de las Oficinas Seleccionadas, la Oficina Internacional preparará una traducción del informe (pero no de los anexos) al inglés y la remitirá a esas oficinas.

RECORDATORIO

4. Para ingresar en la fase nacional el solicitante, dentro de los 30 meses a partir de la fecha de prioridad (o en algunas oficinas incluso después), tiene que realizar ante cada oficina seleccionada ciertos actos (entrega de traducciones y desembolso de honorarios nacionales) (Artículo 39 (1)) (véase también el recordatorio remitido por la Oficina Internacional en el Formulario PCT/IB/301).

Si se tiene que enviar a una Oficina Seleccionada una traducción de la solicitud internacional, entonces esta traducción tiene que incluir traducciones de todos los anexos al informe de examen preliminar internacional. Es obligación del solicitante elaborar dichas traducciones y hacerlas llegar directamente a cada Oficina Seleccionada respectiva.

Mayores detalles en cuanto a los plazos normativos y los requisitos de las Oficinas Seleccionadas se desprenden del Volumen II de la guía PCT para solicitantes.

Nombre y dirección postal de la IPEA Mail Stop PCT, Attn: IPEA/US Comisionado de patentes Casilla postal 1450 Alejandría, Virginia 22313-1450 Fax No. (703) 305-3230	Empleado Autorizado (Firmado) Examinador George C. Yeung Teléfono No. (571) 272-1412
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Formato PCT/IPEA/416 (Julio 1992)

TRATADO DE COOPERACIÓN EN MATERIA DE PATENTES

PCT

INFORME DE EXAMEN PRELIMINAR INTERNACIONAL (Artículo 36 y Regla 70 PCT)

No. de Expediente del Solicitante o Apoderado 9002-1008-1	PROCEDIMIENTO POSTERIOR Consultar Notificación de Transmisión de Informe de Examen Preliminar Internacional (Formato PCT/IPEA/416)	
No. Solicitud Internacional PCT/US03/18292	Fecha Internacional de Presentación (día/mes/año) 11 de junio de 2003 (11.06.2003)	Fecha de Prioridad (día/mes/año) 30 de agosto de 2002 (11.08.2002)
Clasificación Internacional de Patente (IPC) o Clasificación Nacional e IPC IPC(7):A23L 1/00 y USA Cl.:426/508, 463, 464, 622, 626		
Solicitante BARRERA, ROBERTO GONZALEZ		

1.	Este informe de examen preliminar internacional fue elaborado por esta Oficina Encargada del Examen Preliminar Internacional y se envía al solicitante según Artículo 36.
2.	Este INFORME comprende un total de 3 hojas, inclusive esta portada ☐ Este informe también comprende ANEXOS, es decir hojas con la descripción, las reivindicaciones y / o los dibujos que se han corregido y que son la base de este informe y / u hojas que contienen rectificaciones autorizadas por esta Oficina (consultar Regla 70.16 y Sección 607 de las Instrucciones Administrativas bajo el PCT). Estos anexos constan de un total de 0 hojas.
3.	Este informe contiene datos con respecto a los siguientes puntos: I ☒ Base del Informe II ☐ Prioridad III ☐ Sin elaboración de un dictamen sobre novedad, actividad inventiva y posibilidad de aplicación industrial IV ☐ Falta de unidad de la invención V ☒ Comprobación justificada según Artículo 35(2) con respecto a la novedad, la actividad inventiva y la posibilidad de aplicación industrial; documentos y explicaciones sustentando esta comprobación VI ☐ Ciertos documentos enumerados VII ☐ Ciertas deficiencias del registro internacional VIII ☐ Ciertas observaciones relacionadas con la solicitud internacional

Fecha de presentación de la petición 24 de noviembre de 2003 (24.11.2003)	Fecha de la conclusión de este informe 20 de febrero de 2004 (20.02.2004)
Nombre y dirección postal de la IPEA Mail Stop PCT, Attn: IPEA/US Comisionado de patentes Casilla postal 1450 Alejandria, Virginia 22313-1450 Fax No. (703) 305-3230	Empleado Autorizado (Firmado) Examinador George C. Yeung Teléfono No. (571) 272-1412

**INFORME DE EXAMEN
PRELIMINAR INTERNACIONAL**

Solicitud Internacional No. PCT/US03/18292

I. Bases del Informe

1. Con respecto a los elementos de la solicitud internacional:*

☒ La solicitud internacional como se presentó originalmente.

☒ La descripción:

Páginas 1-12 como se presentaron originalmente

Páginas NINGUNA presentadas con la petición

Páginas NINGUNA presentadas con la carta de _____

☒ Las reivindicaciones:

Páginas 13 y 14 como se presentaron originalmente

Páginas NINGUNA según se corrigieron (junto con cualquier declaración) bajo Artículo 19

Páginas NINGUNA presentadas con la petición

Páginas NINGUNA presentadas con la carta de _____

☒ Los dibujos:

Páginas 1/1 como se presentaron originalmente

Páginas NINGUNA presentadas con la petición

Páginas NINGUNA presentadas con la carta de _____

☐ La parte de enumeración de la secuencia de la descripción

Páginas NINGUNA como se presentaron originalmente

Páginas NINGUNA presentadas con la petición

Páginas NINGUNA presentadas con la carta de _____

2. En lo concerniente al idioma, todos los elementos indicados más arriba estuvieron a disposición de esta Administración o le fueron enviados en el idioma en el cual se radicó la solicitud internacional, salvo indicación en contrario consignada bajo este punto.

Estos elementos estuvieron a disposición de esta Administración o le fueron enviados en el idioma siguiente: _____, que es:

☐ el idioma de una traducción enviada para efectos de la búsqueda internacional (según la regla 23.1 (b)).

☐ el idioma de publicación de la solicitud internacional (según la regla 48.3 (b)).

☐ el idioma de la traducción enviada para efectos del examen preliminar internacional (según la regla 55.2 y/o 55.3).

3. En lo que concierne a cualquier secuencia de nucleótidos y/o aminoácidos divulgada en la solicitud internacional, el examen preliminar internacional se llevó a cabo sobre la base del listado de secuencias:

☐ contenido en la solicitud internacional, por escrito.

☐ presentado con la solicitud internacional, en formato de lectura por computador.

☐ remitido posteriormente a la administración, por escrito.

☐ remitido posteriormente a la administración, en formato de lectura por computador.

☐ se ha rendido la declaración, según la cual el listado de secuencias por escrito y suministrado posteriormente no va más allá de la divulgación hecha en la solicitud tal como se radicó.

☐ se ha rendido la declaración, según la cual las informaciones registradas en formato de lectura por computador son idénticas a las de los listados de secuencias, presentados por escrito.

4. ☒ Las modificaciones han acarreado la anulación:

☒ la descripción, páginas NINGUNA

☒ las reivindicaciones, páginas NINGUNA

☒ los dibujos, páginas NINGUNA

5. ☐ El presente informe se preparó sin tener en cuenta (algunas de) las modificaciones, que se consideraron que van más allá de la exposición de la invención (regla 70.2 (c))**

** Las hojas intercambiables que se presentaron ante la Oficina receptora como respuesta a una invitación bajo el Artículo 14 se denominan en el presente informe como "presentadas originalmente" y no se anexan a este informe puesto que no contienen correcciones (Reglas 70.16 y 70.17)*

*** (Toda hoja intercambiable que incluya modificaciones de esta índole debe indicarse en el punto 1 y anexarse al presente informe.)*

**INFORME DE EXAMEN PRELIMINAR
INTERNACIONAL**

Solicitud Internacional No. . PCT/US03/18292

V. Declaración motivada bajo Artículo 35(2) en cuanto a la novedad, la actividad inventiva y la posibilidad de aplicación industrial; citas y explicaciones sustentando esta declaración

1: Declaración

Novedad (N)	Reivindicaciones 1-15	SI
	Reivindicaciones NINGUNA	NO
Actividad Inventiva (IS)	Reivindicaciones 1-15	SI
	Reivindicaciones NINGUNA	NO
Posibilidad de Aplicación Industrial (IA)	Reivindicaciones 1-15	SI
	Reivindicaciones NINGUNA	NO

2. Citas y explicaciones

Las reivindicaciones 1-15 cumplen los requisitos establecidos en el PCT Artículo 33(2)-(4) porque el arte previo no enseña ni prácticamente sugiere el proceso presente para la producción continuada de harina de maíz precocida a la cual se le retiró parcialmente el salvado para arepas y tortillas, donde el proceso comprende los pasos de precocer el grano de maíz limpio con agua calentada en una lavadora corriente abajo para formar una suspensión de maíz y agua, con una proporción de maíz a agua entre 1:1 y 1:1.5, precociendo el grano de maíz a un pH cercano a neutro con una solución que comprende por lo menos una xilasa, para efectuar una hidrólisis parcial de heteroxilanos insolubles o paredes celulares durante la precocción; lavando el grano precocido para extraer los sólidos solubles y la xilanasa desnaturalizada, estabilizando el contenido de humedad del grano de maíz con una precocción enzimática; moliendo el grano de maíz precocido y lavado, y secando el grano de maíz molido para una posterior gelatinización; enfriando y luego secando el grano de maíz molido y secado con aire del ambiente; pasando el maíz molido y frío por un tamiz para obtener una fracción fina, con una malla de menos de 20 a 60 para producir harina de maíz con un tamaño de partícula fina, y una fracción gruesa, y aspirando la fracción gruesa del tamiz para retirar el salvado del maíz para alimento o harina integral.

NUEVAS CITAS

NINGUNA

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 9002-1008-1	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/US03/18292	International filing date (day/month/year) 11 June 2003 (11.06.2003)	(Earliest) Priority Date (day/month/year) 30 August 2002 (30.08.2002)
Applicant BARRERA, ROBERTO G.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the Report

a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.



the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:



contained in the international application in written form.



filed together with the international application in computer readable form.



furnished subsequently to this Authority in written form.



furnished subsequently to this Authority in computer readable form.



the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (See Box II).

4. With regard to the title,



the text is approved as submitted by the applicant.



the text has been established by this Authority to read as follows:

5. With regard to the abstract,



the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No. 1



as suggested by the applicant.



None of the figures



because the applicant failed to suggest a figure.



because this figure better characterizes the invention.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/18292

Box III TEXT OF THE ABSTRACT (Continuation of Item 5 of the first sheet)

The technical features mentioned in the abstract do not include a reference sign between parentheses (PCT Rule 8.1(d)).

NEW ABSTRACT

Precooked and partially-debranned corn flour is produced in a continuous process. First, the cleaned corn kernel is precooked at a near neutral-pH with heated water and a xylanase in a precooker (1) to effect a partial bran hydrolysis. The precooked corn kernel is then passed to a washer (2) where it is washed with steam-heated water. After the moisture content of the precooked washed corn kernel is stabilized using a preconditioner (3), the preconditioned kernel is fed to a mill (4) and a dryer (6) to produce a controlled gelatinization in the ground kernel. The ground kernel is then cooled and further dried in a cooler (8) with ambient air. The cooled ground corn is fed to a sifter where a fine fraction is separated and recovered from a coarser fraction, which is also segregated to partially isolate a bran fraction for animal feed or integral flour. The coarser fraction is remilled and served to produce an instant corn flour for arepa. The fine fraction is admixed with lime to obtain a masa flour for tortilla.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/18292

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A23L 1/00

US CL : 426/508, 463, 464, 622, 626

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)

U.S. : 426/507, 508, 509, 463, 464, 481, 518, 622, 626, 18, 52

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,265,013 B1 (MARTINEZ-MONTES et al) 24 July 2001.	1-15
A	US 6,326,045 B1 (RUBIO et al) 04 December 2001.	1-15



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 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

"A"

document member of the same patent family

Date of the actual completion of the international search

07 August 2003 (07.08.2003)

Date of mailing of the international search report

28 AUG 2003

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US

Commissioner for Patents

P.O. Box 1430

Alexandria, Virginia 22313-1430

Facsimile No. (703)305-3230

Authorized officer

Examiner George C. Young

Telephone No. (703) 308-3848

From the INTERNATIONAL BUREAU

PCT

NOTICE INFORMING THE APPLICANT OF THE
COMMUNICATION OF THE INTERNATIONAL
APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:

JENSEN, Eric
c/o Young & Thompson
745 S. 23rd Street
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

Date of mailing (day/month/year) 11 March 2004 (11.03.2004)		
Applicant's or agent's file reference 9002-1008-1		IMPORTANT NOTICE
International application No. PCT/US2003/018292	International filing date (day/month/year) 11 June 2003 (11.06.2003)	
Priority date (day/month/year) 30 August 2002 (30.08.2002)		
Applicant BARRERA, Roberto Gonzalez et al		

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this notice:

AU, AZ, BY, CH, CN, CO, DZ, EP, HU, JP, KG, KP, KR, MD, MK, MZ, RU, TM, US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:

AE, AG, AL, AM, AP, AT, BA, BB, BG, BF, BZ, CA, CF, CU, CZ, DE, DK, DM, EA, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, ID, IL, IN, IS, KE, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MG, MN, MW, MX, NI, NO, NZ, OA, OM, PH, PL, PT, RO, SC, SD, SE, SG, SK, SL, TJ, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this notice is a copy of the international application as published by the International Bureau on 11 March 2004 (11.03.2004) under No. WO 2004/019700

4. **TIME LIMITS** for filing a demand for international preliminary examination and for entry into the national phase

The applicable time limit for entering the national phase will, subject to what is said in the following paragraph, be 30 MONTHS from the priority date, not only in respect of any elected Office if a demand for international preliminary examination is filed before the expiration of 19 months from the priority date, but also in respect of any designated Office, in the absence of filing of such demand, where Article 22(1) as modified with effect from 1 April 2002 applies in respect of that designated Office. For further details, see *PCT Gazette* No. 44/2001 of 1 November 2001, pages 19926, 19932 and 19934, as well as the *PCT Newsletter*, October and November 2001 and February 2002 issues.

In practice, time limits other than the 30-month time limit will continue to apply, for various periods of time, in respect of certain designated or elected Offices. For regular updates on the applicable time limits (20, 21, 30 or 31 months, or other time limit), Office by Office, refer to the *PCT Gazette*, the *PCT Newsletter* and the *PCT Applicant's Guide*, Volume II, National Chapters, all available from WIPO's Internet site, at <http://www.wipo.int/pct/en/index.html>.

For filing a demand for international preliminary examination, see the *PCT Applicant's Guide*, Volume I/A, Chapter IX. Only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination (at present, all PCT Contracting States are bound by Chapter II).

It is the applicant's sole responsibility to monitor all these time limits.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Authorized officer

Gijsbertus Beijer - Carlos Roy

Facsimile No.(41-22) 740.14.35

Telephone No.(41-22) 338.91.11

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/18292

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A23L 1/00

US CL : 426/508, 463, 464, 622, 626

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)

U.S. : 426/507, 508, 509, 463, 464, 481, 518, 622, 626, 18, 52

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,265,013 B1 (MARTINEZ-MONTES et al) 24 July 2001.	1-15
A	US 6,326,045 B1 (RUBIO et al) 04 December 2001.	1-15

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

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

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

"L" documents which may throw doubt 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 number of the same patent family

Date of the actual completion of the international search

07 August 2003 (07.08.2003)

Date of mailing of the international search report

28 AUG 2003

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US

Commissioner for Patents

P.O. Box 1450

Alexandria, Virginia 22313-1450

Facsimile No. (703)305-3230

Authorized officer

Examiner George C. Yeung

Telephone No. (703) 308-3848

From the INTERNATIONAL BUREAU

PCT

INFORMATION CONCERNING ELECTED
OFFICES NOTIFIED OF THEIR ELECTION

(PCT Rule 61.3)

To:

JENSEN, Eric
c/o Young & Thompson
745 S. 23rd Street
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

Date of mailing (day/month/year)

11 March 2004 (11.03.2004)

Applicant's or agent's file reference

9002-1008-1

IMPORTANT INFORMATION

International application No.

PCT/US2003/018292

International filing date (day/month/year)

11 June 2003 (11.06.2003)

Priority date (day/month/year)

30 August 2002 (30.08.2002)

Applicant

BARRERA, Roberto Gonzalez et al

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

EP: AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR
National: AU, BG, CA, CN, DE, GB, IL, JP, KP, KR, MN, NL, NO, PL, RO, RU, SK, US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

AP: GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW

EA: AM, AZ, BY, KG, KZ, MD, RU, TJ, TM

OA: BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG

National: AE, AG, AL, AM, AT, AZ, BA, BB, BR, BY, BZ, CH, CO, CR, CU, CZ, DK, DM, DZ, EC, EE, ES, FI,
GD, GE, GH, GM, HR, HU, ID, IN, IS, KE, KG, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MW,
MX, MZ, NZ, OM, PH, PT, SC, SD, SE, SG, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM,
ZW

3. The applicant is reminded that he must enter the "national phase" before the expiration of 30 months from the priority date before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing, if prescribed, a translation of the international application (Article 39(1) (a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3) (b) and Rule 74.1).

Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

The entry into European regional phase is postponed until 31 months from the priority date for all States designated for the purposes of obtaining a European patent.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Authorized officer

Gijsbertus Beijer - Carlos Roy

Facsimile No.(41-22) 740.14.35

Telephone No.(41-22) 338.91.11

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

JENSEN, Eric
c/o Young & Thompson
745 S. 23rd Street
Arlington, VA 22202
United States of America

Date of mailing (day/month/year) 18 September 2003 (18.09.03)			
Applicant's or agent's file reference 9002-1008-1	IMPORTANT NOTIFICATION		
International application No. PCT/US03/18292	International filing date (day/month/year) 11 June 2003 (11.06.03)		
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 30 August 2002 (30.08.02)		
Applicant BARRERA, Roberto Gonzalez et al			

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
3. An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
4. The letters "NR" appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
30 Augu 2002 (30.08.02)	10/231,291	US	15 July 2003 (15.07.03)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 338.71.40

Authorized officer

Sedia BANGOURA

Telephone No. (41-22) 338 8213

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF RECEIPT OF
RECORD COPY

(PCT Rule 24.2(a))

From the INTERNATIONAL BUREAU

To:

JENSEN, Eric
c/o Young & Thompson
745 S. 23rd Street
Arlington, VA 22202
United States of America

Date of mailing (day/month/year) 09 September 2003 (09.09.03)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 9002-1008-1	International application No. PCT/US03/18292

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

BARRERA, Roberto Gonzalez (for all designated States except US)
RUBIO, Manuel J. et al (for US)

International filing date : 11 June 2003 (11.06.03)
Priority date(s) claimed : 30 August 2002 (30.08.02)
Date of receipt of the record copy
by the International Bureau : 15 July 2003 (15.07.03)
List of designated Offices :

AP : GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW
EA : AM, AZ, BY, KG, KZ, MD, RU, TJ, TM
EP : AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR
OA : BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG
National : AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ,
EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU,
LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW

ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

- ☒ time limits for entry into the national phase - see updated important information (as of April 2002)
☐ confirmation of precautionary designations (if applicable)
☐ requirements regarding priority documents (if applicable)

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer: Kiwa MPAY
Facsimile No. (41-22) 338.71.40	Telephone No. (41-22) 338 9087

INFORMATION ON TIME LIMITS FOR ENTERING THE NATIONAL PHASE

The applicant is reminded that the "national phase" must be entered before each of the designated Offices indicated on the cover sheet of this Notification by paying national fees and furnishing translations, as prescribed by Articles 22 and 39 and the applicable national laws. In addition, the applicant may also have to comply with other special requirements applicable in certain Offices. It is the applicant's responsibility to ensure the necessary steps to enter the national phase are taken in a timely fashion. Most Offices do not issue reminders to applicants in connection with the entry into the national phase.

The applicable time limit for entering the national phase will, subject to what is said in the following paragraph, be 30 MONTHS from the priority date, not only in respect of any elected Office where a demand for international preliminary examination is filed before the expiration of 19 months from the priority date (see Article 39(1)), but also in respect of any designated Office, in the absence of filing of such demand, where Article 22(1) as modified with effect from 1 April 2002 applies in respect of that designated Office. For further details, see PCT Gazette No. 44/2001 of 1 November 2001, pages 19926, 19932 and 19934, as well as the PCT Newsletter, October and November 2001 and February 2002 issues.

In practice, time limits other than the 30-month time limit will continue to apply, for various periods of time, in respect of certain designated or elected Offices. For regular updates on the applicable time limits (20, 21, 30 or 31 months, or other time limit), Office by Office, refer to the PCT Gazette ("Section IV" part published on a weekly basis), to the PCT Newsletter (on a monthly basis) and to the relevant National Chapters in Volume II of the PCT Applicant's Guide (the paper version of which is updated usually twice a year and the Internet version of which is updated usually on a weekly basis). Finally, a cumulative table of all applicable time limits for entering the national phase is available from WIPO's Internet site, via links from various pages the site including those of the Gazette, Newsletter and Guide, at <http://www.wipo.int/pct/en/index.html>.

Information about the requirements for filing a demand for international preliminary examination is set out in the PCT Applicant's Guide, Volume I/A, Chapter IX. Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination (at present, all PCT Contracting States are bound by Chapter II).

CONFIRMATION OF PRECAUTIONARY DESIGNATIONS

This notification lists only specific designations made under Rule 4.9(a) in the request. It is important to check that these designations are correct. Errors in designations can be corrected where precautionary designations have been made under Rule 4.9(b). The applicant is hereby reminded that any precautionary designations may be confirmed according to Rule 4.9(c) before the expiration of 15 months from the priority date (this time limit may not be extended). If it is not confirmed, it will automatically be regarded as withdrawn by the applicant. There will be no reminder and no invitation. Confirmation of a designation consists of the filing of a notice specifying the designated State concerned (with indication of the kind of protection or treatment desired) and the payment of the designation and confirmation fees. The Notice of confirmation and payment must reach the receiving Office within the 15-month time limit.

REQUIREMENTS REGARDING PRIORITY DOCUMENTS

For applicants who have not yet complied with the requirements regarding priority documents, the following is recalled.

Where the priority of an earlier national, regional or international application is claimed, the applicant must submit a copy of the said earlier application, certified by the authority with which it was filed ("the priority document") to the receiving Office (which will transmit it to the International Bureau) or directly to the International Bureau, before the expiration of 16 months from the priority date, provided that any such priority document may still be submitted to the International Bureau before that date of international publication of the international application, in which case that document will be considered to have been received by the International Bureau on the last day of the 16-month time limit (Rule 17.1(a)).

Where the priority document is issued by the receiving Office, the applicant may, instead of submitting the priority document, request the receiving Office to prepare and transmit the priority document to the International Bureau. Such request must be made before the expiration of the 16-month time limit and may be subjected by the receiving Office to the payment of a fee (Rule 17.1(b)).

If the priority document concerned is not submitted to the International Bureau or if the request to the receiving Office to prepare and transmit the priority document has not been made (and the corresponding fee, if any, paid) within the applicable time limit indicated under the preceding paragraphs, any designated State may disregard the priority claim, provided that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within the time limit which is reasonable under the circumstances.

Where several priorities are claimed, the priority date to be considered for the purposes of computing the 16-month time limit is the filing date of the earliest application whose priority is claimed.

PATENT COOPERATION TREATY

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From the INTERNATIONAL SEARCHING AUTHORITY

To:
ERIC JENSEN
C/O YOUNG & THOMPSON
745 S. 23RD STREET
ARLINGTON, VIRGINIA 22202

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 9002-1008-1 Rubio	Date of Mailing (day/month/year) 28 AUG 2003
International application No. PCT/US03/18292	International filing date (day/month/year) 11 June 2003 (11.06.2003)
Applicant BARRERA, ROBERTO G.	

1. ☐ The applicant is hereby notified that the international search report has been established and is transmitted herewith.
 Filing of amendments and statement under Article 19:
 The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):
 When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.
 Where? Directly to the International Bureau of WIPO, 34, chemin des Colombettes
 1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 740.14.35
 For more detailed instructions, see the notes on the accompanying sheet.
2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.
3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.
☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.
4. **Reminders**
 Shortly after 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90 bis.1 and 90 bis.3, respectively, before the completion of the technical preparations for international publication.
 Within 19 months from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later); otherwise the applicant must, within 20 months from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.
 In respect of other designated Offices, the time limit of 30 months (or later) will apply even if no demand is filed within 19 months.
 See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1490 Alexandria, Virginia 22313-1490 Facsimile No. (703)305-3230	Authorized officer Examiner George C. Yeung Telephone No. (703) 308-3848
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Form PCT/ISA/220 (April 2002)

(See notes on accompanying sheet)

PATENT COOPERATION TREATY

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From the INTERNATIONAL SEARCHING AUTHORITY

To:
ERIC JENSEN
C/O YOUNG & THOMPSON
745 S. 23RD STREET
ARLINGTON, VIRGINIA 22202

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

Date of Mailing (day/month/year) 28 AUG 2003	
Applicant's or agent's file reference 9002-1008-1	FOR FURTHER ACTION See paragraphs 1 and 4 below
International application No. PCT/US03/18292	International filing date (day/month/year) 11 June 2003 (11.06.2003)
Applicant BARRERA, ROBERTO G.	

1. ☐ The applicant is hereby notified that the international search report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

Where? Directly to the International Bureau of WIPO, 34, chemin des Colombettes
1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.
2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.
3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.
☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.
4. **Reminders**

Shortly after 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90 bis.1 and 90 bis.3, respectively, before the completion of the technical preparations for international publication.

Within 19 months from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later); otherwise the applicant must, within 20 months from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of 30 months (or later) will apply even if no demand is filed within 19 months.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703)305-3230	Authorized officer Examiner George C. Feung Telephone No. (703) 308-3848
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NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under Article 19. The Notes are based on the requirements of the Patent Cooperation Treaty and of the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and these requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule" and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions, respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except when, e.g. the applicant wants the later to be published for the purpose of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

What parts of the international application may be amended?

The claims only.

The description and the drawings may only be amended during international preliminary examination under Chapter II.

When? Within 3 months from the date of issuance of the international search report or 16 months from the priority date, whichever date first expires here. It should be noted, however, that the amendments will be considered as having been received on date if they are received by the International Bureau after the expiration of the application time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where and to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How? Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be numbered consecutively (Administrative Instructions, Section 203(b)).

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.

NOTES TO FORM PCT/ISA/220 (continued)

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under Article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

The statement should be brief, it should not exceed 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)".

It should not contain any disparaging comments on the international search report or the relevance of citations contained in the report. References to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

In what language?

The amendments must be made in the language in which the international application is published. The letter and any statement accompanying the amendments must be in the same language as the international application if that language is English or French; otherwise, it must be in English or French, at the choice of the applicant.

Consequences if a demand for international preliminary examination has already been filed?

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

Consequences with regard to translation of the international application for entry into the national phase?

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.



US006326045B1

(12) **United States Patent**
Rubio et al.

(10) Patent No.: **US 6,326,045 B1**
(45) Date of Patent: **Dec. 4, 2001**

(54) **METHOD FOR THE PRODUCTION OF PRECOOKED AND DEHULLED CORN FLOUR FOR AREPA AND TORTILLA**

5,558,898 * 9/1996 Sunderland 426/626

* cited by examiner

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(57) **ABSTRACT**

Precooked and dehulled corn flour for arepa and tortilla is produced in a continuous process. First, the whole cleaned kernel is wetted and crushed to obtain two fractions. The fine fraction only is air-dried and sieved, while segregating both fractions through aspirations to isolate a floury-grit and hull fraction, incorporating the isolated fractions for animal feed by-product, and further producing an endosperm-germ fraction. The endosperm-germ fraction is conditioned and pre-cooked fraction, cooled, air-dried and stabilized as to moisture content in the flaked material. It is then ground to particulate form, separating and collecting fine particles from coarse particles which are further processed, subjecting only the fine particles to centrifugation to yield an integral arepa flour, and, if desired, admixing the fine flour with lime to make a masa flour.

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(52) U.S. Cl. 426/518; 426/463; 426/464; 426/511; 426/622

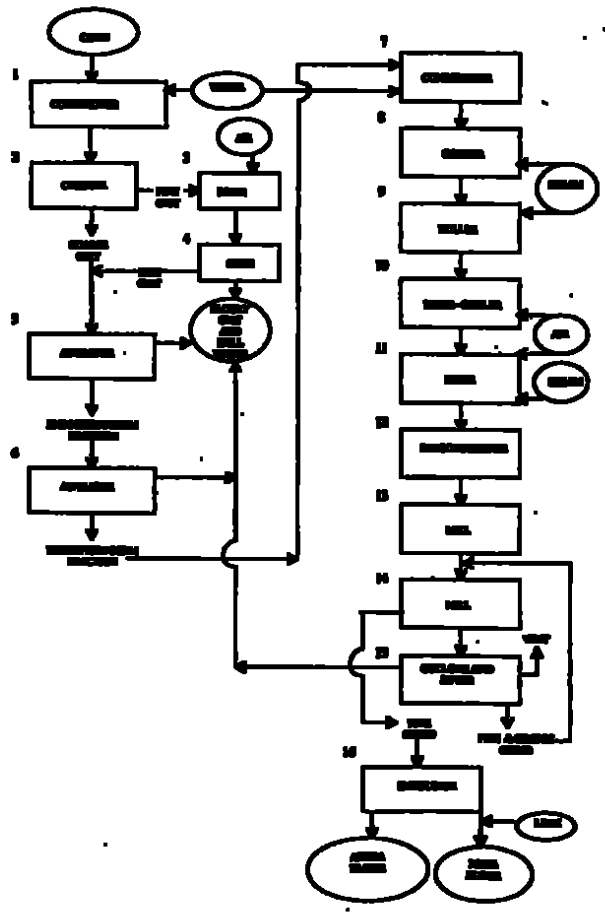
(58) Field of Search 426/506, 510, 426/511, 463, 464, 618, 622, 626, 482

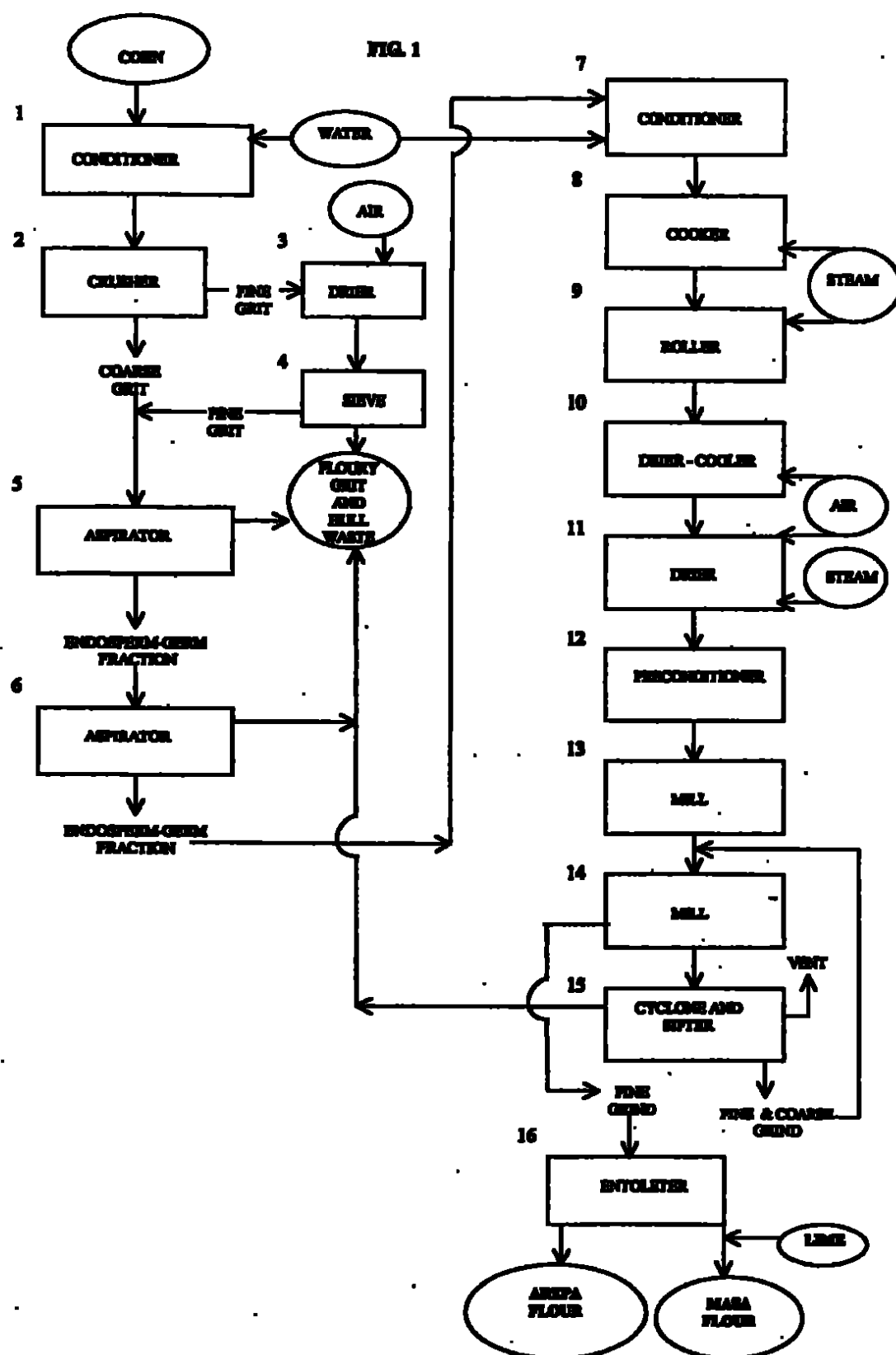
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18 Claims, 1 Drawing Sheet





METHOD FOR THE PRODUCTION OF
PRECOOKED AND DEHULLED CORN
FLOUR FOR AREPA AND TORTILLA

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a thermal-mechanical process for the manufacture of precooked and dehulled corn flour and, more particularly, relates to a continuous column-roller process applied to the production of instant corn flour for use in the preparation of arepa and tortilla and derivatives thereof.

2. Description of Related Art

Corn represents one of the most important cereal grains for the nutrition of the Latin American population. The amounts consumed, as well as the form of consumption, are quite variable among different countries in the region. In Mexico and some Central American countries, the grain is transformed into food products by a unique process known as "nixtamalization", which basically consists of the alkaline cooking of whole corn kernel and breaking of the hull (or pericarp) down toward a partially gelatinized state (U.S. Pat. No. 4,513,018). Afterwards, the cooked corn is washed, ground and dried to give corn masa flour for different product applications. The main edible product of the traditional process is the "tortilla" which is a flat, round, unfermented and baked thin pancakes produced from lime-cooked maize.

In the northern part of South America, particularly in Colombia and Venezuela, hard endosperm corn is processed with dry milling technology and it is further converted into a precooked flour for traditional maize foods. Its consumption is mainly in the form of "arepa" which is a flat, unleavened and baked thick pancakes made from dehulled and degermed cooked-maize. In other South American countries, corn meal and corn flour are used for different bakery and pancake mixes as well as snack products.

At the present time, there is a large expansion in the consumption of corn products in the U.S.A. and tortilla is one raw material for the preparation of snack and traditional "Mex-Mex" dishes. Thus, there is an increasing demand and use of industrially prepared corn flours so they can provide benefits to the consumer, such as convenience, availability, price and a more stable quality. The potential market for masa flours in the U.S.A., Mexico and Central America is estimated at 17.8 million tons per year based on an average annual per capita consumption of 122 kilograms (tortilla and snacks: Sustain, 1997).

In the production of corn products, such as tortillas, chips and the like, from food grade corn, it is known that the hard endosperm corn (U.S. Pat. No. 2: USPGC, 1996) must be partially cooked before it is formed into the end product, so as to cause it to be a partially gelatinized corn flour. In the past, this has been done by processes wherein the corn is cooked and/or steeped in a lime-water solution (traditional nixtamalization) such as those disclosed in U.S. Pat. Nos. 2,584,893 (Lloyd et al.), 3,194,664 (Eyttinge) and 4,326,455 and 4,513,018 (Rubio), and subsequently ground and dried to produce nixtamalized corn flour (masa flour) from which such corn products may be made. As it may be seen from the above, the prior art methods for the industrial production of corn dough or masa flour involve accelerated cooking times with large amounts of processing water and increased costs for water removal. The lime-cooking changes produced in the hull or pericarp fraction are connected with the hydrolysis and solubilization which releases a highly hydrated

dietary fiber having a marked effect on the rheological and mechanical characteristics of the traditional dough and its tortilla. Furthermore, the lime-water residue ("nejayote") is composed of 2.2 to 2.8% total solids from a continuous cooker which included 64-76% dietary fiber, 12-20% starch and 1.4% protein. The new corn quality, cooking-time profile and process-type (Alvarez and Ramirez, 1995) utilized have been proposed as the main variables which determine corn solid losses in nejayote.

With the aim of solving the above described problems by the traditional and/or industrial processes, some workers have developed alkaline-cooking methods with extruders. In this connection reference is made to the following U.S. Pat. Nos: Rubio 4,250,802, Martinez-Bustos et al. 5,532,013 and Barea et al. (1979). Although the above-described prior art provides means for rendering grain, such as corn or dehulled corn, into corn dough and/or masa flour under process conditions involving reduced amounts of water with shortened processing times, an industrial extruder capable of producing such a corn dough or masa flour was still unavailable in the market.

In view of the limitations of the prior art accelerated methods for alkaline-cooking (thermal process) and alkaline-extrusion (thermal-mechanical process) for producing instant masa flour, they are not yet suitable for obtaining a corn flour with "different degrees of starch gelatinization" during precooking of the corn endosperm. In accelerated alkaline-cooking with simultaneous "impact grinding and flash drying processes", the peripheral zone of the endosperm might present starch gelatinization and, while this permits an increase in water adsorption (dough yield) during preparation of the dough, it may also facilitate water evaporation (dehydration) during tortilla cooking, whereby the mechanical properties are negatively affected by hardening or staling of the tortilla without texture additive.

In view of the above, Wimmer et al. in U.S. Pat. No. 3,404,986 proposed a mechanical method for separating germ, endosperm and hull (pericarp) of the corn kernel and then prepared mixtures of moisturized standard corn meal and degerminated meal or flour (containing 18 to 35% moisture) and subjected it to the action of heated rotating mills to cause controlled starch gelatinization (precooking) with subsequent drying and grinding to produce a corn flour. This instant corn flour can be used for a reduced fat snack and may be used in tortilla preparation. Hart, in U.S. Pat. No. 4,329,371, describes a hybrid method without the use of alkali-cooking, by providing a step of dehulling the corn grains with a dehulling apparatus, separating the hull from the endosperm and germ fractions, using the hull for other low-value applications, and cooking the endosperm and germ fractions with steam. This cooked-dehulled fraction is then dried and ground to produce a corn flour for tortilla.

Vaqueiro et al., in U.S. Pat. No. 4,594,260, discloses another hybrid method of obtaining corn flour which essentially comprises removing the hull from the germ and endosperm of the corn kernel until a hull-containing fraction and an endosperm-germ-containing fraction are produced and then nixtamalizing by the traditional method only the hull fraction and remaking the same with the uncooked endosperm-germ fraction (containing 30 to 35% moisture). This moisturized mixture is ground and dried to obtain an instant corn masa flour used in producing tortilla. Herbster, in U.S. Pat. No. 5,176,931, defines a short-time, low-pollution hybrid method of preparing masa flour for making tortilla chips. This procedure preferably comprises subjecting alkali-treated dehulled and moisturized corn (15 to 35%) to near infrared radiation in order to partially cook the

dehulled grain. The precooked-dehulled fraction can be additionally cooked, cooled and milled to desired particle size similar to industrial masa flour (Masa mixta brand) having 55% of non-gelatinized starch granules, 25% partially gelatinized and 20% fully gelatinized (according to microscopic examination).

According to Watson (1987), the corn hull or pericarp (bran) makes up 5-6% of the kernel dry weight. In reference to the value-enhanced corn report (USFGC, 1996), a white-hard-endosperm kernel may contain: 11.5-11% moisture, 72.2-73.2% starch, 10.5-9.8% protein, 4-3.7% fat, and 2.1-2.3% of ash and crude fiber. Furthermore a dry-milled sample might yield, on a dry weight basis, 76.2-74.8% of total endosperm, 18.9-20.5% of germ and 4.9-4.8% of pericarp. A typical materials balance for a Venezuelan arepa plant can yield a minimum of 65% flour on a wet basis (Caesna, 1985). By 1993, a whole or integral arepa flour was produced with more fiber and less protein and fat as compared to the traditional degummed flour which is enriched by Venezuelan law with vitamins (B and A) and iron.

ceased to render from them a desired particle size; subjecting only the fine grind to a high speed centrifugation to further control of fillth material for arepa flour and to admixing with lime to produce masa flour for tortilla and the like.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention may be understood from the description which follows of preferred embodiments when read with the accompanying drawing in which:

FIG. 1 is a schematic flow sheet of an embodiment in accordance with the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring first to FIG. 1, there is depicted, in flow diagram form, an embodiment of the present invention. It includes a conditioner 1; a crusher 2; a drier 3; a sieve 4; a primary aspirator 5; a secondary aspirator 6; a conditioner 7; a cooker 8; a roller 9; a drier-cooler 10; a drier 11; a preconditioner

Fiber Components of Corn Kernel Parts

Part	% Dry Matter	Fiber Load	Starch/Germ	Cellulose	Lignin	Fiber Soluble	Fiber Total	% Kernel Fiber
Whole Kernel	100	8.5	6.7	3	0.3	0.1	9.3	100
Brach endosperm	80.9	1.0	—	—	—	0.5	1.5	12
Alendosperm	2.0	90.0	—	—	—	25.0	75.0	15
Germ	11.0	11.0	18	7	1.0	3.0	14.0	16
Pericarp (hull)	5.3	90.0	67	23	0.1	0.8	90.7	51
Tip cap	0.8	95.0	70	—	2.0	—	95.0	6

SUMMARY AND OBJECTS OF THE INVENTION

Accordingly, it is an object of this invention to provide a complete departure from the prior art precooking methods of thermal and mechanical processing of dehulled corn in order to control starch gelatinization during production of instant corn flour for arepa and tortilla and derivatives thereof.

Another object is to produce this instant corn flour utilizing a continuous precooking process which is not only efficient but also less expensive than prior art accelerated methods for producing masa flour.

Still another object is to produce instant corn flour for arepa and tortilla wherein such flour is relatively uniform and homogeneous in its physical and chemical properties.

The above and other objects and advantages of the invention are achieved by a new continuous process applied to the production of precooked and dehulled corn flour or instant corn flour for arepa and tortilla, embodiments of which comprise the steps of: wetting the whole cleaned kernel to condition the same; crushing the wetted kernel to produce fine and coarse fractions; air-drying and classifying the fine fraction; separating from both fractions a flowy grit and hull fraction as a corn by-product; conditioning the detailed fraction to partially hydrate the starchy endosperm; precooking the conditioned material in a column with steam injection and further roller flaking to obtain a desired degree of gelatinization; cooling, air-drying and stabilizing the flaked material moisture to a desired optimum level for grinding; grinding the dried flakes in a series of primary and secondary mills and producing air-suspendable particles; separating and recovering the fine particles so produced from the coarse particles while the latter are further pro-

12; a primary mill 13; a series of secondary mills 14; a cyclone with an associated sifter 15; and an oscillator 16.

Whole corn kernel, which has been freed of foreign material, is fed to a conditioner 1, where the corn is sprayed with water to wet the hull and germ fractions. The wet kernel is passed through a crusher 2, which breaks the hull loose from the kernel, tears out the germ, and coarsely grinds the endosperm into two fractions.

The large portion of corn endosperm is known as the coarse grit fraction (or "flaking grits"), while the small portion is described as the fine grit fraction composed of endosperm, germ and hull which is also known as "through stock or standard meal".

The fine grit fraction obtained is next directed to an air-drier 3, which reduces the moisture content of the ground fine mixture to about 9-11%, similar to the incoming whole corn, depending on the kernel hardness and its granulation being produced.

The dried fine grit is further conveyed to a sieve 4, wherein two fractions are obtained, the flowy grit with a softened hull fraction (containing from 10%-12% moisture) which is removed and sold as corn by-product, and the fine grit which is thereafter fed to the primary aspirator 5, together with the coarse fraction directly obtained from the crusher 2.

The density separation steps which are performed in both primary 5 and secondary aspirator 6, each produce two fractions in a series of operations. The flowy grit and hull fraction segregated by aspirator 5 and 6 is isolated as corn by-product, and the detailed fraction is conveyed to a conditioner 7 (representing from about 80% to 85% of the total weight incoming corn).

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The dehusked or endosperm-germ fraction is thereafter subjected to a tempering step in conditioner 7, wherein this fraction is sprayed with water in order to partially hydrate from 9% to 12% to about 20% to 22% for a period of about 20 to 30 minutes. After completing the conditioning step, the moisturized material is transferred to a cooker 8, wherein a partial gelatinization or precooking is performed through a column with the addition of live steam at the bottom end (70 to 98 psi and 154° to 162° C.) in order to precook for a period of from about 40 to about 100 minutes. The main degree of partial starch gelatinization is further controlled by passage of the precooked material between closely adjusted heated rotating steel drums or rollers 9. They are heated internally with saturated steam (450 to 500 psi and 210° to 240° C.) so precooking is closely controlled by roll pressure, roll temperature, separation and speed variables which govern the material residence time. Any granular material is squeezed to form precooked flakes with an additional partial gelatinization at a temperature between 88° and about 93° C. having a moisture content between 17% and about 19%.

The precooked flake is thereafter passed through a drier-cooler 10, whereby an adiabatic drying with atmospheric air allows the moisture content of the material to be adjusted to about 14% and 17%, depending on the flake granulation and its incoming temperature (55° to 60° C.). The cooled flake is discharged into a drier 11, wherein the material is further reduced to a moisture content of about 10% to 12% by steam-tube drying (45 to 60 psi and 135° C. to 145° C.) and incoming air for a period of time of from about 2 to about 5 minutes. The dried flake is then passed to a preconditioner 12, where the flake moisture is further stabilized between 30 and about 90 minutes transit time and further enhancing the grinding which is to follow because the moisture is more nearly uniform.

The stabilized flake thus obtained is thereafter ground in a primary mill 13, wherein a coarse grind is obtained by a roller mill from which the premilled flake mixture is passed to a series of secondary mills 14. The premilled flake is further fed to a series of four secondary roller mills 14, where the material is reduced to a coarse and fine grind which are further conveyed by a pneumatic pipe system to a cyclone and sifter 15. The grind material thus obtained is fed to a cyclone and sifter 15, whereby three different fractions are obtained, namely, a light floury-hull which is segregated in the cyclone whose design is known per se and discarded as corn by-product, a fine grind which is directly fed to a single secondary roller mill 14, and a third coarse grind which is thereafter reprocessed in a series of three secondary roller mills 14.

The fine grind which is obtained from a single secondary roller-mill 14, is further centrifuged in an extolater 16, whereby two fractions are produced, namely, a light flint material, and a heavy fine flour which is known as instant corn flour for arepa.

In this method, arepa flour is produced in a 80% to 85% yield per kilogram of corn kernel. There is an improved yield gain from 15% to 20% of the total corn weight as compared to the typical arepa process which yields from 65% to 70%.

Furthermore, and surprisingly, this method produces an arepa flour having higher protein content (by 10% to 20%), fat content (by 50% to 100%) and fiber content (about 100% higher) than dehusked and degermed corn flour for arepa and the like produced by conventional methods.

Finally, this centrifugated fine thus obtained from an extolater 16, may be admixed with lime (0.3% weight, based on flour) from which an instant masa flour is also produced (U.S. Pat. No. 3,730,732).

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From the foregoing, it will be clear that it is possible to manufacture a precooked and dehusked corn flour or an instant masa flour for arepa and tortilla with a new continuous process which is highly efficient because of the minimum use of water, which in turn makes the grinding process more uniform, and avoids expensive costs of removing the water and wasted corn solids that would have been present but for the features of this invention.

It is to be understood that the embodiments of this invention herein illustrated and described, are by way of illustration and not of limitation, and that other embodiments may be made by those skilled in the art without departing from the spirit or scope of this invention.

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We claim:

1. A method for continuously making precooked and dehusked arepa flour from cleaned corn kernel, comprising continuously and repeatedly performing the following steps:
conditioning whole corn kernel, by washing with sprayed water to wet hull and germ fractions thereof,
crushing said whole corn kernel by breaking hull portions loose therefrom and milling the crushed kernel into first and second fractions,
air-drying and classifying said first fraction to remove therefrom a first floury grit and hull fraction as a by-product,
aspirating said second fraction to remove therefrom a second floury grit and hull fraction, and mixing the first and second floury grit and hull fractions as a combined by-product, while producing an endosperm-germ fraction,

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conditioning the endosperm-germ fraction to partially hydrate starchy endosperm thereof,
precooking the conditioned endosperm-germ fraction in a steam column-cooker and further cooking in a roller to effect a controlled partial gelatinization,
cooling the cooked endosperm-germ fraction in an adiabatic drier to produce a flake material, and air-drying and stabilizing the flake material to a desired moisture, grinding the dried flake material in a series of primary and secondary roller mills, separating and collecting a resulting fine grind from a resulting coarse grind while the coarse grind is further processed, and
subjecting only the fine grind to a centrifugation in an entoleter to isolate a light flake material and to produce an integral arepa flour.
2. The method of claim 1, further comprising admixing lime with said integral arepa flour, to produce a masa flour.
3. The method of claim 1 wherein said arepa flour is produced in a 80% to 85% yield per kilogram of corn kernel.
4. The method of claim 1 wherein said crushing of the cleaned and conditioned kernel is carried out with an abrading mill producing a coarse and a fine fraction.
5. The method of claim 4 wherein said fine fraction is dried while removing moisture therefrom to a content of about 9% to 11% and further sieving of said fraction to isolate a flour grit and hull fraction as a corn by-product.
6. The method in accordance with claim 4 wherein said endosperm-germ fraction is further removed through a series of aspirators to isolate a floury grit and hull fraction as an animal-feed, representing from 15% to about 20% of the total weight of corn kernel.
7. The method in accordance with claim 5 wherein said endosperm-germ fraction is further removed through a series of aspirators to isolate a floury grit and hull fraction as an animal-feed, representing from 15% to about 20% of the total weight of corn kernel.
8. The method according to claim 6 wherein said dehulled fraction is tempered by spraying water until reaching a moisture of about 21%, for about 20 to 30 minutes.

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9. The method in accordance to claim 8 wherein said conditioned fraction is partially precooked in two steps:
a) with steam-injection in a column-cooker at a steam temperature of about 154° C. to 162° C. and for 40 to 100 minutes, and
b) with controlled roll pressure and steam temperature.
10. The method according to claim 9 wherein said precooked flake is air-dried in two steps:
a) adiabatic drying or cooling said flake while removing moisture therefrom from about 18% to 15%, and
b) steam-tube drying to decrease the flake moisture from about 15% to about 11% at a steam temperature of about 135° to 145° C., for a time of 2 to 5 minutes.
11. The method according to claim 10 wherein said dried flake is ground in a primary and secondary roller mill and segregated under 30 to 60 mesh depending on a desired arepa flour or end product.
12. The material according to claim 11 wherein said fine grind is centrifuged in an entoleter for producing an arepa flour and admixed with lime for a masa flour (0.3% weight based on arepa flour).
13. The method according to claim 12 wherein said arepa flour is rehydrated by mixing with warm water from a ratio of about 1:1.3 to about 1:1.4 weight ratio for a corn dough used in arepa preparation.
14. The method according to claim 12 said masa flour is rehydrated by mixing with water from a 1:1 to about 1:1.3 ratio for a masa dough used for tortilla elaboration.
15. The method of claim 9, wherein the roll pressure during the precooking is in the range of 450 to 500 psi.
16. The method of claim 13, wherein the steam temperature during the precooking is between 210° C. and 240° C.
17. The method of claim 13, wherein the corn dough used in arepa preparation has a final moisture content between 53% and 60%.
18. The method of claim 14, wherein the masa dough used for tortilla elaboration has a final moisture content between 45% and 49%.

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(12) **United States Patent**
Martinez-Montes et al.

(10) Patent No.: **US 6,265,013 B1**
(45) Date of Patent: **Jul. 24, 2001**

(54) **SELECTIVE NIXTAMALIZATION PROCESS FOR THE PRODUCTION OF FRESH WHOLE CORN MASA, NIXTAMALIZED CORN FLOUR AND DERIVED PRODUCTS**

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(52) U.S. Cl. **426/622; 426/463; 426/507; 426/626**

(58) Field of Search **426/523, 507, 426/509, 463, 464, 481, 518, 622, 626**

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(57) **ABSTRACT**

A process for the production of fresh masa, nixtamalized flour and derived products is disclosed. Water-lime cooking of pericarp fractions of the corn, and appropriate hydration of the germ and endosperm fractions of the corn is achieved to prepare fresh masa, nixtamalized corn flour and derived products. The pericarp fractions are cooked with lime and water at a temperature between about 50° C. to about 300° C. The germ and endosperm fractions are hydrated with water. The pericarp fractions and the germ-endosperm fractions are milled separately, and the milled pericarp, germ and endosperm fractions are then mixed for producing fresh corn masa. The fresh corn masa can be dehydrated and milled for producing nixtamalized corn flour. Also, the pericarp, germ and endosperm fractions can be dried in order to produce nixtamalized corn flour.

35 Claims, No Drawings

SELECTIVE NIXTAMALIZATION PROCESS FOR THE PRODUCTION OF FRESH WHOLE CORN MASA, NIXTAMALIZED CORN FLOUR AND DERIVED PRODUCTS

FIELD OF THE INVENTION

The present invention refers to a process for the preparation of nixtamalized whole corn for the preparation of tortillas, nixtamalized corn flour and corn and tortilla chips. Fractions pericarp, germ, and endosperm of any genotype of corn, lime or a substitute, and water are used as starting materials.

BACKGROUND TO THE INVENTION

Corn was the principal source of food for the pre-Columbian civilizations of the New World. Today corn tortillas and derivative products are still the staple food of Mexico and Central America. Also, corn tortilla, corn chips, and tortilla chips have widely penetrated the market of the United States and some countries of Asia and Europe. The tortilla industry represents one fifth of the global food market in Mexico. The nixtamalization process involves alkaline cooking, steeping, washing, and stone-grinding of the cooked grains to produce masa. Corn masa is kneaded and molded, then baked on a hot griddle to produce table tortillas, which can be fried for tortilla chips and taco shells. Fresh masa can be kneaded, molded, cut, and fried for corn chips, or dried to produce nixtamalized corn flour. In Mexico, approximately 70% of the total corn production is consumed in the form of tortillas. Among the low income population, tortilla is the main source of calories and proteins.

The traditional method to process corn into tortillas (nixtamalization) goes back to early Mesoamerican civilizations, and the basic steps of the process have remained basically unaltered since. The traditional process, whole corn is cooked in a boiling water-lime (or water-ash) solution for a short time (5-45 min) and steeped in this solution, as it cools, for a period of 12 to 18 hours. The cooking liquor, called nejayote, is discarded; with it is lost the fraction of the pericarp and germ dissolved in the nejayote. The cooked, steeped, and drained corn grains (nixtamal) are washed to remove excess lime; here again, a part of pericarp and germ material is lost; the total corn fraction lost varies from 7 to 15%. The nixtamal is ground with a pestle and stone into masa. Finally, the masa is flattened into thin disks that are cooked on a hot griddle for 30-60 seconds on each side to produce tortillas. Tortillas prepared by the traditional method just described generally show excellent rheological characteristics, such as puffing and elastic strength.

Masa for tortilla can also be obtained by hydration of instant flour, which in turn is made from drying fresh masa. Although the quality of tortilla made from instant flour is inferior to that made from fresh masa, the industrial production of nixtamalized corn flour has become popular among the small and large tortilla producers because of its advantages insofar as distribution and storage are concerned.

However the quality of tortillas made from instant flour is usually poorer than the quality of tortillas made with the traditional method. Diverse methods for making tortillas are shown in the U.S. Pat. No. 2,584,893, issued to W. R. Lloyd and R. Millares-Sotres, February 1952; and U.S. Pat. No. 2,704,257 issued to Sollano and Berriozabal, March, 1955.

Prior efforts have been directed towards the improvement of the stability of the end products, the reduction of cooking

time, the reduction of losses of alkali-soluble substances, and to improve the quality of the final product to a level set by the traditional method (U.S. Pat. No. 2,704,257, issued to C. S. F. Diaz de Sollano, and J. M. Berriozabal on Mar. 15, 1955).

Although this method represents an improvement over the traditional nixtamalization process, it requires the use of very costly equipment that is difficult to control.

Mammel Jesus Rubio in his U.S. Pat. No. 3,730,732, reported an increase in the yield of masa by incorporating water alkaline soluble substances. Also, Rubio reported that adding alkali soluble substances to masa retards spoilage of tortillas. However, the tortillas tend to become hard and brittle.

E. L. Wimmer et al in their U.S. Pat. No. 3,404,986, issued on Oct. 8, 1968, reported a method of manufacturing a corn flour with a rich whole corn flavor, different from flour obtained by lime treatment. This patent teaches how to partially gelatinize a previously prepared corn meal with a closely adjusted heated rotating rolls. The resulting flakes are thereafter ground to obtain corn flour. The instant flour obtained by this process can be used for fried snacks but not for the manufacture of tortillas.

Mexican patent No. 125,285, issued to Colocin on Apr. 25, 1972, describes a different process and apparatus for the preparation of nixtamalized corn flour by using a dry process in which a previously prepared corn meal with an appropriate amount of lime is heated in a chamber. However, it may be regarded as producing poor results in view of the fact that mixing of the corn meal and the lime in a powdered state, produces inhomogeneities in the nixtamalization process, with the consequent difficulties in quality control of the corn flour obtained by said process.

U.S. Pat. No. 4,513,018 issued to Rubio, M. J. on Apr. 23, 1985, discloses a continuous method for producing corn flour suitable for making tortillas, taco shells, tortilla chips and the like, which uses a modified nixtamalization process which includes the precooking of corn grains in the presence of lime within a vessel provided with a screw conveyor, although the main problems of the traditional method remain.

Special attention should be given to in U.S. Pat. No. 4,594,260 issued to M. C. Vazquez, and P. Reyes on Jun. 10, 1986. This patent teaches a technology wherein, the hull is removed from the germ and endosperm of the corn kernel, nixtamalized by the traditional method, and then re-mixed with the non nixtamalized endosperm and germ fractions. This method, although more efficient than the traditional method in view of the fact that only a small fraction of the corn kernel has to be nixtamalized, produces contaminated effluents, involves longer processing times and requires rather elaborate equipment to separate the hull fraction. Also the hull must be free of endosperm fractions in order to produce a good quality of masa for instant flour preparation.

Other methods of instant flour production have been proposed by Montemayor and Rubio in the paper "Alkaline cooked corn flour: Technology and uses in tortilla and snack products, Cereal Foods World 28:577, 1983, and in Molhu, M. R., Latona, M. And Bressani, R. 1977, Drum drying technology for the improved production of instant tortilla flour, J. Food Sci. 42:1432-1434.

Some of these processes involve grinding the whole corn grain and to the over-gelatinization of the starch granules are exposed or low hydrolysis of the pericarp could occur, resulting in a masa of poor quality. The cooker-extruder function as a continuous cooking process in which starch

gelatinization and puffing of the extrudate are avoided (Serna-Saldivar, S. O., Gomez, M. H., and Rooney, L. W. 1990. Technology, chemistry and nutritional values of alkaline-cooked corn products. Chapter 4. In: *Advances in Cereal Science and Technology*. Vol. X., Y. Pomeroy (ed) p. 243-307. American Association of Cereal Chemists. St. Paul, Minn.)

Unfortunately, none of these methods provide an integral solution to the tortilla industry. They either solve all problems to an adequate level but are complicated and expensive processes, or they retain the drawback of the traditional process. Our process is simple and inexpensive and addresses all the problems found in the tortilla production.

Many efforts have been expended on for a better understanding of the nixtamalization process. However, these studies have been focused only on the changes that take place in the protein, starch, and lipid components, without considering the importance of the outer layers of the grain (pericarp fraction). The process of the present invention shows the importance of the pericarp fraction and how it can be treated efficiently for preparing fresh masa and nixtamalized corn flour for the preparation of tortillas and derived products.

The importance of the starch during the nixtamalization process has been summarized by Gomez, in the paper "Physicochemical characteristics of fresh masa from alkaline process corn and sorghum and corn dry masa flour. Ph D. dissertation, Texas A&M University, College Station. 105 pp. 1988". This author reported that although the starch granules of the corn grain are severely restricted by the protein matrix and cell walls, they absorb water and swell during cooking and steeping. The susceptibility of the starch to hydrolysis by glucosamylases increases as corn is lime-cooked.

Ortega, E. L., Villegas, E., and Vasei, S. K. 1986 (A comparative study of protein changes in normal and quality protein maize during tortilla making. *Cereal Chem.* 63:446-451); and Vivas, N. E., Wernick, R. D., and Rooney, L. W. 1987 (Effect of tortilla production on protein in sorghum and maize. *Cereal Chem.* 64:384-389) found that lime cooking and tortilla baking decrease the salt-water-soluble proteins (albumins and globulins) and alcohol-soluble proteins (prolamins) and increase the amount of unextractable proteins. Also lime cooking alters the molecular weight distribution of the different protein fractions, as seen in electrophoretic patterns, where the loss of several protein bands and reduced intensity of other bands were observed (see Gomez, M. H. 1988. Physicochemical characteristics of fresh masa from alkaline process corn and sorghum and corn dry masa flour. Ph D. dissertation, Texas A&M University, College Station. 105 pp.) The role of lipids has been previously reported by Pflugfelder, R. L., 1986. This author cited that 1-3% of the masa dry weight is constituted by free lipids distributed throughout the continuous phase of the masa. The lipid fraction is mainly composed of partially emulsified lipids located in the aqueous phase of the masa and free lipids that interact with both peptides and carbohydrates altering the masa properties. In some instances, high concentrations of lime are used to increase the pH of tortillas to a level at which microbial spoilage is retarded or delayed (see Talles-Gilman, A., Villalba, A., McDonough, C., and Rooney, L. W. 1987. The effect of cooking conditions on the quality of table tortillas made from hard and soft corns. (Abstr.) *Cereal Foods World* 32:658).

Calcium ions are carried by water through the tip cap, germ, and pericarp. Calcium absorption follows a trend

similar to that of water absorption but much slower (see Trejo-Gonzalez, A., Faria-Morales, A., and Wild-Altamirano, C. 1982. The role of lime in the alkaline treatment of corn for tortilla preparation. Pages 245-262 in: *Modifications of Protein: Food, Nutritional and Pharmacological Aspects*. R. E. Peeney and J. R. Whitaker, eds. Adv. Chem. Ser. No. 198. Am. Chem. Soc., Washington, DC; and also Gomez, in the paper "Physicochemical characteristics of fresh masa from alkaline process corn and sorghum and corn dry masa flour. Ph D. dissertation, Texas A&M University, College Station. 105 pp. 1988". Most of the calcium is retained in the germ and pericarp.

Trejo-Gonzalez, A., Faria-Morales, A., and Wild-Altamirano, C. 1982, cited above, indicated that calcium binds to the starch; they found approximately 2.9 times more calcium in starch isolated from lime-cooked kernels than in starch isolated from untreated grains. Also, research studies have shown that during the liming of corn losses of some of the nutrients take place, but what is most interesting is the increase in amino acid availability and in general the noticeable improvement of the overall quality of corn (see Bressani, R., Paz y Paz, and Scribshaw, N. S. 1958. Corn nutrient losses: Chemical changes in corn during preparation of tortillas. *J. Agric. Food Chem.* 6:770-773; Cravotto, R. O. 1945. Nutritive value of the Mexican tortilla. *Science* 102: 91-93).

Some works cite the structural alterations suffered by the outer layers of the pericarp, but with any relation with the quality of masa and tortillas (rheological properties). Trejo-Gonzalez, A., Faria-Morales, A., and Wild-Altamirano, C. 1982; The role of lime in the alkaline treatment of corn for tortilla preparation. Pages 245-262 in: *Modifications of Protein: Food, Nutritional and Pharmacological Aspects*. R. E. Peeney and J. R. Whitaker, eds. Adv. Chem. Ser. No. 198. Am. Chem. Soc., Washington, DC. This paper reported that lime acts in a manner similar to stronger alkali (e.g., NaOH) by disrupting fiber components such as hemicellulose.

Paredes-Lopez, O., and Sahasrabudhe, M. E. 1982; "Scanning electron microscopy studies of limed corn kernels for tortilla making"; *J. Food Technol.* 17:687-693, reported that during the lime treatment of the tortilla making process, the outside surface of the alkali-treated kernels (nixtamal) showed substantial structural alterations, which facilitates its separation. Most of the germ remains attached to the starchy endosperm, and greatly contributes to the nutritional quality of the product. The cell walls of the horny and floury endosperm appeared noticeably affected in the preparation of nixtamal. The functional and nutritional properties acquired by nixtamal might be related to the structural modifications. Also, prior efforts have been directed towards the improvement of the tortilla quality, focusing only on the major parameters that govern tortilla production. These parameters are the physical quality and efficient conditions of storage of corn, ingredients and products; the composition of the corn grain (moisture, starch, amylose-amylopectin ratio, lipids, carbohydrates, pigments, vitamins, minerals and fiber contents); the lime-cooking, steeping, and baking, times and temperatures; the types of mills (size of particle of masa and flour); the moisture content of the corn, nixtamal, masa, tortillas, and derivatives; processing conditions of the equipment and lime concentration used, and sanitation of equipment and personnel.

The above investigations have contributed to a better understanding of the nixtamalization process. However, little, if any attention has been given to the role of pericarp in the quality of masa and tortillas. Some investigations have emphasized the importance of pericarp removal and they

have associated this step with better quality of masa and tortilla. The importance of lime treatment has been emphasized to facilitate pericarp removal during cooking and steeping, controlling microbial activity, and affecting the flavor, aroma, color, shelf life, and nutritional value of tortillas (cited in Bressani et al, 1958) (Kostz, R., and Newkorn, H. 1977; "Nature of bound nicotinic acid in cereals and its release by thermal and chemical treatment", page 305 in: Physical, Chemical and Biological Changes in Food caused by Thermal Processing, T. Høyden and O. Kvale, eds. Applied Science Publishers, London); (Rooney, L. W., and Serna-Saldívar, S. O. 1987. Food uses of whole corn and dry-milled fractions. Pages 399-429 in: Corn: Chemistry and Technology. S. A. Whitson and P. E. Ramstad, eds. Am. Assoc. Cereal Chem. St. Paul, Minn. 605 pp.).

Also, a standard method to evaluate pericarp removal has been reported by Serna-Saldívar, S. O., Almeida-Dominguez, H. D., Gomez, M. H., Bockholt, A. J., and Rooney, L. W. 1991. Method to evaluate ease of pericarp removal of lime cooked corn kernels. *Crop Sci.* 31:842-844.

Alkaline cooking and steeping causes partial dissolution of the cuticle and other pericarp layers (cited in Paredes-Lopez and Sahasrabudhe, 1982) and swelling and weakening of the cell walls and fiber components, which facilitate pericarp removal (cited in Gomez, M. H., McDonough, C. M., Rooney, L. W., and Wniska, R. D. 1989. Changes in corn and sorghum during nixtamalization and tortilla baking. *J. Food Sci.* 54:330-336).

Moreover, other authors cited that alterations in starch crystallinity caused by cooking are partially restored by recrystallization or annealing during steeping. The reassociation of starch molecules may be responsible for the development of the rheological properties of masa. (Gomez 1988).

As reported by some researchers, the lime treatment of the corn causes weakening and hydration of the outer layers. However, not enough is known about the phenomena involved in the role of pericarp in the textural quality of masa and tortilla. One of the most important changes that have not been considered in previous works are the resultant components from lime treatment of the pericarp, referred to as corn fiber gums (cited in Whistler, R. I. 1993. *Hemicelluloses*. Pages 295-308 in: *Industrial Gums*. R. I. Whistler and J. N. BeMiller, eds. Academic Press: New York).

The alkaline hydrolysis of the hemicellulose fiber (bran) releases fractions of D-xylose, L-arabinose, galactose and D-glucuronic acid (see Whistler, R. I. and BeMiller, J. N. 1956. Hydrolysis components from methylated corn fiber gum. *J. Am. Chem. Soc.* 78: 1163-1165); (Sugawara, M., Sasaki, T., Totsuka, A., Takeuchi, M., and Ueki, K. 1994. Composition of corn hull dietary fiber. *Starch/Stärke* 46:335-337); (Saulnier, L., Marot, C., Chantelard, R., and Thibault, J. F. 1995. Cell wall polysaccharide interactions in maize bran. *Carbohydr. Olym.* 26:279-287) which are usually employed as adhesives, thickeners, and stabilizers (see Wolf, M. J., MacMasters, M. M., Cannon, J. A., Roswell, E. C., and Rist, C. E. 1953. Preparation and some properties of hemicelluloses from corn hulls. *Cereal Chem.* 30:451-470), and as film formers and emulsifiers (Whistler 1993), which are eventually responsible for the rheological properties of the masa and tortilla.

To partially overcome the problem in the quality of masa and tortilla some industrial producers of instant corn flour use gums as carboxymethyl cellulose, guar, xanthan and Arabic gums to improve keeping properties and functionality in tortillas, helping to counteract the effects of lack of

pericarp gums due to shorter steeping times during the cooking of corn grains. The flour producers remove the pericarp that affect the color of the products. However, tortilla manufacturers know that rehydrated dry masa flour has different rheological properties compared to fresh masa. Rehydrated dry masa flour is less plastic and cohesive than fresh masa. Also, the products made from dry masa flour stale faster (Gomez et al 1988). Similarly, the quality of the texture and flavor of tortilla made from instant corn flour is lower than that made from fresh masa (see Gomez, M. H., Rooney, L. W., Wniska, R. D. and Plugfelder, R. L. 1987. Dry corn masa flours for tortilla and snack production. *Cereal Foods World*. 32:372-377).

All of these adverse factors of instant corn flour can be attributed to the lack of natural gums presents in the nixtamalized pericarp.

As recorded by other workers, corn cooked in a lime solution absorbs more water than that cooked in water alone (Chang, Y. -H., and Hsu, K. H. 1985. Extent of starch gelatinization during hydrothermal processing of corn for masa production (Abstr.) *Cereal Foods World* 30:545.470).

Further, the nixtamalization process does not cause extensive gelatinization of the starch. This is supported by differential scanning calorimetric studies. Alkali-cooking and soaking of maize in water (nixtamalization) cause large increases in viscosity, as compared with native flour (Robles, R. R., Murry E. D., and Paredes-Lopez O. 1988. Physicochemical changes of maize starch during the lime-treatment for tortilla making. *Int. J. Of Food Sci. And Tech.* 23:91-98).

In addition, several granular and molecular forms of starch occur in masa as a result of incomplete gelatinization and retrogradation. Even further, starch solubilization remains unchanged after alkaline cooking and increases after steeping. The physical disruption of the kernel caused by grinding further increases the starch solubilization in masa. Steeping and alkaline cooking produce swelling and agglomeration of starch granules throughout the endosperm. At the same time grinding of nixtamal generates complete physical disruption of kernel. Additionally, starch granules in raw corn exhibit birefringence. The majority of the starch granules in nixtamalized samples are swollen, adhere to other granules, and exhibit partial or total birefringence.

However, the maltese crosses of starch granules are less distinct than those of raw kernels (Gomez, M. H., Lee, J. K., McDonough, C. M., Wniska, R. D., and Rooney, L. W., 1992. Corn starch changes during tortilla and tortilla chip processing. *Cereal Chem* 69: 275-279).

The nixtamalization of corn during dry masa flour production always introduces changes in the organization of starch polymers. The crystallinity of starch in masa is similar to that of raw corn even though the corn is alkaline-cooked, steeped and ground. Microscopic examinations have shown that up to 30% starch birefringence is lost during processing. It is demonstrated also, that nixtamal contains swollen starch granules always restricted by the endosperm cells as that compared to uncooked corn endosperm cells.

After grinding, the endosperm cells are disrupted and the starch granules are released. Most of the starch granules in masa lose their native, regular shape (Gomez, M. H., Wniska, R. D., and Rooney, L. W., 1990. Effects of nixtamalization and grinding conditions on starch in masa. *Starch/Stärke* 42:475-482). Similar processing effects have been observed in fresh masa (Gomez et al 1989).

SUMMARY OF THE INVENTION

The present invention discloses a process for the production of fresh whole corn masa, instant corn flour and the like

by means of a selective nixtamalization process. This process minimizes the crucial steps of the traditional method, so that rheological characteristics and general quality of the traditional tortillas are retained, but such that no fraction of the corn grain is lost, no polluting effluents are generated, and no long steeping times are needed.

Also, with the present invention, the hydrolysis and hydration of the pericarp is achieved by subjecting the pericarp to a rapid cooking at high temperatures and separately hydrating the germ-endosperm fraction. Reduction in steeping time is accomplished with high pressure, which speeds diffusion of water into the internal regions of the grain fractions.

As in the traditional process, starch granules are not damaged because, when grains are cooked, they are fully immersed in water, so water availability is not a limiting factor for starch granule swelling; in addition, granule swelling takes place inside the grain matrix, helping to protect them. The inclusion of the whole pericarp and whole germ enriches the textures and nutritional quality of the final product. The hydrolysis of the pericarp releases gums, conferring appropriate texture to the masa with equal characteristics of those produced by the traditional process.

Water is added in sufficient quantity to appropriately hydrate and hydrolyze the pericarp, so no water is wasted. The combined action of water, lime, temperature, and pressure produce a cooked pericarp with appropriate characteristics to be milled in stone, hammer or disc mills and blended with the hydrated germ-endosperm fractions.

By controlling the cooking parameters (steeping time, cooking pressure, energy, power, temperature, time, and lime content), it is possible to obtain masa or dehydrated masa (nixtamalized corn flour) suitable for the production of fresh masa or for instant flour.

An important result of the method is that, because no effluent is discarded, the yield is from 8 to 15% higher than that achieved in the traditional and the current instant flour production methods.

These and other objectives and advantages of the present invention will be evident to experts in the field from the detailed description of the invention illustrated as follows.

DETAILED DESCRIPTION OF THE INVENTION

The invention refers to a selective nixtamalization process for the production of fresh whole corn masa, instant corn flour, and their derivatives. In general, with the method of the present invention it is possible to make fresh masa and instant flour for tortillas and derivatives.

The method is based on the selective nixtamalization of the pericarp fraction and the appropriate hydration of the germ and endosperm fractions. The treated fractions of pericarp, germ and endosperm are blended in the appropriate proportions, and then stone milled for masa preparation or dehydrated and milled to make nixtamalized corn flour.

In general the process for the production of fresh whole corn masa, instant corn flour, and their derivatives is carried out as follows:

- separating the grains into pericarp, germ and endosperm fractions;
- cooking the pericarp with lime and water at a temperature between about 50° C. to about 300° C.;
- hydrating the germ and endosperm fractions with water at room temperature or higher for a period between 0 and 12 hours;

d) drying and milling separately the pericarp of step b) and the germ and endosperm of step c); and,

e) mixing the milled pericarp, germ and endosperm obtained in step d) for producing fresh masa.

In general the starting materials used in the process are corn pericarp and germ-endosperm fractions, water, and lime. Corn fractions (pericarp, germ and endosperm fractions) can be of any genotype and should be free of impurities and foreign material. These fractions of pericarp, germ and endosperm can be obtained milling or decorticating the whole corn grain (previously hydrated or with its inherent moisture content), or fractions from the corn dry milling or corn wet milling industries.

The processing step of the pericarp (whole or milled pericarp), lime, and water can be done in a cooker-extruder, microwave oven, joule cooking chamber, IR cooker or in a pressurizing chamber, etc. Also, the whole or milled pericarp can be hydrolyzed and hydrated in a vessel in the presence of water and lime at room temperature or at higher temperatures.

The cooking of the pericarp with lime and water with an extruder can be done in any commercial extruder (single or twin-screw extruder; low or high shear type), with temperatures varying from 50° C. to about 300° C. The cooking within a pressurizing chamber can be achieved under a range of pressures between 1 and 100 atmospheres, with time periods between 0 and 30 minutes employing periodical stirring, and temperature ranges between 50° C. and 150° C. The microwave oven for pericarp cooking can be a commercial one with power ranging from 500 watts to several Kilowatts, depending on the mass load. The cooking containers inside microwave ovens must stand temperatures from 50 to 120° C., and heating periods of 1 to 60 minutes. Additionally, the hydrolysis and hydration of the pericarp fraction can be done by the use of enzymes as cellulases, amylases, glucoamylases or a mixture of them.

The germ-endosperm fractions (whole or milled) are hydrated in the presence of water (optionally, lime can be used) at room temperature or higher, for a period between 0 and 12 hours. Also, in this step of germ and endosperm hydration, a pressurizing chamber can be used. The chamber can be fitted with a device that allows the administration of heat by any vehicle, such as hot water, direct fire, hot vapor, joule heating, infrared radiation, microwave radiation, or any other heating system. Similarly, the pressurizing chamber can use an inert gas in order to increase the pressure and to reduce the cooking time. On the other hand, the hydrolysis and hydration of the pericarp fraction can be done by the use of enzymes as cellulases, amylases, glucoamylases, or a mixture of them.

Lime concentrations may vary from 0 to 3% (w/w) and can be substituted by any other compound causing pericarp hydrolysis and hydration of the germ-endosperm fractions in presence of water. Water concentration can vary from 10 to 70% (w/w) and its temperature from 0° C. to 100° C.

The treated corn fractions (pericarp and germ-endosperm) are milled with a stone, hammer, or disc mill with a characteristic pattern and pattern size. Fresh masa is obtained with a moisture content ranging from 8 to 55% (w/w).

Drying and milling the fresh masa in order to elaborate nixtamalized whole corn flour. No drying if the purpose is to elaborate fresh masa.

The process for the production of fresh whole corn masa or nixtamalized corn flour and derivatives are formed from about 0 to about 10% (w/w) of pericarp fractions, from 0 to about 15 (w/w) germ fractions and from 0 to about 90% (w/w) endosperm fractions.

The present invention is referred to a method that minimizes the crucial steps of the traditional method, so the rheological characteristics and general quality of the traditional tortillas are retained, but such that no fraction of the corn grain is lost, no polluting effluents are generated, and no long steeping times are needed.

In the traditional method, nejayote has to be discarded because of its high lime content, and lime is needed to hydrolyze and hydrate the pericarp and allow the diffusion of water into the grain.

In this process, the hydrolysis and hydration of the pericarp is achieved by subjecting the pericarp to a rapid cooking at high temperatures and separately hydrating the germ-endosperm fractions. Reduction in steeping time is accomplished with high pressure, which speeds diffusion of water into the internal regions of the grain fractions. As in the traditional process, starch granules are not damaged because, when grains are cooked, they are fully immersed in water, so water availability is not a limiting factor for starch granule swelling; in addition, granule swelling takes place inside the grain matrix, helping to protect them. The inclusion of the whole pericarp and whole germ enriches the texture and nutritional quality of the final product. The hydrolysis of the pericarp releases gums, conferring appropriate texture to the masa with equal characteristics as those produced by the traditional process.

Water is added in sufficient quantity to appropriately hydrate and hydrolyze the pericarp, so no water is wasted. The combined action of water, lime, temperature, and pressure produces a cooked pericarp with appropriate characteristics to be milled in stone, hammer or disc mills and blended with the hydrated germ-endosperm fractions. By controlling the cooking parameters (steeping time, cooking pressure, temperature, time, and lime content), it is possible to obtain masa or dehydrated masa (nixtamalized corn flour) suitable for the production of fresh masa or for instant flour. An important result of the process is that, because no effluent is discarded, the yield is from 8 to 15% higher than the yield obtained with the traditional and the current instant flour production processes.

EXAMPLES

The following are some examples of the process which was carried out in the laboratory of CICAIA. However, these examples are illustrative and not limiting; they are given to further describe this invention.

Example 1

This example shows the importance of the presence of the nixtamalized pericarp in the rheological quality of masa and tortilla. Whole corn (1 Kg) was cooked in water (3 L) at 80° C. and, lime (1.5% w/w) solution for a 45 min and steeped for a period of 18 hours. The cooking liquor (nejayote) was drained and discarded and 500 grams of the nixtamal (cooked grain) was drained and washed two times with water to remove excess lime, losing pericarp and germ fractions. Then, the nixtamal was ground with a stone mill into masa. The masa was flattened into thin disks that were cooked on a hot griddle for 30-60 sec on each side to become tortillas. These tortillas showed excellent rheological characteristics, such as puffing and elastic strength.

Example 2

This example describes the process, previously referred for the production of nixtamalized corn flour and tortillas using commercial fractions of pericarp, germ, and

endosperm from the corn wet milling industry. The pericarp fraction was ground in a hammer mill and the milled pericarp was steeped with lime (0.8% w/w) and water (18% moisture content). The hydrated and alkalinized pericarp was extruded in a commercial extruder. The temperatures of the barrel were 100° C., and 120° C. at 130 rpm screw speed. The extruded samples were dehydrated and milled in a hammer mill. The germ-endosperm fractions were steeped in water and lime (1% w/w) at 90° C. for 15 minutes. The pericarp fraction was blended with the germ-endosperm fraction and milled in a stone mill to prepare the masa. The fresh masa was dehydrated in a recirculating hot air oven and milled in a hammer mill. The flour was mixed with water until masa was obtained with appropriate consistency (1:1.25 ratio). The masa was flattened into thin disks that were cooked on a hot griddle for 30-60 sec on each side to become tortillas. These tortillas showed excellent rheological characteristics, such as puffing and elastic strength.

Example 3

This example describes the process, previously referred for the production of nixtamalized corn flour and tortillas, using commercial fractions of pericarp, germ, and endosperm from the corn dry milling industry. The pericarp fraction was ground in a hammer mill and the milled pericarp was steeped with lime (0.8% w/w) and water (20% moisture content). The hydrated and alkalinized pericarp was cooked in an experimental infrared chamber at 460° C. during 17 seconds. The germ-endosperm fractions were steeped in water and lime (1% w/w) at 90° C. during 15 minutes. The pericarp fraction blended with the germ and endosperm fraction and milled in a stone mill to prepare the masa. The fresh masa was dehydrated in a recirculating hot air oven and milled in a hammer mill. The nixtamalized flour was then mixed with water (1:1.25 ratio) until a masa was obtained with appropriate consistency. The masa was flattened into thin disks that were cooked on a hot griddle for 30-60 sec on each side to become tortillas. These tortillas showed excellent rheological characteristics, such as puffing and elastic strength, similar to the characteristics of the tortillas made by the traditional process.

Example 4

This example describes the process for obtaining fresh masa and tortillas. Clean whole corn free of foreign material was steeped during 5 minutes in room water and the pericarp was then separated by abrasion and sieving. The pericarp fractions were placed in a vessel with hot water and lime (1% w/w) and then cooked for 6 minutes in a pressurizing chamber heated by an electrical resistor (270° F., 26-27 psi). Similarly, the germ-endosperm fractions were steeped in water and lime (1% w/w) at 90° C. during 15 minutes. The pericarp fraction and the germ-endosperm fraction were blended and milled in a stone mill to prepare the masa. The masa was flattened into thin disks that were cooked on a hot griddle for 30-60 sec on each side to become tortillas. These showed excellent rheological characteristics, such as puffing and elastic strength, similar to the characteristics of tortillas made with the traditional process.

Example 5

In this example is described an experimental process previously referred, in order to obtain nixtamalized corn flour and tortillas. Clean whole corn free of foreign material, was ground in a disc mill and the milled fractions were separated by sieving. The pericarp fractions were placed in

a vessel with hot water and lime (1% w/w) and then cooked for 6 minutes in the pressurizing chamber, heated by an electrical resistor (270° F., 26-27 psi). At the same time, the germ-endosperm fractions were steeped in water and lime (1% w/w) at 90° C. during 15 minutes. The pericarp, germ and endosperm fractions were blended and milled in a stone mill for masa preparation. The masa was dehydrated with hot air. The resulting dehydrated masa was hammer milled and passed through a sieve to yield whole corn flour with a 9% moisture content. The whole corn flour showed an absorption water index of 1.25 (100 gms of flour absorbs 125 ml of water). The resulting nixtamalized whole corn flour was mixed with water to prepare masa. The masa was shaped into flat disks using a manual machine. The disks were cooked on a hot griddle (290° C.±10° C.) for 25 seconds on one side, followed by 35 sec on the opposite side, and turned to the initial side until puffing was achieved. The resulting tortillas showed excellent characteristics of color, flavor, puffing, and texture (rollability).

Example 6

In this example is described the process for obtaining fresh masa and tortillas, using commercial fractions of pericarp, germ, and endosperm from the corn wet milling industry. The pericarp fraction was hammer milled and cooked with lime (0.8% w/w) and water in a commercial microwave oven at full power level of 1000 watts during 20 minutes. On the other hand, the germ-endosperm fractions were cooked with lime (0.25% w/w) and water in a commercial microwave oven at full power of 1000 watts during 2 minutes. The pericarp, germ and endosperm fractions were blended and milled in a stone mill for masa preparation. The masa was shaped in flat discs using a manual machine. The disks were flattened in thin disks and cooked on a hot griddle (290° C.±10° C.) for 25 sec on one side, followed by 35 sec on the opposite side, and turned to the initial side until puffing is achieved. The resulting tortillas showed excellent characteristics of color, flavor, puffing, and texture (rollability).

Thus, the products that can be elaborated from the masa obtained with the process of the present invention comprises the following: Tortilla and derived products with the following options: with and without additives (preservatives, nutrients, hydrants, etc.), from fresh masa or from instant flour.

Notwithstanding the above, reference has been made to various embodiments of the present invention; however it will be evident that experts in the field could make some additional changes, which would be included within the spirit and scope of the invention that is claimed in the following claims:

What is claimed is:

1. A process for the production of fresh whole corn masa and derived products comprising the steps of:
 - a) separating corn grains into pericarp, germ and endosperm fractions;
 - b) cooking the pericarp fraction with lime and water at a temperature between about 50° C. to about 300° C.;
 - c) hydrating the germ and endosperm fractions with water;
 - d) milling the pericarp fraction of step b), and the germ and the endosperm fraction of step c) separately; and,
 - e) mixing the pericarp, germ and endosperm fractions obtained in step d) to produce fresh corn masa.
2. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the

fresh whole corn masa is dehydrated and milled for producing nixtamalized corn flour.

3. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the hydrating step is carried out at room temperature or higher for a period between 0 and about 12 hours.

4. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the lime concentrations are about 0.25 to about 3% (w/w).

5. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the water concentration is between about 10 to about 70% w/w.

6. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the cooking step is carried at a pressure between about 0 to about 100 atmospheres.

7. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the pericarp fractions are ground in a hammer mill.

8. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the pericarp fraction is hydrated with enzymes selected from the group consisting of cellulases, xylanases, amylases, glucosylases, or mixtures thereof.

9. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the fresh whole corn masa is obtained with a moisture content ranging from about 8% w/w to about 55% w/w.

10. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the pericarp fraction is ground in a hammer mill and the milled pericarp is steeped with lime 0.8% w/w and water 18% moisture content.

11. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the germ and endosperm fractions are steeped in water and lime at about 1% w/w at 90° C. for at least 15 minutes.

12. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the pericarp, germ and endosperm fractions are blended and milled in a stone mill for the masa preparation.

13. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the pericarp fraction is ground in a hammer mill and the milled pericarp is steeped with lime at a concentration of about 0.8% w/w and water with about a 20% moisture content.

14. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the germ and endosperm fractions are steeped in water and containing 1% w/w of lime at 90° C. by at least 15 minutes.

15. The process for the production of fresh whole corn masa and derived products as claimed in claim 1 wherein the pericarp fraction is placed in a vessel with hot water and lime at a concentration of about 1% w/w and then cooked for six minutes in a pressurizing chamber.

16. The process for the production of fresh whole corn masa and derived products as claimed in claim 1, wherein the germ and endosperm fractions are steeped in water and lime at a concentration of about 1% w/w at 90° C. for least 15 minutes.

17. The process for the production of fresh whole corn masa and derived products as claimed in claim 2 wherein the masa is dehydrated with hot air.

18. The process for the production of fresh whole corn masa and derived products as claimed in claim 2 wherein the dehydrated masa is hammer milled and passed through a sieve to produce whole corn flour with a 9% moisture content.

19. The process for the production of fresh whole corn mass and derived products as claimed in claim 1, wherein the fresh whole corn mass is formed of at most 10% (w/w) of pericarp fraction, of at most 15% (w/w) of germ fraction and of at most 90% (w/w) of endosperm fraction.

20. Process for the production of nixtamalized corn flour and derived products comprising the steps of:

- a) separating corn grains into pericarp, germ and endosperm fractions;
- b) cooking the pericarp fraction with lime and water at a temperature between about 50° C. to about 300° C.;
- c) hydrating the germ and endosperm fractions with water;
- d) drying the pericarp fraction of step b) and the germ and endosperm fractions of step c) separately; and
- e) mixing the pericarp, germ and endosperm fractions obtained in step d) to produce nixtamalized corn flour.

21. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the step of drying comprises the step of milling the pericarp fraction and the germ and endosperm fractions.

22. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the hydrating step is carried out at room temperature or higher for a period between 0 and about 12 hours.

23. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the lime concentrations are about 0.25% to about 3% (w/w).

24. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the water concentration is between about 10% and about 70% (w/w).

25. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the cooking step is carried out at a pressure between about 0 to about 100 atmospheres.

26. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the pericarp fraction is ground in a hammer mill.

27. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the pericarp fraction is hydrated with enzymes selected from

the group consisting of cellulases, xylanases, amylases, glucoamylases or mixtures thereof.

28. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the pericarp fraction is ground in a hammer mill and the milled pericarp is steeped with lime 0.8% w/w and water 18% moisture content.

29. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the germ and endosperm fractions are steeped in water and lime at about 1% w/w at 90° C. for at least 15 minutes.

30. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the pericarp, germ and endosperm fractions are blended and milled in a stone mill for the preparation of the nixtamalized corn flour.

31. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the pericarp fraction is ground in a hammer mill and the milled pericarp is steeped with lime at a concentration of about 0.8% (w/w) and water with a 20% moisture content.

32. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the germ and endosperm fractions are steeped in water and lime at a 1% (w/w) at 90° C. by at least 15 minutes.

33. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the pericarp fraction is placed in a vessel with hot water and lime at a concentration of about 1% w/w and then cooked for at least six minutes in a pressurizing chamber.

34. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20 wherein the germ and endosperm fractions are steeped in water and lime at a concentration of about 1% w/w at 90° C. by at least 15 minutes.

35. The process for the production of nixtamalized corn flour and derived products as claimed in claim 20, wherein the nixtamalized corn flour is formed of at most 10% (w/w) of pericarp fraction, of at most 15% (w/w) of germ fraction and of at most 90% (w/w) of endosperm fraction.

• • • • •

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Brigard & Castro

BOGOTA - COLOMBIA

PODER

POWER OF ATTORNEY

Roberto Gonzalez BARRERA

I (We) Roberto Gonzalez BARRERA

Domiciliado en Lomas de Chapultepec, Delegación Miguel Alemán, México

domiciled in Lomas de Chapultepec, Delegación Miguel Alemán, México

Nombro(amos) a: RAMIRO CASTRO DUQUE y/o HECTOR GOMEZ MEJIA, de Bogotá, Colombia, apoderados verdaderos y legales con poder especial, amplio y suficiente, para recabar de las oficinas y autoridades colombianas administrativas, judiciales y de policía, en cualquier instancia o recurso, la obtención de patentes de invención, registros de marcas, diseños industriales, modelos de utilidad, depósitos de nombres comerciales y enseñanzas, registros de derechos de autor y contratos sobre los mismos, obtención de certificados de obtentor de variedades vegetales, así como sus prórrogas, renovaciones, anotaciones de traspaso, cambios de nombre y/o domicilio; elaborar, tramitar y registrar contratos de licencia y licencias de cualesquiera clases; intervenir como demandante o como demandado en cualquier instancia y recurso ante cualquier juez, corporación, funcionario público o autoridad en acciones judiciales, administrativas y de policía tales como: oposiciones al registro de marcas; acciones de caducidad, cancelación y nulidad; acciones reivindicatorias, acciones derivadas de la obtención o explotación de licencias; acciones de competencia desleal; demandas penales; acciones de indemnización de perjuicios, reclamos y observaciones a solicitudes de patentes, diseños industriales, modelos de utilidad, en el ejercicio de medidas cautelares y en otras acciones o medidas similares.

Hereby appoint RAMIRO CASTRO DUQUE and/or HECTOR GOMEZ MEJIA, of Bogotá, Colombia, my (our) true and lawful attorneys with special, ample and sufficient power to obtain from the Colombian administrative, judicial and police offices and authorities, in any instance, privileges of patents of invention, registration of trademarks, industrial designs and utility models; registration of commercial names and emblems, registration of copyright and contracts related thereto, certificates of obtainers of vegetables varieties, as well as extensions, renewals and recordal of assignments and changes of name and domicile related to the above; to prepare, prosecute and register licenses of any kind; to act as plaintiff or defendant in any instance or recourse, and before any judge, corporation, public official or authority in judicial, administrative and police actions, such as: oppositions to the registration of trademarks; caducity, cancellation and nullity actions; claim actions derived from the obtaining or exploitation of licenses, action of unfair competition; penal demands, actions of indemnities for damages; claims or observations on patent applications, models, industrial designs and utility models; in the exercise of preventive measures; and in other actions or similar proceedings.

A este efecto, lo(s) facuto(amos) para elevar solicitudes, formular descripciones, enmiendas, protestas, declaraciones, oposiciones, cancelaciones, nulidades, apelaciones y reclamos; pagar impuestos, cuotas y gravámenes prescritos por la ley; renunciar o desistirse a derechos concedidos o en curso de concesión; recibir toda clase de documentos y valores, dando el recibo respectivo, y, en general, para dar ante dichas autoridades todos los pasos necesarios al efecto indicado y tomar todas las medidas que creyeran conducentes al resguardo de mis (nuestros) intereses, con todas las demás facultades legales necesarias.

To that effect they hereby empowered to file applications, formulate descriptions, amendments, protests, declarations, oppositions, cancellations, nullities, appeals and claims; to pay taxes, quotas and assessments prescribed by law, renounce or waive the rights granted or in the process of granting; to receive all kinds of documents and valuables, giving the respective release of receipt, and, in general, to take before said authorities the necessary steps to such effect, and any measures that they may deem pertinent to the safeguard of my (our) interest(s) with all the other necessary legal powers.

Este poder comprende la facultad de ratificar o confirmar en mi (nuestro) nombre lo actuado así como la facultad de desistirse, transigir, comprometer, y la de sustituirlo en todo o en parte y revocar sustituciones. Asimismo nombro(amos) a: RAMIRO CASTRO DUQUE y/o HECTOR GOMEZ MEJIA, domiciliado(s) en la Carrera 7 No. 18-56 Piso 9, mis (nuestros) apoderados en Colombia, con facultades para recibir notificaciones y designar apoderados judiciales o extrajudiciales.

This power includes the faculty to ratify or confirm desist, settle and compromise on my (our) behalf, and to substitute this power in whole or in part and to revoke substitutions. At the same time I (We) hereby appoint RAMIRO CASTRO DUQUE and/or HECTOR GOMEZ MEJIA, domiciled in Carrera 7 No. 18-56, Piso 9, my (our) attorney(s) in fact, with powers to receive notifications and to designate judicial and extrajudicial attorneys.

Otorgado y firmado en Monterrey, N. L.

Granted and signed in Monterrey, N. L.

hoy 17 de Mayo de 2004

this 17th of May 2004

Firma

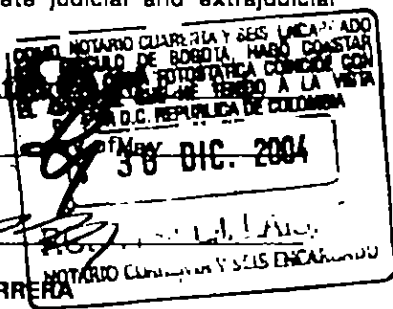
Signature

Nombre Roberto Gonzalez BARRERA
Cargo

Nombre Roberto Gonzalez BARRERA
Title

GUILLERMO ELIZONDO RIOS
Testigo

VALENTIN PARRA AREVALO
Testigo





—EN LA CIUDAD DE MONTERREY, CAPITAL DEL ESTADO DE NUEVO LEON, a los (17) diecisiete días del mes de Mayo de (2004) Dos Mil Cuatro, ANTE MI, LICENCIADO MANUEL GARZA RODRIGUEZ, Notario Público Titular de la Notaría Pública número (78) setenta y ocho, con ejercicio en el Primer Distrito Registral y Notarial en el Estado de Nuevo León, con sede en esta Ciudad, COMPARECIO El señor ROBERTO GONZALEZ BARRERA por sus propios derechos y los señores Licenciados GUILLERMO ELIZONDO RIOS y VALENTIN PARRA AREVALO en su carácter de Testigos, manifestando el señor GONZALEZ BARRERA que ocurre ante esta Notaría a mi cargo, a fin de ratificar en todas y cada una de sus partes el contenido de la carta-poder que antecede, quien junto con los testigos indicados, reconocen como auyas y puestas de su puño y letra las firmas con que la calzan, por haber sido puestas en mi presencia. Lo que asiento por esta Acta para los efectos legales correspondientes a que haya lugar.

—Los comparecientes, a quienes conozco y que a mi juicio tienen capacidad legal, apercibidos por el suscrito de lo dispuesto por el Artículo (128) ciento veintiocho de la Ley del Notariado, bajo protesta de decir verdad, me manifestaron como sus datos generales los siguientes:

—El señor ROBERTO GONZALEZ BARRERA, dijo ser mexicano por nacimiento, casado, mayor de edad, comerciante, con Registro Federal de Contribuyentes GOBR-300901, nacido el 01 de Septiembre de 1930 en Cerralvo, Nuevo León y con domicilio convencional en Calzada del Valle 407 Oriente, Colonia del Valle en San Pedro Garza García, Nuevo León y de tránsito en esta ciudad.

—El Licenciado GUILLERMO ELIZONDO RIOS, dijo ser mexicano por nacimiento, casado, mayor de edad, profesionista, con Registro Federal de Contribuyentes EIRG-720226-6X1, originario de Monterrey, Nuevo León, donde nació el 26 de Febrero de 1972 y con domicilio convencional en Río de la Plata número (407) cuatrocientos siete Oriente, Colonia del Valle en San Pedro Garza García, Nuevo León y de tránsito en esta capital, quien se identifica con Credencial para votar con fotografía con clave de elector ELRSGL72022619H600, folio 35216707, emitida en 1991.

—El Licenciado VALENTIN PARRA AREVALO, dijo ser mexicano, originario de Presa de Guadalupe, Coahuila, donde nació el (14) catorce de Febrero de (1948) mil novecientos cuarenta y ocho, casado, profesionista, con Registro Federal de Contribuyentes número PAAV-480214-M96 y con domicilio convencional en Río de la Plata número (407) cuatrocientos siete Oriente, Colonia del Valle en este Municipio y de tránsito en esta ciudad.

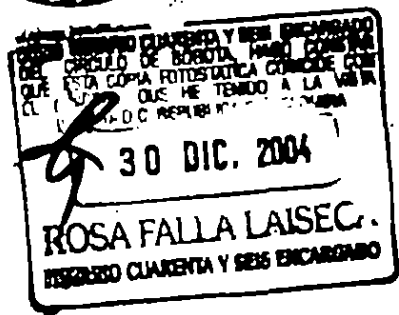
—YO, EL NOTARIO, DOY FE: De la verdad de este acto, de conocer personalmente a los comparecientes a quienes considero con capacidad legal para contratar y obligarse validamente sin que me conste nada en contrario; de que leí la presente acta a los comparecientes y de que les expliqué su valor y consecuencias legales; de que se cumplieron los requisitos que establece la Ley del Notariado vigente; de que los comparecientes manifestaron su conformidad con el contenido de la presente acta, la cual ratificaron en todas sus partes.

—ARTICULO 2448.- En todos los Poderes generales para Pleitos y Cobranzas, bastará que se diga que se otorgan con todas las facultades generales y las especiales que requieran cláusula especial conforme a la Ley, para que se entiendan conferidos sin limitación alguna. En los Poderes Generales para Administrar Bienes, bastará que se den con ese carácter para que el Apoderado tenga todas las facultades administrativas. En los Poderes Generales para ejercer Actos de Dominio bastará que se den con ese carácter para que el Apoderado tenga todas las facultades de dueño, tanto en lo relativo a los bienes como para hacer toda clase de gestiones a fin de defenderlos. Cuando se quisieren limitar en los tres casos antes mencionados las facultades de los Apoderados, se consignarán las limitaciones o los Poderes serán especiales. Los Notarios insertarán este Artículo en los testimonios de los Poderes que otorguen."

—Se tomó razón de lo anterior bajo el número (101,688/2004) del Libro de Actas Fuera de Protocolo que lleva esta Notaría a mi cargo.- DOY FE.

ANTE MI:

LIC. MANUEL GARZA RODRIGUEZ
Notario Público No. 78
(GARM-390521-JD7)



APOSTILLA No. 2104/04
MAYO 27 DE 2004

GOBIERNO DEL ESTADO
NUEVO LEON
SECRETARIA GENERAL
LEGALIZACIONES



N. L.

México

2104/04

76

Apostille

(Convention de La Hays du 5 octobre 1961)

Derechos \$219.00

No. orden 2104/04

En México el presente documento público ha sido firmado

por C. LIC. MANUEL GARZA RODRIGUEZ,

quien actúa en calidad de NOTARIO PUBLICO TITULAR NUMERO 78 DEL PRIMER
DISTRITO EN MONTERREY, NUEVO LEON

y está revestido del sello correspondiente a NOTARIA PUBLICA NUMERO 78 DEL
PRIMER DISTRITO EN MONTERREY, NUEVO LEON

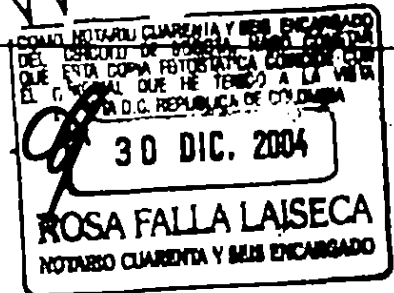
Certificado en MONTERREY, NUEVO LEON por LIC. MARCELA DENISSE LEAL ALANIS,
JEFA DE LA UNIDAD DE LEGALIZACIONES



el 27 de Mayo de 2004

GOBIERNO DEL ESTADO
DE NUEVO LEON
SECRETARIA GENERAL
UNIDAD DE LEGALIZACIONES

Firma





GAVIRI A

77

ORGANIZACION ELECTORAL
REGISTRADURIA NACIONAL DEL ESTADO CIVIL

REGISTRO CIVIL DE DEFUNCIÓN

Indicativo
Serial 5562241

Datos de la oficina de registro																	
Clase de oficina:		Registraduría		Notaría		☒		Consular									
						Corregimiento		Insp. de Policía									
								Código									
								9995									
País: Colombia - Departamento: Cundinamarca - Municipio: Bogotá D.C. - Corregimiento: Bogotá D.C. - Inspección de Policía: Bogotá D.C.																	
COLOMBIA CUNDINAMARCA BOGOTA D.C. NOTARIA 32.																	
Datos del inscrito																	
Apellidos y nombres completos																	
CASTRO DUQUE RAMIRO																	
Documento de identificación (Clase y número)					Sexo (en Letras)												
C.C. No. 170322 DE BOGOTA					MASCULINO												
Datos de la defunción																	
Lugar de la Defunción: País: Colombia - Departamento: Cundinamarca - Municipio: Bogotá D.C. - Corregimiento: Bogotá D.C. - Inspección de Policía: Bogotá D.C.																	
COLOMBIA CUNDINAMARCA BOGOTA D.C.																	
Fecha de la defunción				Hora		Número de certificado de defunción											
Año		2004		Mes		10		Día		30		04:10 PM		A- 2094375.			
Presunción de muerte										Fecha de la sentencia							
Presunción que produce la sentencia										Año		Mes		Día			
Documento presentado										Nombre y cargo del declarante							
Acreditación judicial										Certificado Médico		☒		ANDRES DIAZ CAMPOS			
														R.M. No. 79982662			
Datos del denunciante										Apellidos y nombres completos							
EDGAR DAVID REGINO II.																	
Documento de identificación (Clase y número)										Firma							
C.C. No. 15.030.154 DE LORICA/ CORDOBA																	
Primer testigo										Apellidos y nombres completos							
Documento de identificación (Clase y número)										Firma							
Segundo testigo										Apellidos y nombres completos							
Documento de identificación (Clase y número)										Firma							
Fecha de inscripción										Nombre y firma del funcionario que declara							
Año		2004		Mes		11		Día		02		BLANCA CHOI GONZALEZ RESTREPO		NOTARIA 32			
PADRES: ALFONSO CASTRO										ESPACIO PARA NOTAS							
MERCEDES DUQUE																	

ORIGINAL PARA LA OFICINA DE REGISTRO

NOTARIA 32

DEL CIRCULO DE SANTA FE DE BOGOTA, D.C.

Germán Eleázar Moreno L.

Notario

COMO SECRETARIO DELEGADO DE LA NOTARIA TREINTA Y DOS (32) DEL
CIRCULO DE BOGOTA

CERTIFICO QUE:

La presente acta es fiel copia del original tomada del registr
civil de defunciones serial indicativo número: 556224
que expido en la ciudad de Bogotá D.C. hoy: 11 NOV 2004

NELSON BLONDI
SECRETARIO DELEGADO

REQUISITOS NECESARIOS PARA PRESENTACION Y AGILIZACION DEL TRAMITE

	USUARIO	RADICADOR
PATENTE DE INVENCION	()	()
MODELO DE UTILIDAD	()	()
- Indicación de que se solicita la concesión de una patente.	()	()
- Datos de identificación del solicitante o de la persona que se presenta la solicitud.	()	()
- Descripción de la invención.	()	()
- Dibujos de ser estos pertinentes.	()	()
- Comprobante de Pago de las tasas establecidas.	()	()
COMPLETA ()	INCOMPLETA ()	()
DISEÑO INDUSTRIAL ()		
- Indicación de que se solicita el registro de Diseño Industrial	()	()
- Datos de identificación del solicitante o de la persona que presenta la solicitud.	()	()
- Representación gráfica o fotográfica del Diseño Industrial o muestra del Material que incorpora el diseño.	()	()
- Comprobante de pago de las tasas establecidas	()	()
COMPLETA ()	INCOMPLETA ()	()
ESQUEMA DE TRAZADO ()		
- Indicación de que solicita el registro de un Esquema de trazado.	()	()
- Datos de identificación del solicitante o de la persona que presenta La solicitud.	()	()
- Representación gráfica del esquema de trazado	()	()
- Comprobante de pago de las tasas establecidas.	()	()
COMPLETA ()	INCOMPLETA ()	()

Firma Responsable:

Fecha:

79



Industria y Comercio
SUPERINTENDENCIA

2020
Bogotá, D.C.,

Doctor:
HECTOR GOMEZ MEJIA
Apoderado
ROBERTO GONZALEZ BARRERA

Oficio N° 12111

ASUNTO:	Radicación N°	01-XXXXXX
	Solicitud internacional	PCT/US2003/018292
	Fecha inicio fase nacional	30/03/2005
	Trámite	011
	Evento	379
	Actuación	430
	Folios	001

Como resultado del examen de forma, realizado con fundamento en el artículo 38 de la Decisión 486 de la Comisión de la Comunidad Andina, artículo 27 del Tratado de Cooperación en Materia de Patentes (PCT), regla 51 bis del Reglamento y Circular Única de la Superintendencia de Industria y Comercio, se le comunica que:

- La solicitud no contiene la copia del documento en que consta la cesión del derecho a la patente del inventor al solicitante o a su causante. (Art. 26-k Decisión 486).
- Deberá presentar traducción correspondiente de los dibujos.

En cumplimiento de lo dispuesto por el artículo 39 de la Decisión 486, se le requiere para que dentro del término de dos meses siguientes a la fecha de notificación del presente oficio, complete los requisitos anteriormente enunciados. En caso de no dar cumplimiento al presente requerimiento, la solicitud se considerará abandonada y perderá su prelación.

Notifíquese el presente oficio conforme a lo dispuesto en el numeral 5.2, literal e), del capítulo quinto del título primero de la Circular Única N° 10 de 2001.


ALIX CARMENZA CESPEDES DE VERGEL
Jefe de la División de Nuevas Creaciones.

El anterior requerimiento fue notificado por fijación en lista de fecha, 11 FEB. 2005

202030

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