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54. TITULO PROCESO Y APARATO PARA ELABORAR HARINA DE MAIZ NIXTAMALIZADO

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71. SOLICITANTE

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74. APODERADO

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22. SANTAFE DE BOGOTA, D.C.

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1 SOLICITUD DE:			
☒ Patente de Invención.		☐ Patente de Modelo de Utilidad.	
☐ Capítulo I.		☒ Capítulo II.	
2 SOLICITANTE (71)	Nombre: ROBERTO GONZALEZ BARRERA Dirección: Lomas de Chapultepec, Delegación Miguel Hidalgo, Mexico Nacionalidad o Domicilio: Mexico Lugar de Constitución: Teléfono: Fax: E-mail:		IDENTIFICACION C.C. ☐ NIT ☐ C.E. ☐ Otro ☐ Cual _____ Número _____
3 REPRESENTANTE O APODERADO	Nombre: RAMIRO CASTRO DUQUE Dirección: Cra. 7 No. 16-56 Piso 9 Teléfono: 380-2200 Fax: 380-2700 E-mail:		IDENTIFICACION C.C. ☒ NIT ☐ C.E. ☐ Otro ☐ Cual _____ Número <u>170.322 TP 1003</u>
4 INVENTOR (ES) (72)	Nombre: Manuel J. Rubio, Roberto Contreras, Francisco Sosa Dirección: 1621 Collins Avenue, Miami Beach, FL 33139, US; R. Cortines 2002 Qte, Guadalupe, N.L. 67110, MX; R. Cortines 2002 Ote, Guadalupe, N.L. 67110, MX Nacionalidad o Domicilio: Estados Unidos de América y Mexico (Respectivamente)		
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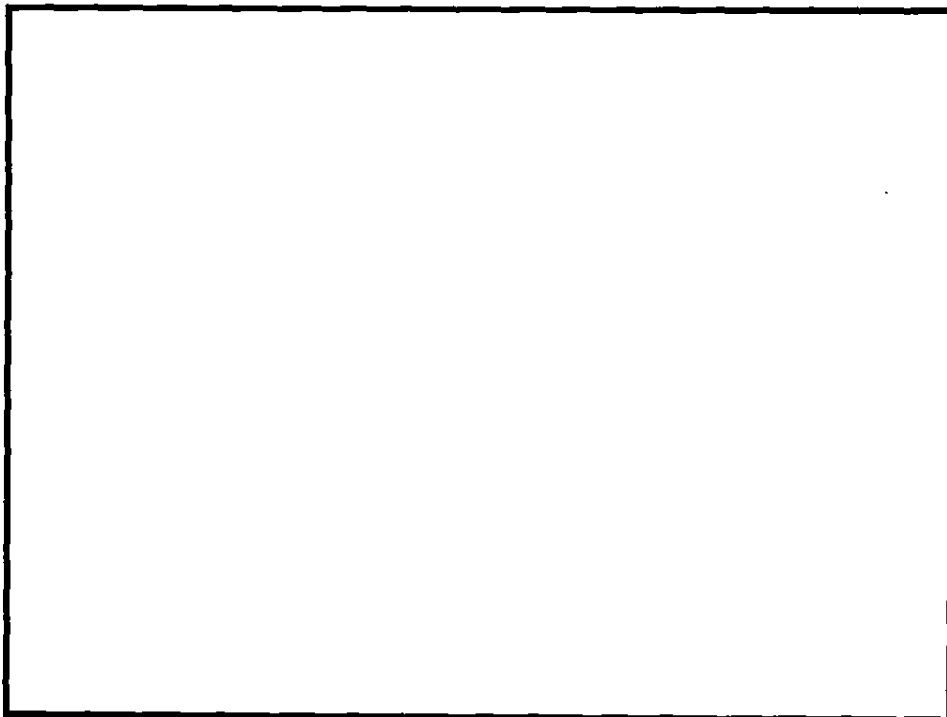
Instrucciones para el diligenciamiento del presente formulario, ver reverso de esta página.

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ANEXOS

- ☒ Comprobante de pago de la tasa de presentación de la solicitud. \$422.000
- ☐ Documento que acredite la existencia y representación legal cuando el solicitante sea persona jurídica.
- ☐ Poderes, si fuere el caso.
- ☐ 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)
- ☐ Copia del examen preliminar efectuado por la IPEA.
- ☐ Traducción del examen preliminar efectuado por la IPEA.
- ☐ De ser el caso, copia del contrato de acceso.
- ☐ De ser el caso, documento que acredite la licencia o autorización de uso de conocimientos tradicionales de las comunidades indígenas.
- ☐ 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: RAMIRO CASTRO DUQUE

FIRMA:

C.C. 170.322 de Bogotá T.P. 1003 del C.S.J.

Instrucciones para la presentación de los anexos, ver reverso de esta página.

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***** CONCEPTO *****

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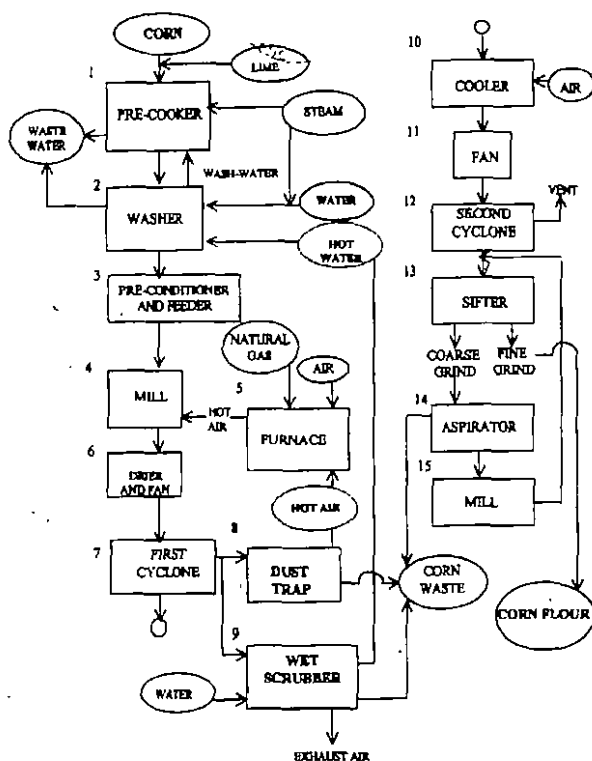
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| (30) Priority Data: | 10059,331, 31 January 2002 (31.01.2002) US | |
| (71) Applicant (for all designated States except US): | GONZALEZ BARRERA, Roberto [MX/MX]; Lomas de Chapultepec, Delegación Miquel Hidalgo, MX (MX). | |

[Continued on next page]

(54) Title: NIXTAMALIZED CORN FLOUR PROCESS AND APPARATUS IMPROVEMENT FOR RECOVERING HEAT AND REDUCING PARTICULATE EMISSION FROM WASTE HOT AIR



(57) Abstract: A process and apparatus improvement for energy and particulate recovery during the production of nixtamalized corn flour, by precooking with a lime solution to effect partial cooking, reduced energy use for pre-cooking and washing by recycling hot water. Next, moisture content is stabilized, and the corn is milled and dried in a super-heated stream of air with reduced energy consumption by recycling waste hot air. Dust trapping is performed on a portion of waste hot air which is reused for preheating combustion air. Wet scrubbing of the remaining waste hot air is performed where heated water is reused and exhaust air vented. Cooling and further drying of the dried-milled particles follows. A fine grind or flour is separated and recovered from the coarse grind which is also aspirated to isolate a hull fraction as corn waste along with particulate collected after entrapping and scrubbing waste hot air. Re-milling and sieving the coarse grind produces a corn flour for tortilla and the like.

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European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

Declaration under Rule 4.17:

— as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for the following designations 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, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent

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NIXTAMALIZED CORN FLOUR PROCESS AND APPARATUS
IMPROVEMENT FOR RECOVERING HEAT AND REDUCING
PARTICULATE EMISSION FROM WASTE HOT AIR

5 BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a food system for recovering the heat and preventing pollution from waste hot air after nixtamalized corn dehydration and, more particularly, it relates to a process improvement involving heat recovery from the waste hot air laden with particulate produced after flash drying, especially milled corn and the like, and for minimizing particulate emission in both the exhaust vented to the atmosphere and the hot water recycled to the process.

2. Description of Related Art

Nixtamalized corn flour (NCF) is conventionally produced by alkaline cooking of food-grade corn under atmospheric pressure, steeping and washing, grinding the partially cooked corn (nixtamal) and drying to give corn masa flour. At the industrial or commercial level, the "milling and dehydration" steps are major cost factors. In any case, the availability of an instant flour has many advantages such as shelf-life (4 to 8 months), less labor, lower water and energy use for the customer. Any method which may decrease both time and cost, and still yield an acceptable nixtamalized corn or masa flour product per unit of raw corn, would be advantageous to the final customer.

By combining energy efficiency and pollution prevention technologies is an opportunity for alignment among business, environmental advocates and regulators. The efficient use of resources is key to a sustainable development and industrial ecology. Energy recovery and renewable energy have supplied more than 80% in the US incremental energy requirements since 1973 (\$0.25 USD/MM-Btu). But given today's low prices for natural gas (\$1.5-2.2 USD in 1997 and \$3 USD by mid-2001: oilnergy.com), no

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realistic reductions in carbon emissions will happen without concerted national programs and incentives to encourage the faster adoption of efficient and renewable energy as well as natural gas. The success and cost effectiveness of this approach have been proven by redesigning or improving processes: reduce/recycle/re-sell waste, reduce energy use and emissions (Acee, 1997).

In this connection, reference is made to the following U.S. patents: 4,594,260, 5,176,931, 5,532,013, 6,025,011 and 6,265,013 requiring a low-temperature drying. However, U.S. patents 4,513,018, 5,558,898 and 6,068,873 only used a high-temperature short time dehydration without a heat recovery system. These prior art methods for the industrial production of corn and masa flour involve accelerated cooking with reduced amounts of water along with short processing times as well as low energy requirements for a high yield of the end product.

As previously mentioned by Rubio in U.S. Patent No. 4,513,018 and more recently by Sunderland in U.S. Patent No. 5,558,898, the waste hot air produced by combustion of natural gas with excess air is actually not pure combustion gas, but rather a mixture of hot air, water and particulate matter (very fine particles). This hot exhaust mix is drawn from the dryer by a fan and fed into a cyclone for removal of solid and liquid matter (hereafter referred to as dust or particulate) from such waste hot air for pollution control. A single-cyclone is the most widely used of the dry separator having a medium collection efficiency (80-95% for 15-50 micron size), a low pressure drop (2-5 in. water) and a high throughput (Theodore and Buonicore, 1976).

Another method of treating contaminated air from a food processing operation in the past has been by direct incineration or wet scrubbing. A scrubber is a system which uses a liquid, usually water, to achieve the removal of particulates from a gas stream. Scrubbers (particulate collectors) may be loosely categorized by pressure drop (inches of water) or energy consumption (Theodore and Buonicore, 1976): a) Spray chambers and towers (Knapp, 2000: U.S. Patent No. 6,019,818), for

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example, provide the lowest drop (< 5 in.) and, correspondingly, the lowest collection efficiencies (70-90% for > 10 micron), b) Centrifugal fan, atomizing and packed-bed scrubbers have a medium drop (5-15 in.) and medium efficiency (90-95%), and c) 5 Venturi-type has the highest drop (> 15 in.) along with the highest efficiency (>99%). In this connection, a high-pressure venturi scrubber (40 in. water) was used commercially in treating a medical waste incinerator exhaust gas which not only 10 claimed a 44% energy recovery for preheating incinerator or combustion air, but also complied with particulate EPA-limits (Andersen, 2001).

A few food processing plants have implemented both energy recovery and particulate emission using wet scrubbers to improve process efficiency during dehydration:

15 For example, West in U.S. patent No. 3,805,686, describes a batch scrubber system for treating moist air laden with particulate matter from a food smoke and drying chamber, cooled to condense liquid and solid out of the air in a dehumidifying tower, and reheated for recycling to the smoke chamber without 20 discharge to the atmosphere.

Furthermore, Williams in U.S. Patent No. 6,019,819, discloses another improved scrubber for extracting heat from contaminated waste steam. Waste gas is ducted from a food fryer to a condensing tower by spraying water into the gas. This 25 cooled waste gas is pulled into a low pressure water washer, and clean gas is sucked by a fan and vented.

Many applications for heat recovery included waste hot gas from a high-temperature process furnace, an incinerator and a high-temperature direct-fired dryer. Although the above 30 described prior art methods are capable in improving energy or particulate collection efficiency, a low-cost industrial application was still unavailable in the market at the time of the present invention.

SUMMARY AND OBJECTS OF THE INVENTION

The purpose of this invention is to provide a process improvement by reducing particulate matter and extracting heat and from the waste hot air of a flash dryer and recycle said heat into the furnace and washer as well.

Another object of the invention is to use an industrial method not only with a low-energy trapping and scrubbing apparatus, but also with a food process energy saving.

The above and other objects and advantages of the invention are achieved through a process improvement and apparatus applied to the production of nixtamalized corn flour, embodiments of which include pre-cooking with a lime solution so as to effect corn partial cooking, pre-cooking and washing with reduced energy, stabilizing moisture content to an optimum level for grinding, milling and flash dehydration of the milled corn with reduced energy and particulate emission, dust trapping of a portion of waste hot air which is reused for preheating combustion air, wet scrubbing of the remaining waste hot air where heated water is reused and exhaust air vented, cooling and drying the dry-milled particles, separating and recovering the fine grind so produced from the coarse grind while the latter is further aspirated to remove a hull fraction as corn waste, re-milling the isolated coarse grind and further sieving it to obtain a corn flour for tortilla and derivatives thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The sole drawing figure depicts an embodiment of this invention in flowchart form illustrating the continuous process improvement for energy and particulate recovery and depicting schematically the associated apparatus.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The drawing figure shows a pre-cooker 1; a washer 2; a pre-conditioner 3 with a feeder; a primary mill 4; a furnace 5; a drier 6 with a fan; a first cyclone separator 7; a dust trap for

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waste hot air 8; a wet scrubber 9 for waste hot air; a cooler 10 with an associated fan 11; a second cyclone separator 12; a sifter 13; an aspirator system 14; and a secondary mill 15.

The pre-cooker 1 is fed with a corn and lime mixture into which hot water recycled from the washer 2 is introduced to form an aqueous suspension which is also heated by steam. By regulating the steam heating along with the kernel residence time, it is possible to precook the corn to a temperature of from about 75° to about 94°C for a period of 20 to 45 minutes. This allows the precooked kernel to be produced at moisture contents of between 32% and 37%, while the pH is raised to about 9 to 12 with lime. Wastewater in the process is replaced with recycled hot water from the washer 2, which is regulated to maintain the waste solids of the cooker suspension in the range from about 1.0% to about 3.0%. The incoming corn quality, cooking time-temperature profile and process have been proposed as the main factors that determine the organic load in wastewater or "nejayote" (Ramirez and Alvarez, 1995; Jackson and Sahai, 2001).

The partially cooked corn suspension is passed to a washer 2 wherein it is sprayed with steam heated water at a temperature of about 60° to 70°C and also with hot water at about 53° to 58°C for 30-60 seconds, recycled from the wet scrubber 9, which serves to wash off excess waste solids.

The washed corn is thereafter passed to a pre-conditioner 3 wherein the precooked corn is tempered to achieve a moisture content of 34-39% for 20-210 minutes.

Thereafter, the preconditioned corn is fed through a feeder, whose design is known per se, to a primary mill 4 such that the milled corn and recycled hot air coming from a furnace 5, are mixed and partially cooked by a dryer 6 whose design is known per se. This milled corn kernel is thereby dried at a high temperature and short time profile, and is partially dried to yield a moisture content of 16% to about 18% depending on the desired particle size.

Waste hot air laden with particulate and moisture is extracted from the dryer 6 with a specially designed fan and fed

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into a first cyclone separator 7 for solids removal from such waste hot air. Afterwards, the waste hot air (127°C to about 138°C, and 13% to about 15% moisture) is equally fed into a dust trap 8 and a wet scrubber 9 for further particulate extraction.

5 A portion of the waste hot air is drafted into a low-pressure dust trap 8 wherein it is removed from particulate. The cleaned hot air (127°C to 138°C) is reused and mixed for preheating combustion air in the furnace 5 wherein natural gas is used. Collected solids are removed as waste.

10 The remaining waste hot air is cocurrently cooled and cleaned downflow by water spray nozzles inside the wet scrubber 9, under a low-pressure drop and a low liquid to gas ratio. The hot water is recycled to the washer 2 while wet coarse solids are isolated as corn waste. At the same time, a cool and clean
15 hot air (96°C to about 104°C, and 15% to about 18% moisture) is vented through an exhaust manifold.

Moisture laden-warm air is removed from the dry material through a cooler 10 with an associated fan 11, thus further reducing the moisture content from 16-18% to about 9-12%
20 depending upon the shelf-life of the corn flour.

After further extraction of the moisture with a second cyclone separator 12 wherein the warm exhaust air (49°C to 52°C) is vented, the precooked dry flour is directed to a sifter 13 wherein the fine grind is separated as corn flour and the coarse
25 grind is further processed.

The latter coarse grind is further separated in the aspirator system 14 wherein two fractions are obtained, a light hull fraction which is isolated as waste for feed with a moisture content between 9% to 12 % (representing from about 3%
30 to 5% of the total weight of incoming corn), and a heavy coarse fraction that is re-milled in a secondary mill 15. The milled product from secondary mill 15 is recycled to the sifter 13 for further sieving and producing a homogeneous corn flour for tortilla and the like.

35 The low-pressure dust trap of the present invention results in a 78% reduction in particulate matter emission flowrate and from a 36% to about 38% reduction in load emission (40 CFR, part

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60, Appendix A-EPA) with correspondingly lower environmental costs. It also achieves a 25% to about 30% energy recovery in the furnace by recycling the waste hot air, as compared to the conventional process.

- 5 In this method, the low-pressure wet scrubber results in a range of 75% to 81% decrease in particulate emission matter flowrate and from a 65% to about 72% decrease in load emission (40 CFR, part 60, Appendix A-EPA), with correspondingly lower energy costs, as compared to the industrial process.
- 10 Furthermore, the low liquid to waste hot air ratio in the scrubber allows a 20% to about 25% reduced energy usage in the washer and pre-cooker by reusing such hot water with correspondingly lower water usage costs.

- From the foregoing, it will be apparent that it is possible
- 15 to improve a nixtamalized corn flour process with low-cost industrial apparatus which is efficient because of a reduced energy consumption and particulate emission, wherein the recovery of this loss results in a higher energy saving and a lower pollution from waste hot air than would have been possible
- 20 absent the features of this invention.

- While the present invention has been described above in connection with the embodiments of this invention herein illustrated and described in detail and with published references, these are by way of illustration and not of
- 25 limitation. After reading this disclosure, it will be apparent to those skilled in this art that various changes and modifications can be made without departing from the spirit and scope of the present invention.

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We claim:

1. A process for energy and particulate recovery during production of nixtamalized corn flour, comprising the steps of:
 - 5 pre-cooking corn kernel using steam and a lime solution to effect partial cooking of the corn kernel,
 - washing the precooked corn kernel with steam heated water and hot water that is recycled from a downstream scrubbing of waste hot air,
 - 10 stabilizing a moisture content of said washed and precooked corn kernel to within a predetermined range,
 - milling said stabilized corn kernel and flash drying said milled corn kernel using a furnace, producing waste hot air, the furnace receiving as preheated combustion air recycled cleaned
 - 15 hot air,
 - dust trapping a first portion of the waste hot air for particulate removal to produce the cleaned hot air fed to the furnace,
 - wet scrubbing a second portion of the waste hot air with
 - 20 water spraying for particulate extraction to produce said hot water used in the washing step,
 - cooling and drying said dry-milled particles with ambient air having a low moisture content,
 - separating and recovering said dry milled particles into a
 - 25 finer fraction, under 25 to 60 mesh, and a coarser fraction that is further aspirated to remove corn hull as waste and thereafter re-milled,
 - collecting the finer fraction with a predetermined size as corn flour.
 - 30
2. The method according to claim 1 wherein said hull and particulate collected after the dust trapping and scrubbing steps is a fraction representing from 3% to about 5% of the total weight of corn kernel.
- 35
3. The method according to claim 1, further comprising recycling the re-milled coarser fraction.

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4. The method of claim 1, wherein the washing step produces heated water, the heated water being recycled as an input to the pre-cooking step.

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5. The method of claim 1, wherein the hot water produced by the wet scrubbing step and used in the washing step has a temperature in the range of about 53°C to 58°C.

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6. The method of claim 1, wherein the predetermined moisture range of the precooked corn kernel at an end of the stabilizing step is 34% to about 39%.

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7. The method of claim 6, wherein the stabilizing step is performed for between 20 and 210 minutes.

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8. The method of claim 1, wherein the flash drying step is performed until the milled corn kernel has a moisture content in the range of about 16% to 18%.

9. The method of claim 1, wherein the waste hot air produced by the flash drying step has a temperature in a range of 127°C to about 138°C.

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10. The method of claim 9, wherein the waste hot air produced by the flash drying step has a moisture content in a range of 13% to about 15%.

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11. The method of claim 1, wherein the waste hot air produced by the flash drying step is distributed equally between the first and second portions.

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12. The method of claim 1, wherein the furnace is fueled by natural gas.

13. A device for producing nixtamalized corn flour comprising:

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- a pre-cooker having a steam input;
a washer connected to receive an output of the pre-cooker, the washer having a steam-heated water input and a hot water input;
5 a pre-conditioner and feeder connected to receive an output of the washer;
a mill connected to receive an output of the pre-conditioner and feeder, the mill having an input delivering hot air from a furnace;
10 a drier and fan connected to receive an output of the mill;
a first cyclone connected to receive an output of the drier and fan;
a cooler connected to receive an output of the first cyclone;
15 a fan connected to receive an output of the cooler;
a second cyclone connected to receive an output of the fan;
and
a sifter;
wherein at least some of the hot water input to the washer
20 is recycled to the pre-cooker; and
wherein the first cyclone is connected to a dust trap and a wet scrubber so that waste hot air is passed to both the dust trap and the wet scrubber, the dust trap being connected to the furnace to provide cleaned hot air thereto, the wet scrubber
25 being connected to the washer to provide the hot water thereto.

14. A device for producing nixtamalized corn flour comprising:
a pre-cooker having a steam input;
30 a washer connected to receive an output of the pre-cooker, the washer having a steam-heated water input and a hot water input;
a pre-conditioner and feeder connected to receive an output of the washer;
35 a mill connected to receive an output of the pre-conditioner and feeder, the mill having an input delivering hot air from a furnace;

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a drier and fan connected to receive an output of the mill;
and

a first cyclone connected to receive an output of the drier
and fan;

5 wherein at least some of the hot water input to the washer
is recycled to the pre-cooker.

15. The device of claim 14, wherein the first cyclone is
connected to a dust trap so that a first portion of waste hot
10 air is passed thereto, the dust trap being connected to the
furnace to provide cleaned hot air thereto.

16. The device of claim 15, wherein the first cyclone is
further connected to a wet scrubber so that a second portion of
15 the waste hot air is passed to the wet scrubber, the wet
scrubber being connected to the washer to provide the hot water
thereto.

17. The device of claim 16, wherein the waste hot air
20 produced by the first cyclone is divided equally between the
dust trap and the wet scrubber.

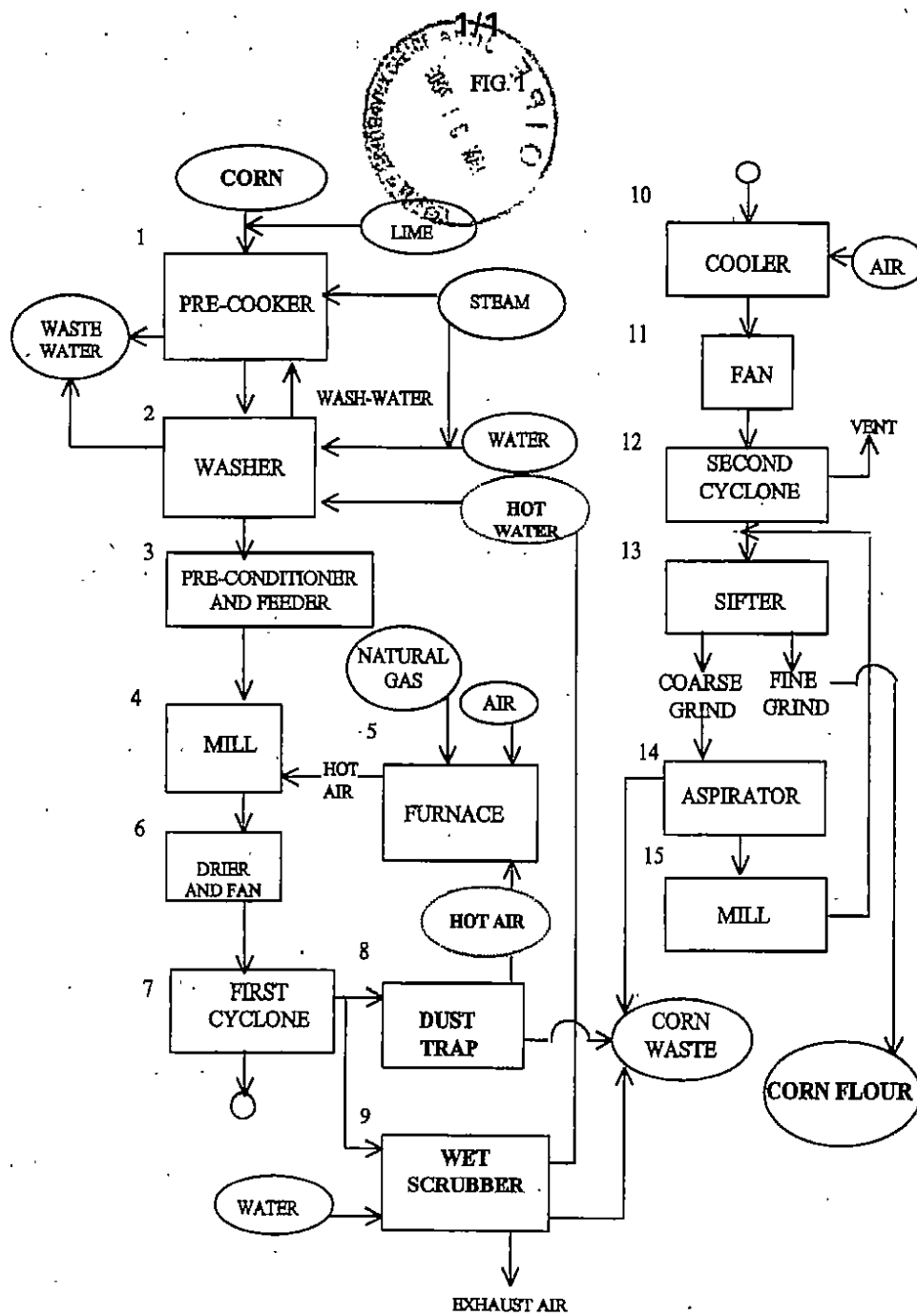
18. The apparatus according to claim 17, wherein energy
consumption is reduced from 25% to about 30% by trapping and
25 recycling the waste hot air.

19. The apparatus in accordance to claim 17, wherein
energy use is reduced from 20% to about 25% by said wet
scrubbing of the remaining waste hot air.

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20. The apparatus of claim 13, wherein said particulate
matter emission is reduced in a range of 75% to about 81% by
entrapping and scrubbing particulate from said waste hot air.

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(54) Title: PROCESS AND APPARATUS FOR MARKING NIXTAMALIZED CORN FLOUR

(57) Abstract: A process and apparatus improvement for energy and particulate recovery during the production of nixtamalized corn flour, by precooking with a lime solution to effect partial cooking, reduced energy use for pre-cooking and washing by recycling hot water. Next, moisture content is stabilized, and the corn is milled and dried in a super-heated stream of air with reduced energy consumption by recycling waste hot air. Dust trapping is performed on a portion of waste hot air which is reused for preheating combustion air. Wet scrubbing of the remaining waste hot air is performed where heated water is reused and exhaust air vented. Cooling and further drying of the dried-milled particles follows. A fine grind or flour is separated and recovered from the coarse grind which is also aspirated to isolate a hull fraction as corn waste along with particulate collected after entrapping and scrubbing waste hot air. Re-milling and sieving the coarse grind produces a corn flour for tortilla and the like.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/02756

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A23L 1/00

US CL : 426/508

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. : 426/508, 463, 482, 464, 618, 622, 626,

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
noneElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,322,836 B1 (RUBIO et al) 27 November 2001 (27.11.2001), columns 3-4.	1-20
Y	US 5,558,898 A (SUNDERLAND) 24 September 1996 (24.09.1996), columns 3-5.	1-12
Y	US 5,176,931 A (HERBSTER) 05 January 1993 (05.01.1993), columns 2-4.	1-12

☐ 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	* "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
* "E" earlier application or patent published on or after the international filing date	* "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
* "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)	* "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
* "O" documents referring to an oral disclosure, use, exhibition or other means	* "&" document member of the same patent family
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INTERNATIONAL SEARCH REPORT

PCT/US03/02756

Continuation of Item 4 of the first sheet:

The title is too long.

Process And Apparatus For Marking Nixtamalized Corn Flour.

Continuation of B. **FIELDS SEARCHED** Item 3:

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search terms: corn, nixtamalize, masa, lime

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(74) Agente: **JENSEN, Eric**; c/o YOUNG & THOMPSON, 745 South, 23rd Street, Second Floor, Arlington, Virginia, 22202 (US).

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Declaración bajo regla 4.17:

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(54) Título: PROCESO Y APARATO PARA ELABORAR HARINA DE MAÍZ NIXTAMALIZADO

(57) Extracto: Un mejoramiento de un proceso y de un aparato para recuperación de energía y particulado durante la producción de harina de maíz nixtamalizado, pre-cociendo con una solución de cal para llevar a cabo un cocimiento parcial, uso reducido de energía para el pre-cocimiento y lavado reciclando agua caliente. A continuación, se estabiliza el contenido de humedad, y el maíz se muele y seca en una corriente supercalentada de aire con consumo reducido de energía reciclando el aire caliente de desecho. El atrapamiento del polvo se realiza en una porción del aire caliente de desecho que se reutiliza para precalentar el aire de combustión. La depuración húmeda del aire caliente de desecho restante se efectúa donde se reutiliza el agua calentada y el aire de escape se descarga a la atmósfera. Luego vienen el enfriamiento y posterior secamiento de las partículas molidas secas. Un molturado fino o harina se separa y recupera del molturado grueso, el cual se aspira asimismo para aislar una fracción de cascarilla como desecho de maíz, junto con el particulado recogido después de atrapar y depurar el aire caliente de desecho. La re-molienda y cernido del molturado grueso produce una harina de maíz para tortilla y similares.

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**MEJORAMIENTO DE UN PROCESO DE HARINA DE MAÍZ
NIXTAMALIZADO Y APARATO PARA RECUPERAR CALOR Y
REDUCIR LA EMISIÓN DE PARTICULADO DEL AIRE
CALIENTE DE DESECHO**

ANTECEDENTES DE LA INVENCION

1. Campo de la Invención

La presente invención se refiere a un sistema de alimentos para recuperar el calor y evitar la contaminación del aire caliente de desecho después de la deshidratación del maíz nixtamalizado y, más particularmente, se relaciona con el mejoramiento de un proceso que involucra recuperación de calor del aire caliente de desecho cargado con particulado, producido después del secamiento instantáneo, especialmente maíz molido y similares, y para minimizar la emisión de particulado en el tubo de escape descargada a la atmósfera y en el agua caliente reciclada al proceso.

2. Descripción del Arte Relacionado

La harina de maíz nixtamalizado (NCF, por sus siglas en inglés) se produce convencionalmente por cocimiento alcalino de maíz de grado alimenticio bajo presión atmosférica, remojo y lavado, moliendo el maíz parcialmente cocido (nixtamal) y secándolo para producir harina de masa de maíz. A nivel industrial o comercial, los pasos de "molido y deshidratación" son factores importantes de costo. En cualquier caso, la disponibilidad de una harina instantánea tiene muchas ventajas, tales como vida en estante (4 a 8 meses), menos trabajo, menor uso de agua y energía para el cliente. Cualquier método que pueda disminuir el tiempo y el costo, y producir aún un maíz nixtamalizado aceptable o un producto de harina para masa por unidad de maíz crudo, sería ventajoso para el cliente final.

Combinar tecnologías de eficiencia de energía y prevención de la contaminación constituye una oportunidad de alinearse entre el negocio, los

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defensores del medio ambiente y los organismos reguladores. El uso eficiente de los recursos es clave para un desarrollo sostenible y la ecología industrial. La recuperación de energía y la energía renovable han aportado más del 80% en los requerimientos crecientes de energía de los Estados Unidos desde 1973 (\$0.25 USD/MM-Btu). Pero dados los precios bajos de hoy para el gas natural (\$1.5-2.2 USD en 1997 y \$3 USD a mediados de 2001: *oilnergy.com*), no ocurrirán reducciones realistas en las emisiones de dióxido de carbono sin programas nacionales concertados e incentivos para estimular la adopción más rápida de energía eficiente y renovable, así como gas natural. El éxito y la rentabilidad de este enfoque se han comprobado rediseñando o mejorando procesos: reducir/reciclar/revender desecho, reducir el uso de energía y las emisiones (Acee, 1997).

En este sentido, se hace referencia a las siguientes patentes de los Estados Unidos: 4,594,260, 5,176,931, 5,532,013, 6,025,011 y 6,265,013 que requieren un secamiento a baja temperatura. No obstante las patentes de los Estados Unidos 4,513,018, 5,558,898 y 6,068,873 sólo utilizaban una deshidratación de corto tiempo a alta temperatura, sin un sistema de recuperación de calor. Estos métodos del arte previo para la producción industrial de maíz y harina para masa involucran un cocimiento acelerado con cantidades reducidas de agua, junto con tiempos de procesamiento cortos, así como bajos requerimientos energía para un alto rendimiento del producto final.

Como se mencionó previamente por Rubio en la Patente de los Estados Unidos No. 4,513,018 y, más recientemente, por Sunderland en la Patente de los Estados Unidos No. 5,558,898, el aire caliente de desecho producido por la combustión de gas natural con exceso de aire no es realmente gas de combustión puro, sino más bien una mezcla de aire caliente, agua y material particulado (partículas finísimas). Esta mezcla de escape caliente se extrae del secador por un ventilador y se alimenta en un ciclón para el retiro de material sólido y líquido (denominado, en lo sucesivo, polvo o particulado) de dicho aire caliente de desecho para control de la contaminación. Un ciclón único es el usado más ampliamente

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del separador de aire que tiene una eficiencia de recolección media (80-95% para tamaños de 15-50 micrones), una baja caída de presión (2-5 pulgadas de agua) y un rendimiento elevado (Theodore y Buonicore, 1976).

Otro método de tratar aire contaminado, proveniente de una operación de procesamiento de alimentos, ha consistido en el pasado en la incineración directa o depuración húmeda. Un depurador es un sistema que utiliza un líquido, usualmente agua, para obtener la eliminación de particulados de una corriente de gas. Los depuradores (colectores de particulado) pueden clasificarse en líneas generales en categorías por caída de presión (pulgadas de agua) o consumo de energía (Theodore y Buonicore, 1976): a) cámaras de aspersión y torres (Knapp, 2000: patente de los Estados Unidos No. 6,019,818), por ejemplo, proporcionan la caída más baja (< 5 in.) y, correspondientemente, las eficiencias de recolección más bajas (70-90% para > 10 micrones), b) depuradores con ventilador centrífugo, atomización y lecho empacado tienen una caída media (5-15 in.) y una eficiencia media (90-95%), y c) el tipo venturi tiene la caída más alta (> 15 in.) junto con la eficiencia más elevada (>99%). En este sentido, un depurador de venturi de alta presión (40 in. de agua) se usó comercialmente en tratar un gas de escape en un incinerador de desechos hospitalarios que no sólo aducía una recuperación de energía del 44% para precalentar el incinerador o aire de combustión, sino que, además, cumplía los límites de la EPA (Agencia de Protección Ambiental de los Estados Unidos) para particulados (Andersen, 2001).

Unas cuantas plantas de procesamiento de alimentos han implementado la recuperación de energía y la emisión de particulado utilizando depuradores húmedos para mejorar la eficiencia del proceso durante la deshidratación:

Por ejemplo, West en la Patente de los Estados Unidos No. 3,805,686, describe un sistema depurador en lotes para tratar aire húmedo cargado con material particulado proveniente de una cámara de ahumado y secamiento de alimentos, enfriada para condensar líquidos y sólidos del aire en una torre de deshumidificación, y recalentada para reciclarlos a la

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cámara de humos sin descarga a la atmósfera.

Más aún, Williams en la Patente de los Estados Unidos No. 6,019,819, divulga otro depurador mejorado para extraer calor de vapor de desecho contaminado. El gas de desecho se conduce por medio de tubos desde una freidora de alimentos a una torre de condensación, rociando agua en el gas. Este gas de desecho enfriado se arrastra a un lavador de agua a baja presión, y se aspira y se descarga gas limpio al aire mediante un ventilador.

Muchas aplicaciones para la recuperación de calor incluían gas caliente de desecho proveniente de un horno de procesamiento a alta temperatura, un incinerador y un secador alimentado directamente a alta temperatura. Aunque los métodos del arte previo descritos anteriormente están en capacidad de mejorar la eficiencia de la energía o recolección de particulado, hasta ahora no se hallaba disponible en el mercado una aplicación industrial a bajo costo al momento de la presente invención.

SUMARIO Y OBJETIVOS DE LA INVENCION

El propósito de esta invención es proporcionar una mejora de un proceso reduciendo el material particulado y extrayendo calor del aire caliente de desecho de un secador instantáneo y reciclar dicho calor tanto al horno como al lavador.

Otro objetivo de la invención es utilizar un método industrial no sólo con un aparato atrapador y depurador de baja energía, sino también con un ahorro de energía en procesamiento de alimentos.

El anterior y otros objetivos y ventajas de la invención se logran mediante una mejora de un proceso y un aparato aplicados a la producción de harina de maíz nixtamalizado, cuyas incorporaciones incluyen pre-cocer con una solución de cal, de manera que el cocimiento parcial del maíz, el pre-cocimiento y lavado se lleven a cabo con energía reducida, estabilizar el contenido de humedad a un nivel óptimo para el triturado, molienda y deshidratación instantánea del maíz molido con energía y emisión de particulado reducidas, atrapar polvo de una porción de aire caliente de

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desecho, el cual se reutiliza para precalentar el aire de combustión, depuración húmeda del aire caliente de desecho remanente donde el agua calentada se reutiliza y el aire de escape se descarga al aire, enfriar y secar las partículas molidas secas, separar y recuperar el molido fino así producido a partir del molido grueso, mientras que éste último se sigue aspirando para retirar una fracción de cascarilla como desecho de maíz, remoler el molido grueso aislado y continuar cerniéndolo para obtener una harina de maíz para tortilla y sus derivados.

BREVE DESCRIPCIÓN DE LOS DIBUJOS

La figura única de dibujo representa una incorporación de esta invención en forma de un diagrama de flujo que ilustra el mejoramiento de un proceso continuo para recuperación de energía y particulado y que describe de manera esquemática el aparato asociado.

DESCRIPCIÓN DETALLADA DE INCORPORACIONES PREFERIDAS

La figura de dibujo muestra un pre-cocedor 1; un lavador 2; un pre-acondicionador 3 con un alimentador; un molino primario 4; un horno 5; un secador 6 con un ventilador; un primer separador de ciclón 7; una trampa de polvo para aire caliente de desecho 8; un depurador húmedo 9 para aire caliente de desecho; un enfriador 10 con un ventilador asociado 11; un segundo separador de ciclón 12; un cribador 13; un sistema aspirador 14; y un molino secundario 15.

El pre-cocedor 1 se alimenta con una mezcla de maíz y cal en la cual se introduce agua caliente reciclada del lavador 2 para formar una suspensión acuosa que se calienta igualmente por vapor. Regulando el calentamiento por vapor junto con el tiempo de residencia del grano, es posible precocer el maíz a una temperatura de desde alrededor de 75° a alrededor de 94°C durante un período de 20 a 45 minutos. Esto permite

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producir el grano precocido con un contenido de humedad de entre 32% y 37%, mientras que el pH se eleva a alrededor de 9 a 12 con cal. El agua de desecho en el proceso se reemplaza con agua caliente reciclada del lavador 2, el cual se regula para mantener los sólidos de desecho de la suspensión del cocedor en el rango desde alrededor de 1.0% a alrededor de 3.0%. La calidad del maíz entrante, el perfil tiempo de cocción-temperatura y el proceso se han propuesto como los factores principales que determinan la carga orgánica en el agua de desecho o "nejayote" (Ramírez y Álvarez, 1995; Jackson y Sahai, 2001).

La suspensión del maíz parcialmente cocido se pasa a un lavador 2 en donde se rocía con agua calentada con vapor a una temperatura de alrededor de 60° a 70°C y además con agua caliente a alrededor de 53° a 58°C durante 30-60 segundos, reciclada del depurador húmedo 9, el cual sirve para eliminar por lavado el exceso de sólidos de desecho.

El maíz lavado se pasa seguidamente a un pre-acondicionador 3 en donde el maíz pre-cocido se atempera para lograr un contenido de humedad de 34-39% durante 20-210 minutos.

Más tarde, el maíz pre-acondicionado se alimenta a través de un alimentador, cuyo diseño es conocido de por sí, a un molino primario 4 tal que el grano molido y el aire caliente reciclado proveniente de un horno 5, se mezclan y se cocinan parcialmente por un secador 6 cuyo diseño es conocido de por sí. En consecuencia, este grano de maíz molido se seca a un perfil de alta temperatura y tiempo corto, y se seca parcialmente para producir un contenido de humedad de 16% a alrededor de 18% dependiendo del tamaño de partícula deseado.

Aire caliente de desecho cargado con particulado y humedad se extrae del secador 6 con un ventilador especialmente diseñado y se alimenta en un primer separador de ciclón 7 para retiro de los sólidos de dicho aire caliente de desecho. Acto seguido, el aire caliente de desecho (127°C a alrededor de 138°C, y 13% a alrededor de 15% de humedad) se alimenta igualmente a una trampa de polvo 8 y un depurador húmedo 9 para extracción adicional de particulado.

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Una porción del aire caliente de desecho se succiona a una trampa de polvos de baja presión 8 en donde se retira del particulado. El aire caliente limpio (127°C a 138°C) se reutiliza y se mezcla para pre-calentar el aire de combustión en el horno 5, en donde se usa gas natural. Los sólidos recolectados se eliminan como desecho.

El aire caliente de desecho remanente se enfría simultáneamente y se limpia corriente abajo por toberas de rociado de agua al interior del depurador húmedo 9, bajo una caída de baja presión y una baja relación líquido a gas. El agua caliente se recicla al lavador 2 mientras que los sólidos gruesos húmedos se aíslan como desecho de maíz. Al mismo tiempo, un aire frío y caliente limpio (96°C a alrededor de 104°C, y 15% a alrededor de 18% de humedad) se descarga a la atmósfera mediante un múltiple de escape.

El aire caliente con carga de humedad se retira del material seco mediante un enfriador 10 con un ventilador asociado 11, reduciendo así aún más el contenido de humedad desde 16-18% a alrededor de 9-12%, dependiendo de la vida en estante de la harina de maíz.

Luego de una extracción adicional de la humedad con un segundo separador de ciclón 12, en donde el aire de escape caliente (49°C a 52°C) se descarga a la atmósfera, la harina seca pre-cocida se dirige a un cribador 13 en donde el molido fino se separa como harina de maíz y el molido grueso se sigue procesando.

El último molido grueso se separa aún más en el sistema aspirador 14 en donde, se obtienen dos fracciones, una fracción liviana de cascarilla que se aísla como desecho para alimentarla con un contenido de humedad entre 9% a 12 % (representando desde alrededor de 3% a 5% del peso total del maíz que entra), y una fracción gruesa pesada que se remuele en un molino secundario 15. El producto molido del molino secundario 15 se recicla al cribador 13 para cernirlo aún más y producir una harina de maíz homogénea para tortilla y similares.

La trampa de polvo de baja presión de la presente invención resulta en una reducción del 78% en el caudal de salida de emisión de material

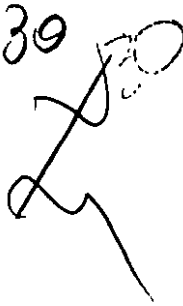
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particulado y desde una reducción de 36% a alrededor de 38% en la emisión de carga (40 CFR, parte 60, Apéndice A-EPA) con costos ambientales correspondientemente más bajos. Asimismo logra una recuperación de energía de 25% a alrededor de 30% en el horno, reciclando el aire caliente de desecho, comparada con el proceso convencional.

En este método, el depurador húmedo de baja presión resulta en un rango de disminución de 75% a 81% en el caudal de salida de material de emisión de particulado y una disminución desde 65% a alrededor de 72% en la emisión de carga (40 CFR, parte 60, Apéndice A-EPA), con costos de energía correspondientemente menores, comparadas con el proceso industrial. Más aún, la baja relación de líquido a aire caliente de desecho en el depurador permite una utilización reducida de energía de 20% a alrededor de 25% en el lavador y el pre-cocedor, reutilizando tal agua caliente con costos de utilización de agua correspondientemente más bajos.

De lo anterior, será evidente que es posible mejorar un proceso de harina de maíz nixtamalizado con un aparato industrial de bajo costo que es eficiente debido a un consumo y emisión de particulado reducidos, en donde la recuperación de esta pérdida resulta en un ahorro más alto de energía y una menor contaminación a partir del aire caliente de desecho de lo que habría sido posible en ausencia de las características de esta invención.

Aunque la presente invención se ha descrito anteriormente en conexión con las incorporaciones de esta invención ilustradas aquí y descritas en detalle con referencias publicadas, éstas son a manera de ilustración y no de limitación. Luego de leer esta divulgación, será evidente a aquellas personas expertas en el arte que pueden hacerse varios cambios y modificaciones, sin apartarse del espíritu y el ámbito de la presente invención.

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Reivindicamos

1. Un proceso para recuperación de energía y particulado durante la producción de harina de maíz nixtamalizado, que comprende los pasos de:

pre-cocer grano de maíz usando vapor en una solución de cal para realizar la cocción parcial del grano de maíz,

lavar el grano de maíz pre-cocido con agua calentada con vapor y agua caliente que se recicla de una depuración, corriente abajo, de aire caliente de desecho,

estabilizar un contenido de humedad de dicho grano de maíz lavado y pre-cocido hasta dentro de un rango predeterminado,

moler dicho grano de maíz estabilizado y secar instantáneamente dicho grano de maíz molido usando un horno, produciendo aire caliente de desecho, recibiendo el horno como aire de combustión precalentado aire caliente limpio reciclado,

atrapar polvo de una primera porción del aire caliente de desecho para retiro del particulado para producir el aire caliente limpio alimentado al horno,

depurar en húmedo una segunda porción del aire caliente de desecho con atomización de agua para extracción de particulado para producir dicha agua caliente usada en el paso de lavado,

enfriar y secar dichas partículas molidas secas con aire ambiente que tiene un bajo contenido de humedad,

separar y recuperar dichas partículas molidas secas en una fracción más fina, mediante malla 25 a 60, y una fracción más gruesa que se sigue aspirando para retirar la cascarilla del maíz como desecho y, a renglón seguido, se remuele,

recoger la fracción más fina con un tamaño predeterminado como harina de maíz.

2. El método de acuerdo con la reivindicación 1 en donde dicha cascarilla y particulado, recogidos después de los pasos de atrapamiento de

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polvo y depuración, es una fracción que representa desde 3% a alrededor de 5% del peso total del grano de maíz.

3. El método de acuerdo con la reivindicación 1, que comprende además reciclar la fracción más gruesa re-molida.

4. El método de la reivindicación 1, en donde el paso de lavado produce agua calentada, reciclándose el agua calentada como un insumo al paso de pre-cocido.

5. El método de la reivindicación 1, en donde el agua caliente producida por el paso de depuración húmeda y usada en el paso de lavado tiene una temperatura en el rango de aproximadamente 53 °C a 58°C.

6. El método de la reivindicación 1, en donde el rango de humedad predeterminado del grano de maíz pre-cocido al final del paso de estabilización es de 34% a alrededor de 39%.

7. El método de la reivindicación 6, en donde el paso de estabilización se lleva a cabo durante entre 20 y 210 minutos.

8. El método de la reivindicación 1, en donde el paso de secamiento instantáneo se lleva a cabo hasta que el grano de maíz tiene un contenido de humedad en el rango de alrededor de 16% a 18%.

9. El método de la reivindicación 1, en donde el aire caliente de desecho producido por el paso de secamiento instantáneo tiene una temperatura en un rango de 127°C a alrededor de 138°C.

10. El método de la reivindicación 9, en donde el aire caliente de desecho producido por el paso de secamiento instantáneo tiene un contenido de humedad en un rango de 13% a alrededor de 15%.

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11. El método de la reivindicación 1, en donde el aire caliente de desecho producido por el paso de secamiento instantáneo se distribuye igualmente entre las porciones primera y segunda.

12. El método de la reivindicación 1, en donde el horno de alimenta con gas natural.

13. Un dispositivo para producir harina de maíz nixtamalizado que comprende:

un pre-cocedor que tiene una entrada de vapor;

un lavador conectado para recibir una salida del pre-cocedor, teniendo el lavador una entrada de agua calentada por vapor y una entrada de aire caliente;

un pre-acondicionador y un alimentador conectados para recibir una salida del lavador;

un molino conectado para recibir una salida del pre-acondicionador y alimentador, teniendo el molino una entrada que entrega aire caliente de un horno;

un secador y ventilador conectados para recibir una salida del molino;

un primer ciclón conectado para recibir una salida del secador y ventilador;

un enfriador conectado para recibir una salida del primer ciclón;

un ventilador conectado para recibir una salida del enfriador;

un segundo ciclón conectado para recibir una salida del ventilador; y

un cribador;

en donde por lo menos alguna de la entrada de agua caliente al lavador se recicla al pre-cocedor; y

en donde el primer ciclón se conecta a una trampa de polvo y a un depurador húmedo, de manera que el aire caliente de desecho pase a la trampa de polvo y al depurador húmedo, conectándose la trampa de polvo al horno para proporcionarle aire caliente limpio, conectándose el

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depurador húmedo al lavador para proporcionarle el agua caliente.

14. Un dispositivo para producir harina de maíz nixtamalizado que comprende:

un pre-cocedor que tiene una entrada de vapor;

un lavador conectado para recibir una salida del pre-cocedor, teniendo el lavador una entrada de agua calentada con vapor y una entrada de agua caliente;

un pre-acondicionador y alimentador conectado para recibir una salida del lavador;

un molino conectado para recibir una salida del pre-acondicionador y alimentador, teniendo el molino una entrada que entrega aire caliente de un horno;

un secador y ventilador conectados para recibir una salida del molino;
y

un primer ciclón conectado para recibir una salida del secador y ventilador;

en donde por lo menos alguna de la entrada de agua caliente al lavador se recicla al pre-cocedor.

15. El dispositivo de la reivindicación 14, en donde el primer ciclón se conecta a una trampa de polvo de manera que una primera porción de aire caliente de desecho se pase a ella, conectándose la trampa de polvo al horno para proporcionarle aire caliente limpio.

16. El dispositivo de la reivindicación 15, en donde el primer ciclón se conecta además a un depurador húmedo de manera que una segunda porción del aire caliente de desecho pase al depurador húmedo, conectándose el depurador húmedo al lavador para proporcionarle el agua caliente.

17. El dispositivo de la reivindicación 16, en donde el aire caliente

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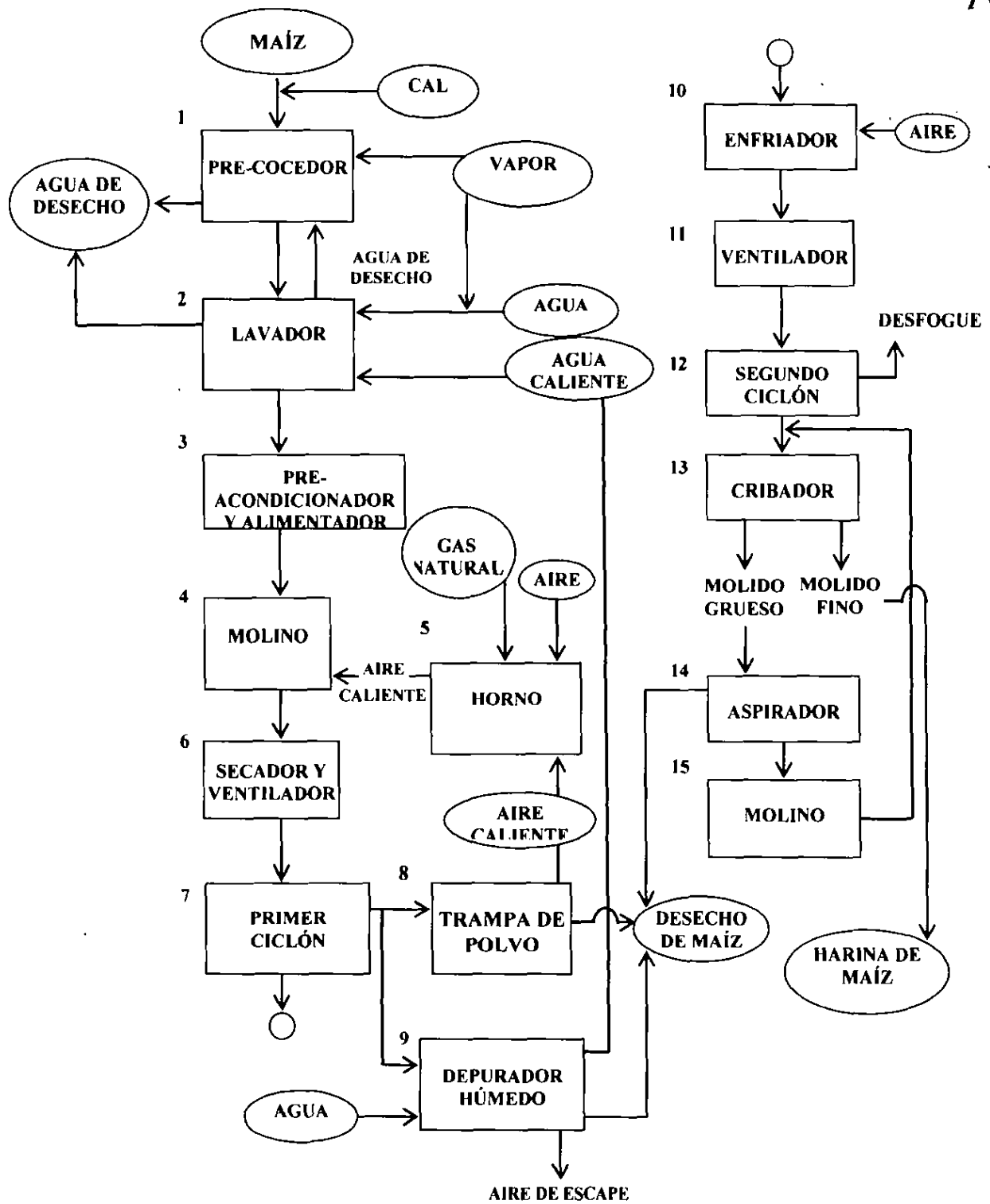
de desecho producido por el primer ciclón se divide igualmente entre la trampa de polvo y el depurador húmedo.

18. El aparato de acuerdo con la reivindicación 17, en donde el consumo de energía se reduce de 25% a alrededor de 30% atrapando y reciclando el aire caliente de desecho.

19. El aparato de acuerdo con la reivindicación 17, en donde el uso de energía se reduce de 20% a alrededor de 25% por dicha depuración húmeda del aire caliente de desecho remanente.

20. El aparato de la reivindicación 13, en donde dicha emisión de material particulado se reduce en un rango de 75% a alrededor de 81% atrapando y depurando particulado de dicho aire caliente de desecho.

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Declaration under Rule 4.17:

— as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for the following designations 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, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

Published:

— with international search report
— with amended claims and statement

(88) Date of publication of the international search report:
16 October 2003

Date of publication of the amended claims and statement:
31 December 2003

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 2003/063594 A3

(54) Title: PROCESS AND APPARATUS FOR MARKING NIXTAMALIZED CORN FLOUR

(57) Abstract: A process and apparatus improvement for energy and particulate recovery during the production of nixtamalized corn flour, by precooking with a lime solution to effect partial cooking, reduced energy use for pre-cooking and washing by recycling hot water. Next, moisture content is stabilized, and the corn is milled and dried in a super-heated stream of air with reduced energy consumption by recycling waste hot air. Dust trapping is performed on a portion of waste hot air which is reused for preheating combustion air. Wet scrubbing of the remaining waste hot air is performed where heated water is reused and exhaust air vented. Cooling and further drying of the dried-milled particles follows. A fine grind or flour is separated and recovered from the coarse grind which is also aspirated to isolate a hull fraction as corn waste along with particulate collected after entrapping and scrubbing waste hot air. Re-milling and sieving the coarse grind produces a corn flour for tortilla and the like.

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AMENDED

CLAIMS

AMENDED CLAIMS

[received by the International Bureau on 16 Septembre 2003 (16.09.03);
original claim 1 amended; remaining claims unchanged]

1. A process for energy and particulate recovery during production of nixtamalized corn flour, comprising the steps of:

5 pre-cooking corn kernel using steam and a lime solution to effect partial cooking of the corn kernel,

washing the precooked corn kernel with steam heated water and hot water, the hot water being recycled from a downstream scrubbing of waste hot air,

10 stabilizing a moisture content of said washed and precooked corn kernel to within a predetermined range,

milling said stabilized corn kernel and flash drying said milled corn kernel using a furnace, producing waste hot air, the furnace receiving as preheated combustion air recycled
15 cleaned hot air,

dust trapping a first portion of the waste hot air for particulate removal to produce the cleaned hot air fed to the furnace,

20 wet scrubbing a second portion of the waste hot air with water spraying for particulate extraction to produce said hot water used in the washing step,

cooling and drying said dry-milled particles with ambient air having a low moisture content,

25 separating and recovering said dry milled particles into a finer fraction, under 25 to 60 mesh, and a coarser fraction that is further aspirated to remove corn hull as waste and thereafter re-milled,

collecting the finer fraction with a predetermined size as corn flour.

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2. The method according to claim 1 wherein said hull and particulate collected after the dust trapping and scrubbing steps is a fraction representing from 3% to about 5% of the total weight of corn kernel.

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3. The method according to claim 1, further comprising recycling the re-milled coarser fraction.

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XSTATEMENT UNDER ARTICLE 19(1)

International Bureau
34, chemin des Colombettes
Geneva, Switzerland

September 16, 2003

Sir:

Responsive to the International Search Report of July 17, 2001, applicant makes of record the following statement:

Applicant has amended claim 1 to clarify that it is the hot water that is recycled from the downstream scrubbing of waste hot air

The International Search Report identifies three references, namely RUBIO et al., SUNDERLAND, and HERBSTER.

The recitations of amended independent method claim 1 include the following steps:

washing the precooked corn kernel with steam heated water and hot water, the hot water being recycled from a downstream scrubbing of waste hot air,

...
milling said stabilized corn kernel and flash drying said milled corn kernel using a

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furnace, producing waste hot air, the furnace receiving as preheated combustion air recycled cleaned hot air,

dust trapping a first portion of the waste hot air for particulate removal to produce the cleaned hot air fed to the furnace,

wet scrubbing a second portion of the waste hot air with water spraying for particulate extraction to produce said hot water used in the washing step,

As is evident from the amended passages from claim 1, hot water for the washing step is recycled from the downstream scrubbing step. Furthermore, cleaned hot air is recycled from the dust trapping step to the drying step.

In the cited RUBIO et al. patent, the source of air for the furnace 5 and the source of water for the washer 2 are unidentified, as is most clearly indicated by the sole drawing figure of such reference. In sharp contrast, amended claim 1 now clearly recites that hot water is recycled from the scrubbing step to the washing step.

The HERBSTER reference similarly discloses a method for the production of flour. It appears that the only reference to a recycling step or apparatus is described in connection with the rotary grain abrasion device discussed in the specification of such reference beginning on line 10 of column 3. However, such recirculation refers merely to the reintroduction of the process water from within the apparatus performing the abrasion step, directly back into such apparatus/step. This does not appear to be the same as the

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recycling of hot water from a wet scrubber to a washer, as recited in the amended claim.

The SUNDERLAND reference describes another continuous method of producing flour. In the paragraph spanning columns 3 and 4, the reference states that "an intermediate recycle conduit 68, equipped with airlocks 70, 72 may be employed for recycling oversized material from the top of tower 64 back to hammermill 62 for reprocessing."

However, this recycling refers to passing the grain itself through a continuous cycle through the hammermill until the grain has been ground to a sufficiently fine consistency. This repeated grinding of the grain itself appears to be distinct from the recycling of hot water recited in the amended claim.

Accordingly, applicant suggests that amended claim 1 recites the recycling of hot water in a manner unlike that disclosed by the references.

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REIVINDICACIONES
MODIFICADAS

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REIVINDICACIONES MODIFICADAS

[recibidas por la Oficina Internacional el 16 de septiembre de 2003 (16.09.03); reivindicación original 1 modificada; reivindicaciones restantes sin modificar]

1. Un proceso para recuperación de energía y particulado durante la producción de harina de maíz nixtamalizado, que comprende los pasos de:

pre-cocer grano de maíz usando vapor y una solución de cal para llevar a cabo la cocción parcial del granos de maíz,

lavar el grano de maíz pre-cocido con agua calentada con vapor y agua caliente, reciclándose el agua caliente de una depuración corriente abajo de aire caliente de desecho,

estabilizar un contenido de humedad de dichos grano de maíz lavado y pre-cocido hasta dentro de un rango predeterminado,

moler dicho grano de maíz estabilizado y secar instantáneamente dicho grano de maíz molido usando un horno, produciendo aire caliente de desecho, recibiendo el horno como aire de combustión pre-calentado aire caliente limpio reciclado,

atrapar polvo de una primera porción del aire caliente de desecho para retiro de particulado para producir el aire caliente limpio alimentado al horno,

depurar en húmedo una segunda porción del aire caliente de desecho con atomización de agua para extracción de particulado para producir dicha agua caliente usada en el paso de lavado,

enfriar y secar dichas partículas molidas secas con aire ambiente que tiene un bajo contenido de humedad,

separar y recuperar dichas partículas molidas secas en una fracción más fina, mediante malla de 25 a 60, y una fracción más gruesa que se aspira aún más para retirar cascarilla de maíz como desecho y, a renglón seguido, se re-muele,

recoger la fracción más fina con un tamaño predeterminado como harina de maíz.

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2. El método de acuerdo con la reivindicación 1 en donde dicha cascarilla y particulado recogidos después de los pasos de atrapamiento de polvo y depuración es una fracción que representa desde 3% a alrededor de 5% del peso total de grano de maíz.

3. El método de acuerdo con la reivindicación 1, que comprende además reciclar la fracción más gruesa re-molida.

HOJA MODIFICADA (ARTÍCULO 19)

DECLARACIÓN BAJO ARTÍCULO 19 (1)

Oficina Internacional
34, chemin des Colombettes
Ginebra, Suiza

16 de septiembre de 2003

Señor:

En respuesta al Informe de Búsqueda Internacional del 17 de julio de 2001, el solicitante hace formalmente la siguiente declaración:

El solicitante ha modificado la reivindicación 1 para aclarar que es el agua caliente la que se recicla de la depuración, corriente abajo, de aire caliente de desecho.

El Informe de Búsqueda Internacional identifica tres referencias, a saber, RUBIO y colaboradores, SUNDERLAND, y HERBSTER.

Las enumeraciones de la reivindicación 1 del método independiente modificada incluyen los siguientes pasos:

Lavar el grano de maíz pre-cocido con agua calentada con vapor y agua caliente, reciclándose el agua caliente de una depuración corriente abajo de aire caliente de desecho,

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moler dicho grano de maíz estabilizado y secar instantáneamente dicho grano de maíz molido usando un horno, produciendo aire caliente de desecho, recibiendo el horno como aire de combustión precalentado aire caliente limpio reciclado,

atrapar polvo de una primera porción del aire caliente de desecho para retiro de particulado para producir el aire caliente limpio alimentado al horno,

depurar en húmedo una segunda porción del aire caliente de desecho con atomización de agua para extracción de particulado para producir dicha agua caliente usada en el paso de lavado,

Como es evidente de los pasajes modificados de la reivindicación 1, el agua caliente para el paso de lavado se recicla del paso de depuración corriente abajo. Más aún, el aire caliente limpio se recicla del paso de atrapado de polvo al paso de secamiento.

En la patente citada de RUBIO y colaboradores, la fuente de aire para el horno 5 y la fuente de agua para el lavador 2 no se identifican, como muy claramente se indica por la figura única de dibujo de dicha referencia. En marcado contraste, la reivindicación 1 modificada enumera ahora claramente que el agua caliente se recicla del paso de depuración al paso de lavado.

En forma similar la referencia HERBSTER divulga un método para la producción de harina. Parece que la única referencia a un paso de reciclado o aparato se describe en conexión con el dispositivo de abrasión de grano rotatorio, discutido en la especificación de dicha referencia que comienza en renglón 10 de columna 3. Sin embargo, tal recirculación se refiere simplemente a la re-introducción del agua de proceso desde el interior del aparato que realiza el paso de abrasión, directamente de regreso a dicho aparato/paso. Esto no parece ser lo mismo que el reciclado de agua caliente desde un depurador húmedo a un lavador, como se cita en la reivindicación modificada.

La referencia SUNDERLAND describe otro método continuo de

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producir harina. En el párrafo que abarca las columnas 3 y 4, la referencia establece que " puede emplearse una tubería de reciclado intermedio 68, equipada con esclusas de aire 70, 72 para reciclar material demasiado grande desde arriba de la torre 64, de regreso al molino de martillo 62 para el reprocesamiento."

No obstante, este reciclado se refiere a pasar el grano mismo a través de un ciclo continuo por el molino de martillo, hasta que el grano se haya molido a una consistencia suficientemente fina. Esta molienda repetida del grano mismo parece ser distinta del reciclado de agua caliente mencionado en la reivindicación modificada.

En consecuencia, el solicitante sugiere que la reivindicación modificada 1 mencione el reciclado de agua caliente en una manera distinta a la divulgada por las referencias.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 9002-1001-1	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US03/02756	International filing date (day/month/year) 31 January 2003 (31.01.2003)	Priority date (day/month/year) 31 January 2002 (31.01.2002)
International Patent Classification (IPC) or national classification and IPC IPC(7): A23L 1/00 and US Cl.: 426/508		
Applicant GONZALEZ BARRERA, ROBERTO		
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>—</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 31 July 2003 (31.07.2003)	Date of completion of this report 31 October 2003 (31.10.2003)	
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 Cano Milton Telephone No. 703-308-0661	

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

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US03/02756

17
48

I. Basis of the report

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

- ☒ the international application as originally filed.
- ☒ the description:
pages 1-7 as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____
- ☒ the claims:
pages 8-11 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 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/US03/02756

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>1-20</u>	YES
	Claims <u>NONE</u>	NO
Inventive Step (IS)	Claims <u>1-20</u>	YES
	Claims <u>NONE</u>	NO
Industrial Applicability (IA)	Claims <u>1-20</u>	YES
	Claims <u>NONE</u>	NO

2. CITATIONS AND EXPLANATIONS

Claims 1-20 the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest a process for the production of nixtamalized corn flour which includes the steps of dust trapping a first portion of the waste hot air and wet scrubbing a second portion of the waste hot air with water. Also, the prior art does not teach or fairly suggest an apparatus in which the first cyclone is connected to a dust trap and a wet scrubber or an apparatus in which the washer has a steam-heated water input and a hot water input and the drier includes a fan. There is no suggestion to include these features in the prior art apparatus. There is no suggestion to modify the prior art process to include the steps of dust trapping and wet scrubbing.

Claims 1-20 meet industrial applicability as defined by PCT Article 33(4) because the invention can be made and used in industry.

PATENT COOPERATION TREATY

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PCT

From the INTERNATIONAL BUREAU

NOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

JENSEN, Eric
c/o YOUNG & THOMPSON
745 South 23rd Street
Second Floor
Arlington, Virginia 22202
United States of America

Date of mailing (day/month/year) 02 May 2003 (02.05.03)	
Applicant's or agent's file reference 9002-1001-1	IMPORTANT NOTIFICATION
International application No. PCT/US03/02756	International filing date (day/month/year) 31 January 2003 (31.01.03)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 31 January 2002 (31.01.02)
Applicant GONZALEZ BARRERA, Roberto 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.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
31 Janu 2002 (31.01.02)	10/059,331	US	26 Marc 2003 (26.03.03)

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 338.70.10	Authorized officer Jean-Marie MCADAMS (Fax 338 7010) Telephone No. (41-22) 338 9913
--	---

EPO - DG 1

PATENT COOPERATION TREATY

11.08.2003

PCT

From the INTERNATIONAL BUREAU

(109)

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

To:

JENSEN, Eric
c/o YOUNG & THOMPSON
745 South 23rd Street
Second Floor
Arlington, Virginia 22202
United States of America

Date of mailing (day/month/year) 25 July 2003 (25.07.03)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 9002-1001-1	
International application No. PCT/US03/02756	International filing date (day/month/year) 31 January 2003 (31.01.03)

1. The following indications appeared on record concerning:		
☒ the applicant	☒ the inventor	☐ the agent ☐ the common representative
Name and Address SOSA, Francisco R. Cortines 2002 Ote. Guadalupe, N.L. MX Mexico	State of Nationality MX	State of Residence MX
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:		
☐ the person	☐ the name	☒ the address ☐ the nationality ☐ the residence
Name and Address SOSA, Francisco R. Cortines 2002 Ote Guadalupe, N.L. 67110 Mexico	State of Nationality MX	State of Residence MX
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
3. Further observations, if necessary:		
4. A copy of this notification has been sent to:		
☒ the receiving Office	☒ the designated Offices concerned	
☒ the International Searching Authority	☐ the elected Offices concerned	
☐ the International Preliminary Examining Authority	☐ other:	

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Monique BROSSE (Fax 338 7010)
Facsimile No. (41-22) 338.70.10	Telephone No. (41-22) 338 8326

EPO-DG 1

PATENT COOPERATION TREATY

11.08.2003

109

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

To:

JENSEN, Eric
c/o YOUNG & THOMPSON
745 South 23rd Street
Second Floor
Arlington, Virginia 22202
United States of America

Date of mailing (day/month/year) 25 July 2003 (25.07.03)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 9002-1001-1	
International application No. PCT/US03/02756	International filing date (day/month/year) 31 January 2003 (31.01.03)

1. The following indications appeared on record concerning:

☒ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address CONTRERAS, Roberto R. Cortines 2002 Ote. Guadalupe, N.L. MX Mexico	State of Nationality MX	State of Residence MX
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address CONTRERAS, Roberto R. Cortines 2002 Ote Guadalupe, N.L. 67110 Mexico	State of Nationality MX	State of Residence MX
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office ☒ the designated Offices concerned
☒ the International Searching Authority ☐ the elected Offices concerned
☐ the International Preliminary Examining Authority ☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 338.70.10	Authorized officer Monique BROSSE (Fax 338 7010) Telephone No. (41-22) 338 8325
--	---

Copy for the designated Office (DO/EP)
PATENT COOPERATION TREATY

PCT/US2003/002756

31

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING
OF A CHANGE

(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

To:

JENSEN, Eric
c/o YOUNG & THOMPSON
745 South 23rd Street
Second Floor
Arlington, Virginia 22202
United States of America

Date of mailing (day/month/year) 06 January 2004 (06.01.2004)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 9002-1001-1	
International application No. PCT/US2003/002756	International filing date (day/month/year) 31 January 2003 (31.01.2003)

1. The following indications appeared on record concerning: ☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative	
Name and Address GONZALEZ BARRERA, Roberto Lomas de Chapultepec Delegación Miguel Hidalgo, MX Mexico	State of Nationality MX State of Residence MX Telephone No. Facsimile No. Teleprinter No.
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning: ☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence	
Name and Address GONZALEZ BARRERA, Roberto Lomas de Chapultepec Delegación Miguel Hidalgo, MX 11000EPO - DG 1 Mexico 24.02.2004 (103)	State of Nationality MX State of Residence MX Telephone No. Facsimile No. Teleprinter No.
3. Further observations, if necessary:	
4. A copy of this notification has been sent to: ☒ the receiving Office ☒ the designated Offices concerned ☐ the International Searching Authority ☐ the elected Offices concerned ☐ the International Preliminary Examining Authority ☐ other:	

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 338.70.10	Authorized officer Jean-Marie MCADAMS (Fax 338 7010) Telephone No. (41-22) 338 8813
--	---

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/02756

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A23L 1/00
US CL : 426/508

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. : 426/508, 463, 482, 464, 618, 622, 626,

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
noneElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,322,836 B1 (RUBIO et al) 27 November 2001 (27.11.2001), columns 3-4.	1-20
Y	US 5,558,898 A (SUNDERLAND) 24 September 1996 (24.09.1996), columns 3-5.	1-12
Y	US 5,176,931 A (HERBSTER) 05 January 1993 (05.01.1993), columns 2-4.	1-12

☐ 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

29 May 2003 (29.05.2003)

Date of mailing of the international search report

17 JUL 2003

Name and mailing address of the ISA/US

Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703)305-3230

Authorized officer

Lien Tran

Telephone No. 703-308-0661

Form PCT/ISA/210 (second sheet) (July 1998)

86 15 55

INTERNATIONAL SEARCH REPORT

PCT/US03/02756

Continuation of Item 4 of the first sheet:
The title is too long.
Process And Apparatus For Marking Nixtamalized Corn Flour.

Continuation of B. FIELDS SEARCHED Item 3:
WEST
search terms: corn, nixtamalize, masa, lime



US006322836B1

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

(10) Patent No.: **US 6,322,836 B1**
(45) Date of Patent: **Nov. 27, 2001**

(54) **CONTINUOUS PRODUCTION OF AN INSTANT CORN FLOUR FOR AREPA AND TORTILLA, USING AN ACID-COOKING**

5,176,931 • 1/1993 Herbster 426/626
6,025,011 • 2/2000 Wilkinson et al. 426/626

(76) Inventors: **Manuel J. Rubio**, 1621 Collins Ave., Miami Beach, FL (US) 33139; **Roberto Contreras**, R. Cortines 2002, Ote. Guadalupe, N.L. (MX); **Francisco Arroyo**, 501 W. Chapin Rd., Edinburg, TX (US) 78539

* cited by examiner

Primary Examiner—George C. Yeung

(74) Attorney, Agent, or Firm—Young & Thompson

(57) **ABSTRACT**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: 09/764,280

(22) Filed: Jan. 19, 2001

(51) Int. Cl.⁷ A23L 1/00

(52) U.S. Cl. 426/508; 426/463; 426/464;
426/622; 426/626

(58) Field of Search 426/508, 463,
426/464, 618, 622, 626, 482

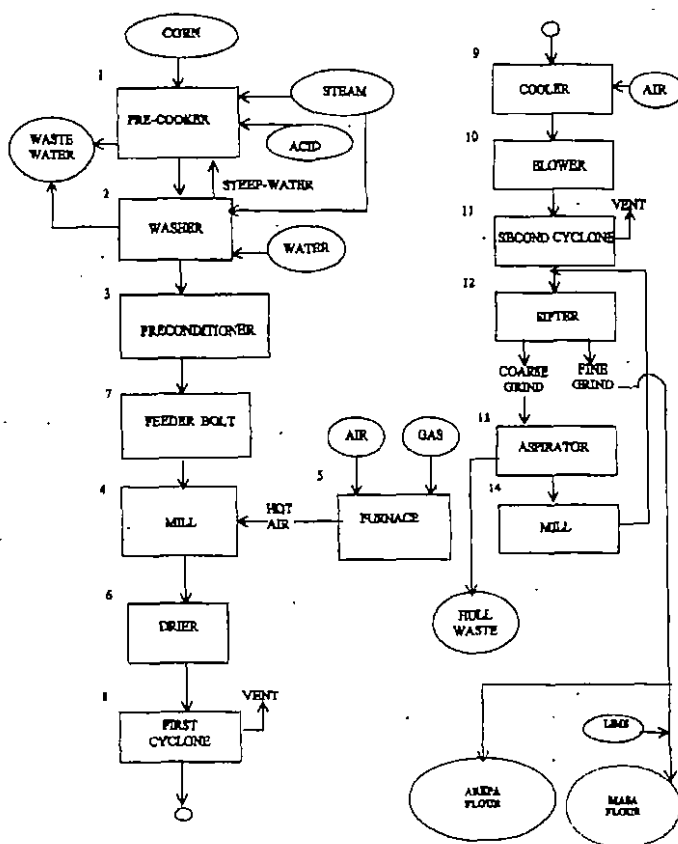
(56) **References Cited**

U.S. PATENT DOCUMENTS

1,045,490 • 11/1912 Vulkan 426/626

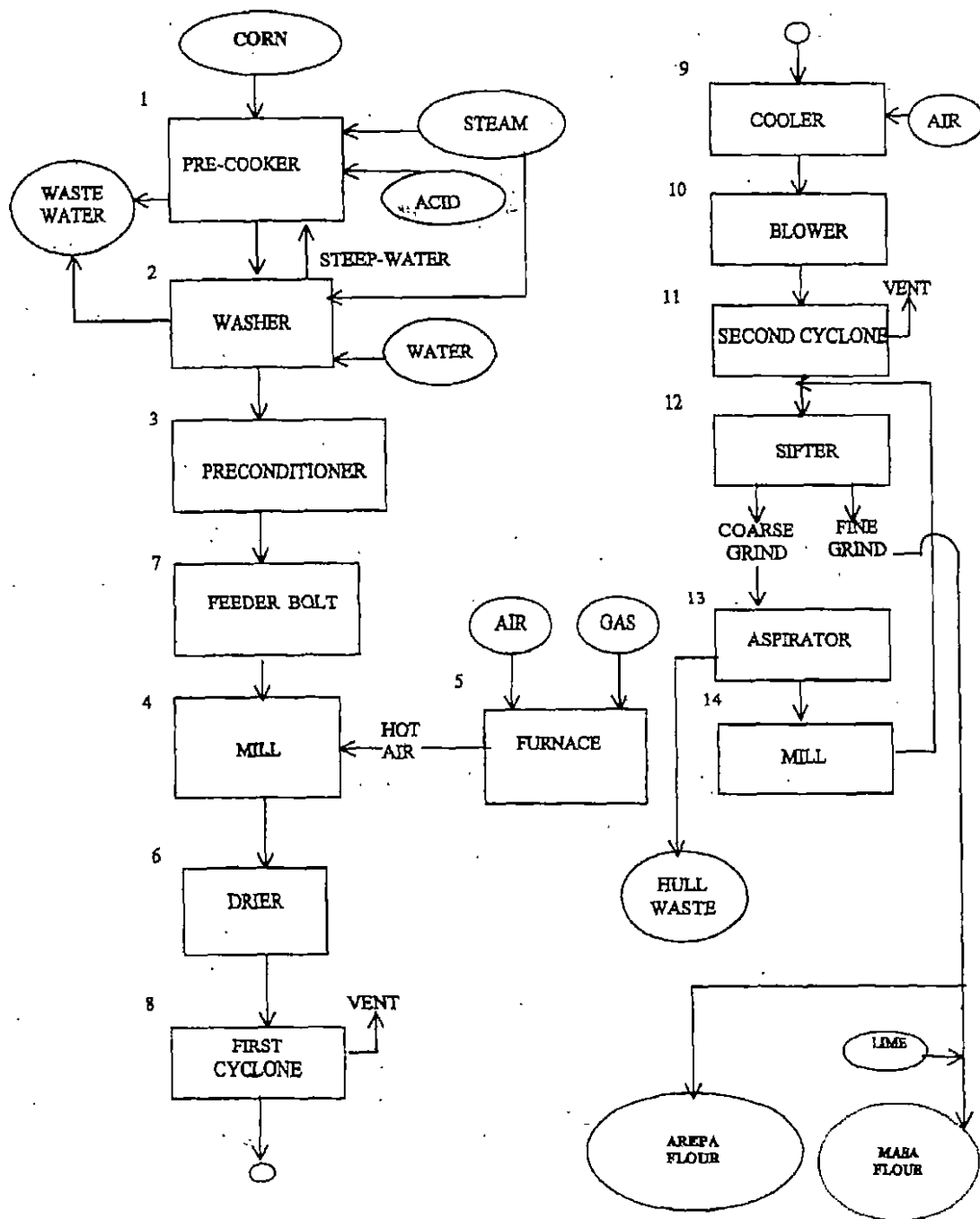
Precooked and partially-dehulled corn flour is produced using an acid-cooking in a continuous process, by acid-precooking to effect corn hull hydrolysis with sodium metabisulfite or sodium hydrogen sulfite or sodium sulfite, with reduced kernel washing and solid loss. Moisture content is then stabilized, followed by grinding and drying in a superheated stream of air, cooling and further drying the dried-ground particle. A fine grind or flour is separated and recovered from the coarse grind which is also segregated to isolate a hull fraction as corn hull waste, regrinding and sieving the coarse grind to produce an instant corn flour for arepa, and admixing the fine grind with lime to obtain a masa flour for tortilla and the like.

9 Claims, 1 Drawing Sheet



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FIG. 1



CONTINUOUS PRODUCTION OF AN INSTANT CORN FLOUR FOR AREPA AND TORTILLA, USING AN ACID-COOKING

BACKGROUND OF INVENTION

1. Field of the Invention

The present invention relates to an accelerated thermal process under acidic cooking for the production of precooked corn flour and, more particularly, it relates to a continuous partial removal of the corn hull fraction with an acidic reducing agent applied to the production of instant corn flour for the manufacture of arepa and tortilla and the like.

2. Description of Related Art

Tortilla and corn dough (masa) are traditionally made from whole corn kernel which is cooked and/or steeped in calcium hydroxide (lime) or sometimes in sodium hydroxide (lye) or wood ashes, in order to produce a reaction known as "nixtamalization". The nixtamalized corn is further steeped, washed with partial hull removal and finally stone ground into a corn dough. Corn dough texture is determined by factors such as corn variety or cultivar, endosperm hardness as well as the water uptake (dough yield) and degree of starch gelatinization mainly during corn "cooking" (thermal) and cooked corn (nixtamal) "grinding" (mechanical) operations.

During alkali-cooking and/or steeping, there are chemical and physical changes such as nutrient losses along with partial hull removal and gelatinization in the corn kernel. The most important nutritional modifications are: an increase in the calcium level with improvements in the Ca to P ratio, a decrease in insoluble dietary fiber and zein-protein, a significant reduction in thiamin and riboflavin, an improvement of the leucine to isoleucine ratio reducing the requirement for niacin and reduction of the aflatoxins by leaching into the lime-water.

The cooking method, raw corn quality and cooker-type (batch or continuous) used have been proposed as the critical variables which determine solid losses in lime-water residue (nejayote). This wastewater by-product was composed of corn solids ranging from 1.5% (batch-cooker) to 2.5% (continuous-cooker). Dry solid matter includes an average of 50-60% dietary fiber, 15-20% ash, 15% starch, 5-10 % protein and 5% fat. The corn pericarp makes up 4-6% of the kernel dry weight (Watson, 1987). It also contains 67% hemicellulose, 23% cellulose and 0.6% soluble-fiber. It is estimated that dietary fiber in the pericarp (4.9%) and endosperm (2.6%) make up 80% of the total dietary fiber (9.5% in a dry-weight basis).

During the formation of corn dough, grinding disrupts the swollen and partially gelatinized starch granules and further distributes the hydrated soluble starch, protein and fiber fractions around the ungelatinized fraction of the endosperm-germ granules.

Tortilla is the main edible corn product in Latin 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 (retrogradation) due to a physicochemical change in the starch constituent of either stored or reheated tortilla. It is known that tortilla when kept under conditions

in which no moisture is lost (plastic package storage), nevertheless become inflexible with time and break or crumble easily when bent.

Properly processed industrial 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 potentially has the following quality cost disadvantages: high cost, lack of flavor, and poor texture in tortilla products or snacks prepared from masa flour.

There is nevertheless an increasing demand for and use of industrially prepared corn flours for the benefits they provide to the consumer, such as convenience, availability, incorporation of micronutrients and additives, low price and a more stable product quality (Sustain, 1997). The basic difference between tortilla (from Mexico and some Central American countries) and arepa flour (Venezuela and Colombia) is that for the former, whole corn is alkali-cooked and the hull is partially separated to obtain a lime-precooked corn flour (masa flour). On the other hand, arepa flour (precooked flour) is prepared from dehulled and degerminated corn without using an alkali-cooking treatment (INCAP, 1961). However, arepa flour is further enriched, by Venezuelan law, with B-vitamins and iron to improve the nutritional value of this traditional South American food mainly based on this baked thick pancake (flat-cornbread: Cuevas et al. 1985).

Corn processes 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 apparatus where the grain is cooked and/or steeped in a lime-water solution such as those disclosed in U.S. Pat. Nos. 2,584,893; 3,194,664; 4,326,455 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 and washing operations.

Many and varied methods for the production of instant corn flour for tortilla involving reduced amounts of water with short process times and low energy requirements for a high yield of the end product have been developed, as reflected by the following U.S. Pat. Nos. 4,250,802; 4,329,371; 4,594,260 and 5,532,013. Although the above described prior art methods are capable of producing corn flour with increasing yields and processing efficiencies, a continuous process was still unavailable in the expanding masa flour industry for tortilla and the like.

SUMMARY AND OBJECTS OF THE INVENTION

Accordingly, it is an object of this invention to provide a novel method and apparatus for continuous production of an instant corn flour under processing conditions involving not only a reduced amount of water and solids loss but also an increased yield of the product.

Another object is to achieve this objective using an acidic cooking with sodium metabisulfite and the like for partial removal of the hull fraction and producing a precooked corn flour for arepa and tortilla and the like.

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 acid-precooking with a sodium metabisulfite, or sodium hydrogen sulfite or sodium sulfite solution so as to effect corn hull hydrolysis, reduced washing of precooked kernel, stabilization of the moisture content to a desired optimum level for grinding, grinding and drying the preconditioned kernel to produce a uniform partial cooking, cooling and drying the dry-ground particle, separating and recovering the fine grind so produced from the coarse grind while the latter is further aspirated to remove a hull fraction as corn waste, regrinding the isolated coarse 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 DRAWING

The invention will be more fully understood from the description which follows and from the appended drawing in which:

FIG. 1 depicts an embodiment of this invention in a block-type flowchart illustrating the continuous process.

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; a primary mill 4 with an associated furnace 5; a dryer 6; a feeder bolt 7; a first cyclone separator 8; a cooler 9 with an associated blower 10; a second cyclone separator 11; a sifter 12; a series of aspirators 13; and a secondary mill 14.

The pre-cooker 1 is fed with corn and a sodium metabisulfite solution, to form an acidic aqueous suspension which is heated by steam injection. By regulating the steam heating along with the kernel residence time, it is possible to precook the corn to a temperature of from about 75° to about 94° C. for a period of 35 to 45 minutes. This allows the precooked kernel to be produced at moisture contents of between 35% and 37%, while the pH is lowered to about 6.2-6.6 with the addition of a 10% acidic solution to supply a 0.16% sulfite-additive with respect to corn. Water loss in the process is replaced with wash water from the washer 2, which is regulated to maintain the solid content of the solution at about 0.6% to 0.7%. The pre-cooker performs a partial acidic hydrolysis that promotes a uniform diffusion of the cooking water through the tip cap into the germ, endosperm and their cell walls made of dietary fiber. Acid-cooking also softens the corn, permitting a 70% reduction in waste solids as well as a 15% reduced wastewater overflow (with a concomitant lower sewage cost) compared to the industrially used alkali-cooking (Alvarez and Ramirez, 1995).

The partially cooked corn suspension is then passed to a washer 2 where it is sprayed with steam heated water at a temperature of about 60° to 70° C. for 30 to 60 seconds, which also serves to wash off excess waste solids.

The washed corn is thereafter passed to a preconditioner 3, where the kernel is equilibrated to obtain a residual moisture content of 38%-39% for 150-210 minutes.

Thereafter, the preconditioned particle is fed to a primary mill 4 by feeder bolt 7. The mill 4 has an associated specially designed venturi such that the premilled corn and hot air coming from a furnace 5, is mixed and partially cooked by a dryer 6 whose design is known per se. The premilled

kernel is thereby dried at a higher temperature and short time, and is partially gelatinized or precooked to yield a moisture content of 12% to 14% depending on the granulation being produced.

Moisture laden-hot air (195° C. to 205° C.) is extracted with a first cyclone separator 8 so that further moisture extraction may take place by impelling the drier material through a cooler 9 with air sucked by the blower 10, thus further decreasing the moisture content from 12-14% to about 11-12% (similar to the incoming corn).

After further extraction of moisture laden-warm air with a second cyclone separator 11, the precooked dry particle is directed to a sifter 12 where the fine grind is discharged as instant corn flour for arepa and the coarse grind is further segregated in a series of aspirators 13. The former fine grind may be admixed with lime (0.3% based on flour) for production of instant masa flour for tortilla or snack foods.

The latter coarse grind particle is further separated in the aspirator system 13 wherein two fractions are obtained, a light hull fraction which is isolated as corn waste with a moisture content between 11% to 13% (representing from about 3% to 6% to about 5% to 10% of the total weight of incoming corn), and a heavy coarse fraction that is milled in a secondary mill 14. The milled product from secondary mill 14 is recycled to the sifter 12 for further sieving and to obtain a homogeneous corn flour for arepa. If desired, the arepa flour can be admixed with lime to produce a masa flour for making tortilla.

For use in arepa manufacture, the instant 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 for arepa elaboration (53% to 60% final moisture).

For use in tortilla manufacture, the masa flour made from the present method can be rehydrated with water from a 1:1 to about 1:1.3 weight ratio for a masa dough used in tortilla preparation (45% to 49% final moisture).

In this method, the novel acid-cooking results in a 65% to 75% reduction in solid loss and a 15% to 20% reduction in wastewater effluent, with correspondingly lower sewage and energy costs, as compared to the conventional methods. Furthermore, the acid-cooking of the invention allows a 50% reduction in lime use if an instant masa flour were produced to improve the traditional lime flavor and tortilla and/or snack shelf life. The bisulfite and sulfite ions in aqueous solutions not only aid in stopping the growth of putrefactive organisms, but also inhibit browning reactions during the corn preconditioning.

There is furthermore a potential gain in corn flour yield from 88% to 92% of the total weight of acid-cooked corn as compared to the traditional alkali-cooking process which approximately yields from 87% to about 89%. Whereas the precooked and partially dehulled corn flour produced by the present method may thus comprise a higher than 90% average yield of flour per kilogram of corn, the dehulled and degermed flour produced by traditional arepa processing obtains only a 70% average yield.

Still further, the instant corn flour produced by the present method has a higher nutritional value than that produced by the conventional methods, with more protein (15% to 25%), fat (70% minimum), and dietary fiber content (100%) than the typical arepa or cornmeal flour which mainly needs vitamins (B and A) and mineral (iron) fortification.

From the foregoing, it will be apparent that it is possible to manufacture a precooked and partially-dehulled corn flour for arepa and masa flour with a novel continuous process which is efficient because of a reduced solid and wastewater

effluent, wherein some of the solid loss that would have been present but for the features of this invention is prevented. The shelf life of tortilla, however, could be improved with refrigeration, antimicrobial agents, fiber-gum antistaling agents, or by adding more than 0.3% lime during cooking or into the corn dough (U.S. Pat. No. 3,730,732) or less washing of the precooked corn.

The following table gives a typical nutrient average composition for an instant corn flour for tortilla, and a South American precooked corn flour for arepa elaboration (NCAP, 1961; Cuevas, 1985):

Nutritional profile (per 100 g) of Instant Corn Flour		
Nutrient	Corn flour	Arepa flour
Water (g)	11.0	11.0
Protein (g)	8.1	7.0
Fat (g)	3.7	0.7
Ash (g)	1.3	0.3
Dietary fiber (g)	6.1	3.0
Starch (g)	69.8	78.0
Calories	356	365

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 modifications are possible and will present themselves to those skilled in the prior art and by the spirit of the appended claims.

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We claim:

1. A method of processing corn kernel to produce precooked and partially dehulled corn flour for arepa and tortilla, comprising continuously and repeatedly the following steps:

15 acid-cooking corn kernel in a solution comprising at least one acid component selected from the group consisting of sodium metabisulfite, sodium hydrogen sulfite and sodium sulfite, to partially hydrolyze the hull of said corn kernel,

20 stabilizing a moisture content of said acid-cooked corn kernel to within a predetermined range,

grinding said corn kernel and drying said corn kernel with a high temperature-short time apparatus or flash drier, cooling and drying said ground corn with ambient air having a relatively lower moisture content,

25 separating and recovering said ground corn into a finer fraction, under 25 to 60 mesh, and a coarser fraction that is further aspirated to remove hull by-product and thereafter re-ground,

30 whereby there is produced an instant corn flour with fine particle size suitable for arepa.

2. The method of claim 1 wherein said hull by-product is a light hull fraction representing a minimum by-product yield from 3% to about 5% of the total weight of corn kernel.

3. The method according to claim 1, further comprising recycling the reground coarser fraction by performing said separating and recovering step on the reground coarser fraction.

4. The method for claim 1 wherein said precooked and partially dehulled corn flour comprises an average yield of about 90% flour per kilogram of corn kernel.

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

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

7. The method according to claim 6, further comprising rehydrating said masa flour with water from a 1:1 to about 1:1.3 weight ratio to form a masa dough used in tortilla preparation.

8. The method of claim 5, wherein the corn dough has a final moisture content of 53% to 60%.

9. The method of claim 7, wherein the masa dough has a final moisture content of 45% to 49.

* * * * *

61 (13)



US005558898A

United States Patent [19]
Sunderland

[11] **Patent Number:** **5,558,898**
[45] **Date of Patent:** **Sep. 24, 1996**

[Handwritten signature]

- [54] **CONTINUOUS METHOD OF PRODUCING MASA FLOUR**
- [75] **Inventor:** Robert D. Sunderland, Sabetha, Kans.
- [73] **Assignee:** Wenger Manufacturing Inc., Sabetha, Kans.
- [21] **Appl. No.:** 309,199
- [22] **Filed:** Sep. 20, 1994
- [51] **Int. Cl.^o** **A23L 1/00**
- [52] **U.S. Cl.** **426/626; 426/456; 426/459; 426/463**
- [58] **Field of Search** **426/626, 456, 426/459, 463**

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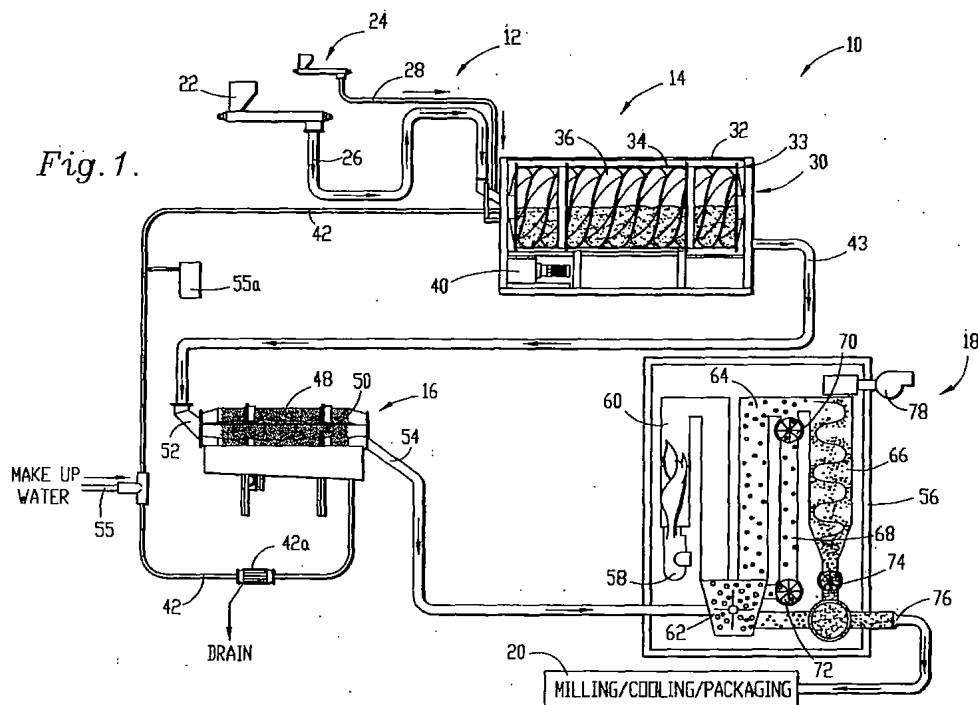
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Primary Examiner—Esther Kepplinger
Assistant Examiner—Choon P. Koh
Attorney, Agent, or Firm—Hovey, Williams, Timmons & Collins

[57] **ABSTRACT**

A short-time low-pollution method for preparing masa flour is provided wherein whole grain is first partially cooked in a hot alkaline treating solution to achieve at least about 15% gelatinization and loosening of the bran fraction of the grain. The partially cooked grain is then debranned and is subjected to a flash dehydration for quickly subdividing and reducing the moisture content of the grain. The dehydrated grain is then milled to create an acceptable masa flour.

27 Claims, 2 Drawing Sheets

Fig. 1.



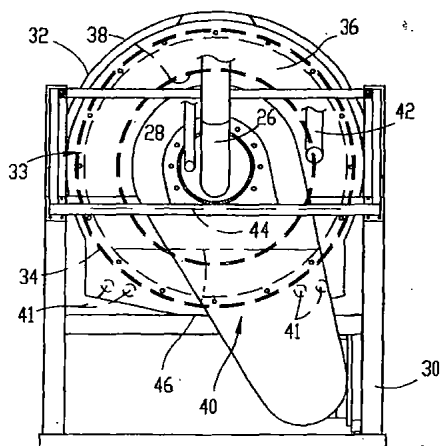


Fig. 2.

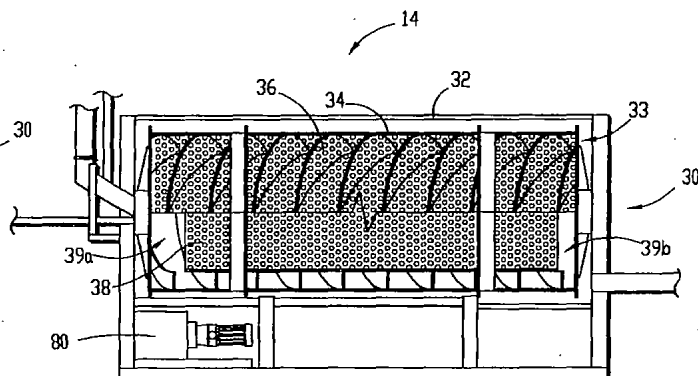


Fig. 3.

**CONTINUOUS METHOD OF PRODUCING
MASA FLOUR****BACKGROUND OF THE INVENTION****1. Field of the Invention**

The present invention is broadly concerned with a method for the preparation of masa flour which eliminates many of the costly, time-consuming, pollution causing steps conventionally carried out in the preparation of such flours. More particularly, it is concerned with a masa preparation method wherein debranned, moisturized and partially cooked grain (e.g., corn or wheat) is subjected to a flash dehydration process in order to quickly dehydrate the debranned grain, which can then be milled into an acceptable masa flour. In the flash dehydration, high velocity hot air currents having a temperature of from about 600°-1000° F. are employed for the rapid grain dehydration.

2. Description of the Prior Art

Masa flour, typically made using food grade corn or wheat, is produced in tremendous quantities in the United States and around the world. Such flour is used to fabricate such familiar products as tortilla chips and taco shells.

Despite the demand for masa flour, for the most part it is prepared using very old and time honored techniques. In the first step, whole kernel corn is cooked in a mixture of water and 1% lime up to a temperature of 175°-205° F., depending upon the hardness of the starting corn and other factors. The corn is then allowed to steep in the lime water for a period of 8-12 hours, in order to allow the lime to penetrate, loosen and partially dissolve the pericarp or bran fraction of the corn.

The steeped corn is then passed through a corn washer, comprising a perforated, rotatable cylinder equipped with internal water jets, in order to complete the removal of bran and to reduce the pH of the corn to about 6.5-7.5.

In the next step, the washed, debranned corn is passed through a stone grinder to mill the corn to a desired particle size and thus complete the flour preparation. The flour may then be appropriately dried for storage, sale and use, or used directly. Masa products are typically prepared by forming a 1:1 (w/w) dough of the masa flour and water, followed by forming the dough through an extruder or other like device, followed with subsequent drying, equilibrating and frying. The final fried masa products are then cooled, salted and packaged.

The conventional masa flour preparation technique presents a number of serious difficulties. First of all, the time required to process the flour is considerable, owing principally to the need for extended steeping. Secondly, the established method has serious ecological consequences, in that the steeping water contains considerable quantities of objectionable dissolved pericarp and soluble starches. Removal of these organic substances from the steeping water is an expensive proposition for masa flour producers, and some flour plants are reported to incur expenses of many thousand dollars per month simply to remove these pollutants from their process streams.

U.S. Pat. No. 5,176,931 represents a new approach to masa flour production. This patent describes a process wherein, after alkali metal hydroxide treatment of grain, the grain is subjected to near infrared radiation and subsequent milling. By this means, process times are significantly reduced as compared with the traditional process. However,

the technique described in the '931 patent can be difficult to control in commercial scale production, particularly during the near IR treatment step.

SUMMARY OF THE INVENTION

The present invention provides an improved, short-time method for masa flour production which eliminates many of the problems encountered in conventional processing. Broadly speaking, the method of the invention involves first contacting whole grain (typically wheat or corn, but virtually any grain could be used) with a heated alkaline solution for a period of time to partially cook the grain and loosen the pericarp or bran fraction thereof. The bran fraction is then essentially completely separated to yield debranned grain. The latter product is flash dehydrated using high velocity, high temperature air currents until the debranned grain has a moisture content of less than about 20% by weight MCWB. This dehydrated and debranned grain is then reduced by milling to a masa flour which may optionally be cooled and packaged.

In more detail, the heated alkaline solution used in the process of the invention should have a temperature of at least about 180° F., and a pH of at least about 9. Generally, the solution is made by dispersing an alkali metal or alkaline earth hydroxide or salt in water, with calcium hydroxide being the most preferred agent. This treating solution is used in excess, and is contacted with the grain for a period of at least about 20 minutes, in order to achieve a partial gelatinization of the grain on the order of at least about 15%.

The partially cooked grain is then passed through a conventional washer/abrader having an elongated, rotatable, perforated reel with internal water jets. The action of the washer/abrader serves to essentially completely remove the bran fraction leaving a cooled, debranned grain product.

The flash dehydration advantageously makes use of incoming hot air currents which are passed through the grain during a hammermill subdivision thereof. Such hot air currents should have a temperature of from about 600°-1000° F. Total residence time of the grain within the flash dehydrator is on the order of 2-15 seconds.

In another aspect of the invention, an improved apparatus for partial cooking of whole grain and loosening the bran fraction thereof is provided. This apparatus includes an elongated, generally horizontally disposed body including inlets for whole grain and treating solution, and a spaced product outlet. An elongated reel assembly is located within the body and includes an outer perforate screen and helical flighting inboard of the outer screen. Means is provided for heating and maintaining the temperature of the treating solution within the body. In use, the reel assembly is rotated in order to assure even heating, partial cooking and moisturization of the incoming grain product, which is then discharged for downstream processing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic flow diagram illustrating the preferred apparatus and process scheme for the production of masa flour in accordance with the invention;

FIG. 2 is an end view partially in phantom and illustrating the construction of the grain cooker used in the preferred process; and

FIG. 3 is an essentially schematic, fragmentary view further illustrating the construction of the continuous grain cooker apparatus used in the process of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning first to the drawings, an overall apparatus 10 is illustrated in FIG. 1 for the continuous production of masa-type flours from grain sources. Broadly speaking, the apparatus 10 includes a feeder assembly 12 operatively coupled with a continuous grain cooker 14. A grain washer 16 is coupled downstream of cooker 14, and a fluidized bed flash dehydrator 18 is connected to the output of washer 16. A conventional two-stage milling, cooling and packaging assembly 20 is located downstream of dehydrator 18.

In more detail, the feeder assembly 12 includes conventional screw-type grain and alkali feeders 22, 24 coupled via conduits 26, 28 to the input of cooker 14. As those skilled in the art will readily understand, the feeders 22, 24 are designed to feed grain and alkali at a controlled rate into the continuous cooker 14.

The cooker 14 (see FIG. 2) includes an upright frame assembly 30 supporting an elongated, horizontally disposed, closed metallic housing 32 having an axially rotatable reel 33 therein. The latter includes an elongated, perforated $\frac{1}{2}$ " outer screen 34 having helical flighting 36 along the inner surface thereof. A secondary, inboard perforated $\frac{1}{4}$ " screen 38 is tack welded to the inner surface of flighting 36 as shown, and is relieved as at 39a, 39b adjacent the inlet and outlet ends of the reel 33. Reel 33 is axially rotated within housing 32 by means of conventional drive assembly 40. At the exit of reel 38, a conventional bucket strainer is provided, serving to deliver concentrated grain to the output of the cooker. A pair of steam heating coils 41 are also situated within housing 32 as shown, in order to heat and maintain the temperature of water within the cooker.

As illustrated in FIG. 2, grain and alkali input conduits 26, 28 feed directly into the interior of reel 33. In a similar fashion, a water line 42 is likewise operatively coupled to the cooker 14 for delivery of water into the interior of housing 32. A water/grain output line 43 is operatively coupled to the end of housing 32 remote from input lines 26, 28 and 42. As will be explained in greater detail hereinafter, during typical operation, the water level within housing 32 is shown at 44, whereas the grain level within screen 34 is shown at 46.

The grain washer and abrader 16 is of conventional design and includes an elongated, rotatable, perforated reel 48 with internal water jets 50. An inlet transition 52 is coupled with line 43 as shown, for delivery of the output from cooker 14 to the interior of reel 48. In the washer device 16, the loosened pericarp of the grain is detached and strained for subsequent processing or disposal. The resultant debranned grain is then ready for flash dehydration and for this purpose passes into output line 54 having a conventional inline filter 42a. Separated water from the device 16 is delivered via line 42 back to cooker 14. Makeup water may be added as needed through input line 55, and the water stream is heated by means of heater 55a before delivery to washer 14.

Flash dehydrator 18 includes an upright housing 56 adapted to receive and flash dehydrate the abraded, moisturized grain from device 16. To this end, the housing 56 includes a high capacity (e.g., 1.8M BTU) gas fired burner 58 which feeds directly into a baffled equilibration tunnel 60. A hammermill 62 is disposed at the end of tunnel 60 remote from burner 58 and is adapted to receive both incoming moisturized grain and the hot dehydration air generated by burner 58. The output of hammermill 62 is connected with an upright drying tower 64 which feeds to a conventional cyclone separator 66. An intermediate recycle conduit 68,

equipped with airlocks 70, 72 may be employed for recycling oversized material from the top of tower 64 back to hammermill 62 for reprocessing. The lower end of separator 66 has an airlock 74, which feeds to output line 76. A negative pressure fan 78 is operatively coupled to the upper end of separator 66 and serves to induce airflow through tunnel 60, hammermill 62 and tower 64. The dehydrator 18 is of the type described in U.S. Pat. No. 4,573,278, incorporated by reference herein.

The milling, cooling and packaging assembly 20 is operatively connected to output line 76 as shown, and serves in the usual fashion to reduce the dehydrated grain to an appropriate particle size with subsequent ambient air cooling and packaging. The milling section would conventionally be a two-stage mill.

In normal operations using apparatus 10, the desired grain to be processed is fed through feeder 22 and line 26 into cooker 14. At the same time, heated water is directed through line 42 into the cooker, along with alkali. The incoming water temperature is at least about 180° F., and more preferably from about 190°-212° F.; this water temperature is maintained by means of the steam coils 41 within housing 32. Generally speaking, an excess of alkaline solution is provided in cooker 14, relative to the amount of grain. Preferably, at least about 200% by weight of alkaline solution is provided, based upon the amount of grain taken as 100% by weight; more preferably, this ratio should be from about 250-280% by weight alkaline solution, as compared with the grain taken at 100% by weight. The alkali employed is typically calcium hydroxide, although other types of alkali metal or alkaline earth metal hydroxides could be used. The pH of the processed water within cooker 14 should be at least about 9, and more preferably from about 10-12. The residence time of the grain within cooker 14 is variable, but generally should be at least about 20 minutes. In actual practice, this residence time usually ranges from about 20-60 minutes, most preferably about 40 minutes. The purpose of treatment within cooker 14 is to loosen the pericarp of the grain and to partially hydrate and cook or gelatinize the grain. In preferred practice, processing within cooker 14 should be sufficient to achieve at least about 15% gelatinization of the grain, and more preferably from about 20-45% gelatinization. The moisture content of the grain exiting cooker 14 should be from about 15-50% by weight MCWB (moisture content wet basis), and more preferably from about 35-50% by weight MCWB. The temperature of the grain leaving cooker 14 is generally from about 160°-210° F.

The output from cooker 14 passes via conduit 43 into washing device 16. In this device, the loosened pericarp is removed from the grain and separated. For this purpose, low pressure ambient temperature water is directed through the jets 50 onto the rotating grain within reel 48. The pericarp is then strained and the resulting processed grain is passed through output line 54 into dehydrator 18. At the same time, the separated alkaline solution is passed through line 42 for filtration, addition of makeup water as needed, preliminary heating, and passage back into cooker 14. The moisture content of the grain leaving washer 16 is generally slightly lower than that of the grain from cooker 14. Usually, this reduction is from about 2-8%. The temperature of the grain leaving washer 16 is less than 80° F.

The moisturized and debranned grain is delivered through line 54 directly into hammermill 62. At the same time, high temperature induced air currents are directed into the hammermill via fan 78 and burner 58. The temperature of the incoming air stream is from about 600°-1000° F., and more

preferably from about 700°-900° F. This air is directed into the hammermill at a relatively high velocity on the order of from about 1,000-15,000 cfm, and more preferably from about 2,000-12,000 cfm. In preferred practice, the amount of heated air employed should be from about 0.5-7.5 cf/lb. of incoming wet grain, and more preferably from about 1.0-6.0 cf/lb of incoming wet grain. The hammermill 62 serves to reduce the incoming grain to a maximum particle size of less than about 3 mm, and preferably smaller. In this fashion, the total surface area of the grain is very substantially increased. At the same time, the grain is subjected to significant flash dehydration within the hammermill. The output from hammermill 62 passes upwardly through tower 64, being conveyed by the induced air currents within the dehydrator 18. As necessary, the airlocks 70, 72 may be operated for recycling purposes. Finished product is delivered to separator 66. The incoming air temperature to the separator 66, referred to as the process temperature, is from about 160°-320° F., and more preferably from about 180°-300° F. The output, from separator 66 is in the form of subdivided, substantially dried grain, typically having a moisture content of from about 8-15% by weight MCWB, and more preferably from about 10-12% by weight MCWB. The temperature of this output material is normally from about 100°-150° F., and more preferably from about 110°-140° F. The total residence time of the debranned grain within dehydrator 18 is from about 2-15 seconds, more preferably from about 5-12 seconds.

In the final assembly 20, the grain is further processed by a two-stage milling to achieve a standard flour particle size. It is then cooled and is ready for packaging.

nothing therein should be taken as a limitation upon the overall scope of the invention.

A total of four processing runs were carried out, three using yellow dent corn, and one using hard red winter wheat. The three corn runs were carried out under identical processing conditions, except that retention times in the cooker 14 were varied. In particular, in all four runs, water, lime and grain were delivered to the cooker 14, and the grain was retained in the cooker for measured amounts of time. The water temperature within the cooker 14 was maintained at 212° F., and lime addition was at 3-3.5% by weight. After the product exited the cooker 14, it was immediately washed with 30 psi, ambient temperature tap water. The washed product was cooled to a temperature below 80° F. and then collected in drums. The collected products were then processed through the flash dehydrator, with subsequent milling and cooling.

In particular, the measured conditions within the flash dehydrator for these four samples were as follows. Temperature of incoming hot air currents, 716° F.; process temperature, 290° F.; agitator load, 30%; fan damper position, 25% open; burner position, 15% open; estimated residence or dwell time in flash dehydrator, 6 seconds.

The corn samples after flash dehydration were milled to two particle sizes, namely: a coarse milling with 50% through a 40-mesh screen, and 50% through a 60-mesh screen; and a fine milling with 100% through 60-mesh. The wheat sample was fine ground only. This gave a total of eight samples of flour for evaluation, a coarse and fine milling of the three corn runs, the fine grind wheat run, and a control corn masa flour from a commercial source.

The following table sets forth other processing conditions and product parameters for these tests.

	Corn	Corn	Corn	Wheat
Cooker Residence Time (Min.)	18.6	27.0	40.0	18.6
Moisture Content From Cooker (% by weight MCWB)	39.5	43.1	46.4	38.7
Temperature of Product From Cooker (°F.)	202	207	207	205
Moisture Content From Washer (% by weight MCWB)	33.7	38.0	39.7	—
Moisture Content from Dehydrator (% by weight MCWB)	10.8	12.6	13.0	11.6
Final Flour Water Absorption Index ¹	3.23	3.72	3.61	3.53
Final Flour Water Solubility Index ² (%)	5.01	4.97	5.06	5.97
Final Flour Reducing Sugar Content (Mg Maltose/10 g Product) ³	114.5	93.0	103.5	90.0
Final Flour pH ⁴	6.63	6.62	6.60	7.75
Final Flour Moisture Content (% by weight MCWB) ⁵	9.92%	7.18%	7.96%	7.97%

¹WAI values obtained by grinding the product through a 60-mesh screen, adding 2.5 g of the ground product (dry basis) to 30 ml water and allowing the mixture to stand at room temperature for 1-1/2 hours with stirring or agitation every 30 minutes; sample is then centrifuged for 20 minutes, the supernate is decanted and the wet gel is weighed; the weight of this gel in grams is divided by 2.5 g to give the WAI. The dry corn masa flour control had a WAI of 3.52.

²WSI values obtained by oven drying the supernate described in footnote 1 at 110° C. The dried solids are then weighed and the weight in grams is divided by 2.5 g and the result is multiplied by 100 to give the WSI. The dry corn masa flour control had a WSI of 6.55%.

³Reducing sugar content values obtained using A.A.C.C. (American Association of Cereal Chemists) Method 80-60; the dry corn masa flour control had a value of 95 mg.

⁴pH values obtained using A.A.C.C. Method 02-51; the dry corn masa flour control had a pH of 6.75.

⁵Moisture content values obtained using A.A.C.C. Method 44-15; the dry corn masa flour control had a 9.62% by weight MCWB.

EXAMPLES

The following examples illustrate preferred aspects of the present invention. It is to be understood, however, that these examples are presented by way of illustration only, and

The eight flours were evaluated by rehydration, conventional sheeting, preliminary toasting and final frying. The flours produced by the method of the invention gave acceptable aroma and flavor characteristics, and the fine flours rehydrated and sheeted easily. The coarse flour made chips

having an unacceptable rough texture, as compared with conventional masa chips. The fine flours gave fully acceptable flour-type soft tortillas. However, when fried these products absorbed too much oil and did not have completely acceptable texture and color. It was concluded that these frying and color problems derived from use of too much lime in the initial processing; this is believed to deleteriously affect both color and frying quality.

I claim:

1. A method of producing masa flour, comprising the steps of:
 - providing a quantity of whole grain;
 - contacting said whole grain with a heated alkaline solution for a period of time to partially cook the grain and loosen the bran fraction thereof;
 - separating said bran fraction from said grain to yield debranned grain;
 - flash dehydrating said debranned grain by passing hot air currents therethrough until the debranned grain has a moisture content of up to about 20% by weight; and
 - reducing the flash dehydrated and debranned grain to a masa flour.
2. The method of claim 1, including the step of contacting said whole grain with said heated alkaline solution for a period of at least about 20 minutes.
3. The method of claim 2, said period being from about 20-60 minutes.
4. The method of claim 1, said heated alkaline solution having temperature of at least about 180° F.
5. The method of claim 4, said temperature being from about 190°-212° F.
6. The method of claim 1, said heated alkaline solution having a pH of at least about 9.
7. The method of claim 6, said pH being from about 10-12.
8. The method of claim 1, including the step of contacting said grain with at least about 200% by weight of said heated alkaline solution, based upon the amount of whole grain taken as 100% by weight.
9. The method of claim 8, wherein said whole grain is contacted with about 250-280% by weight of said heated alkaline solution, based upon the amount of whole grain taken as 100% by weight.

10. The method of claim 1, said heated alkaline solution comprising an alkali metal or alkaline earth metal hydroxide dispersed in water.

11. The method of claim 10, said heated alkaline solution comprising calcium hydroxide dispersed in water.

12. The method of claim 1, said contacting step being carried out until said grain is at least about 15% gelatinized.

13. The method of claim 12, said contacting step being carried out until said grain is from about 20-45% gelatinized.

14. The method of claim 1, the moisture content of said grain after said contacting step being from about 15-50% by weight.

15. The method of claim 14, said moisture content being from about 35-50% by weight.

16. The method of claim 1, the temperature of said grain after said contacting step being from about 160°-210° F.

17. The method of claim 16, wherein said temperature is from about 700°-900° F.

18. The method of claim 1, said hot air currents having a velocity of from about 1,000-15,000 cfm.

19. The method of claim 18, said velocity being from about 2,000-12,000 cfm.

20. The method of claim 1 said flash dehydration step being carried out until the moisture content of the debranned grain is from about 8-15% by weight.

21. The method of claim 20, said moisture content being from about 10-12% by weight.

22. The method of claim 1, the temperature of said grain after said flash dehydration step being from about 100°-150° F.

23. The method of claim 1, including the step of subdividing said debranned grain during at least a portion of the time that said hot air currents are contacting the debranned grain.

24. The method of claim 1, wherein said hot air currents have a temperature of from about 600°-1000° F.

25. The method of claim 1, including the step of flash dehydrating said debranned grain for a period of from about 2-15 seconds.

26. The method of claim 22, said period being from about 5-12 seconds.

27. The method of claim 1, said residence time being from about 5-12 seconds.

* * * * *



US005176931A

United States Patent [19]
Herbster

[11] **Patent Number:** **5,176,931**
[45] **Date of Patent:** **Jan. 5, 1993**

- [54] **PREPARATION OF MASA FLOUR**
[75] **Inventor:** Jeffrey C. Herbster, Morrill, Kans.
[73] **Assignee:** Wenger Manufacturing, Inc.,
Sabetha, Kans.
[21] **Appl. No.:** 851,215
[22] **Filed:** Mar. 13, 1992
[51] **Int. Cl.:** A23L 1/00
[52] **U.S. Cl.:** 426/242; 426/462;
426/464; 426/626
[58] **Field of Search:** 426/242, 462, 464, 483,
426/626

- [56] **References Cited**
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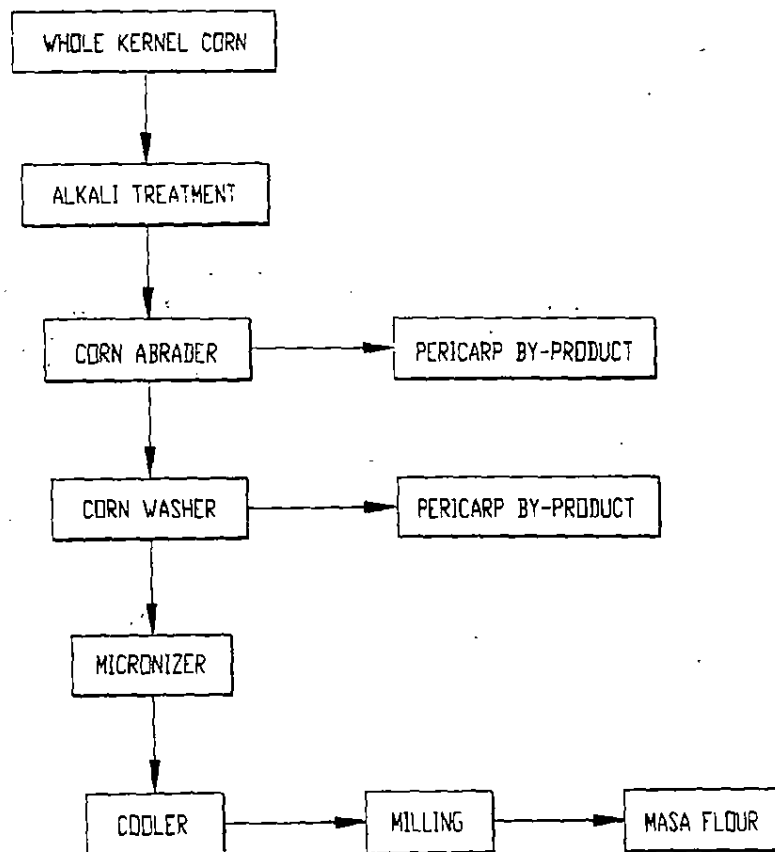
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Spring, 1989: The Proctor Department of Food Sci-
ence: The University of Leeds.

Primary Examiner—George Yeung
Attorney, Agent, or Firm—Hovey, Williams, Timmons &
Collins

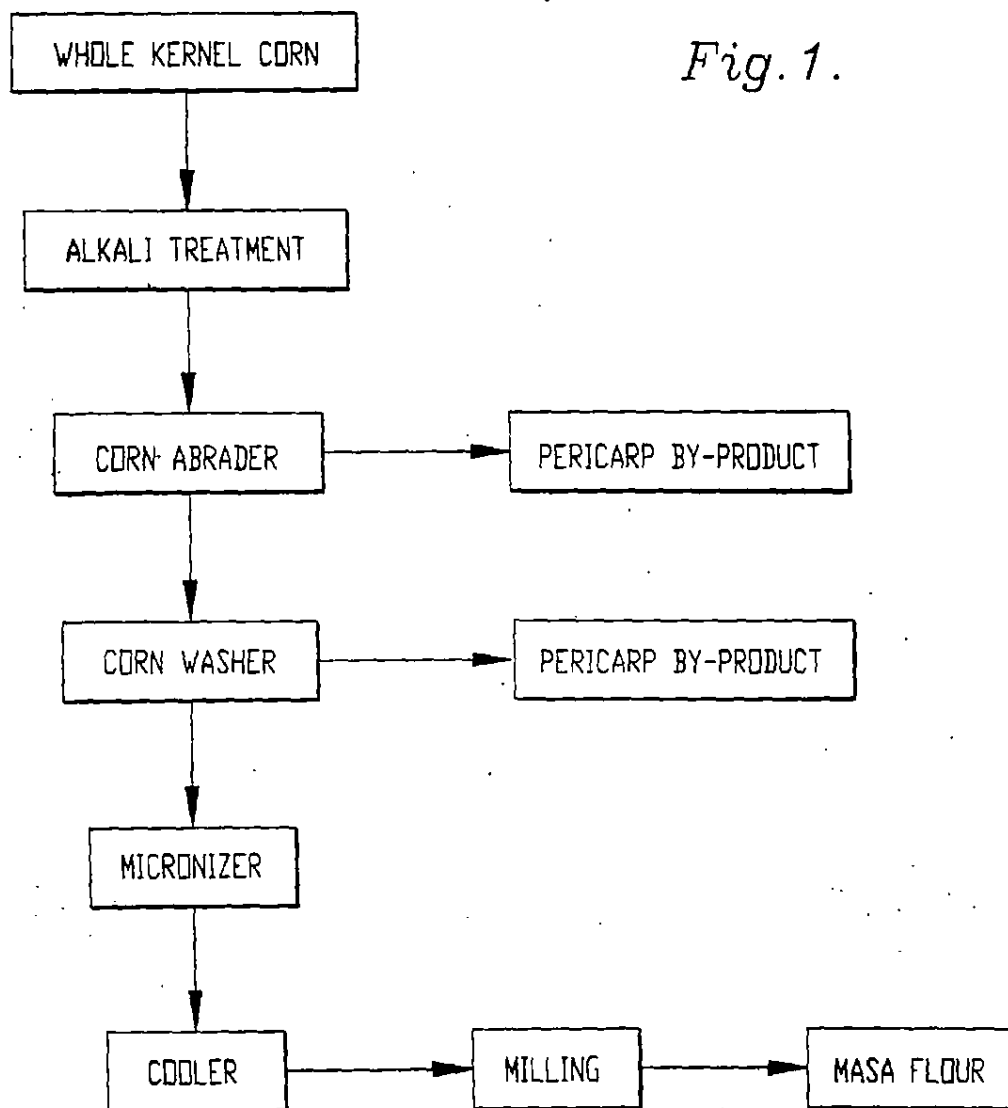
[57] **ABSTRACT**
A short-time, low-pollution method of preparing masa
flour is provided which yields flour equivalent to con-
ventionally fabricated masas with a total processing
time significantly less than prior techniques. The proce-
dure preferably comprises subjecting alkali-treated,
debranned and moisturized grain (e.g., corn) to near
infrared radiation in order to partially cook the grain.
The grain can then be milled to desired particle size
specifications. Masa prepared in accordance with the
invention may be produced in as little as one-half hour,
as compared with prior methods involving many hours
of preparation time. The preferred alkali treatment of
the grain prior to infrared processing substantially re-
duces pollution inherent in prior art methods.

14 Claims, 3 Drawing Sheets



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Fig. 1.



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U.S. Patent

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Sheet 2 of 3

5,176,931

Fig. 2.

(Prior Art)

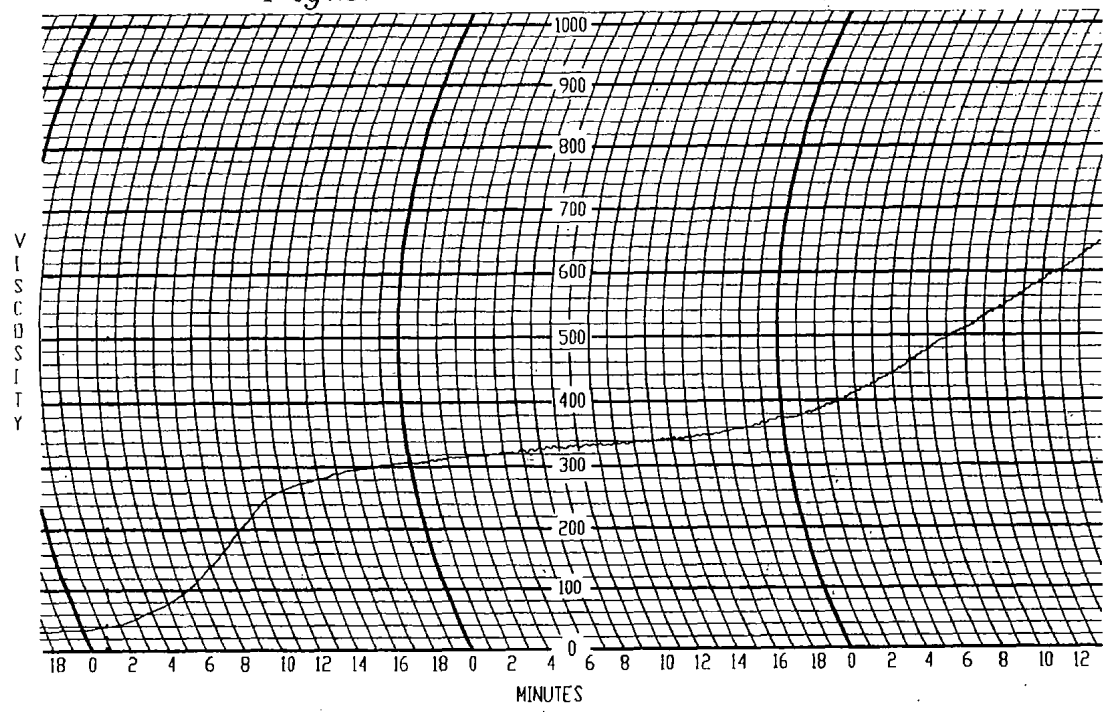
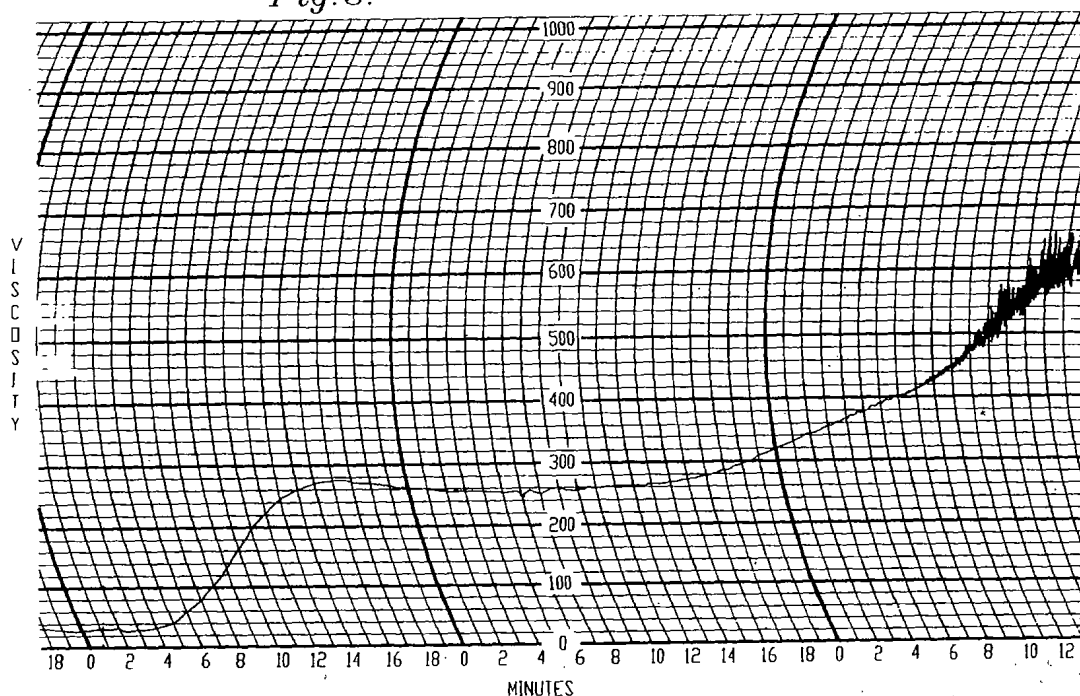


Fig. 3.



PREPARATION OF MASA FLOUR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is broadly concerned with a method for the preparation of masa flour which eliminates many of the costly, time-consuming, pollution causing steps conventionally carried out in the preparation of such flours. More particularly, it is concerned with a masa preparation method wherein debranned, moisturized grain (e.g., corn or wheat) is subjected to near infrared radiation for partial cooking thereof, followed by reduction of the cooked, debranned grain to masa flour. The method of the invention may be carried out in as little as one-half hour of processing time, as compared with conventional techniques requiring many hours of preparation time. The resultant flours in accordance with the invention are essentially equivalent to conventional flours in terms of cook, water absorption and handling characteristics.

2. Description of the Prior Art

Masa flour, typically made using food grade corn or wheat, is produced in tremendous quantities in the United States and around the world. Such flour is used to fabricate such familiar products as tortilla chips and taco shells.

Despite the demand for masa flour, for the most part it is prepared using very old and time honored techniques. In the first step, whole kernel corn is cooked in a mixture of water and 1% lime up to a temperature of 175°-205° F., depending upon the hardness of the starting corn and other factors. The corn is then allowed to steep in the lime water for a period of 8-12 hours, in order to allow the lime to penetrate, loosen and partially dissolve the pericarp or bran fraction of the corn.

The steeped corn is then passed through a corn washer, comprising a perforated, rotatable cylinder equipped with internal water jets, in order to complete the removal of bran and to reduce the pH of the corn to about 6.5-7.5.

In the next step, the washed, debranned corn is passed through a stone grinder to mill the corn to a desired particle size and thus complete the flour preparation. The flour may then be appropriately dried for storage, sale and use, or used directly. Masa products are typically prepared by forming a 1:1 (w/w) dough of the masa flour and water, followed by forming the dough through an extruder or other like device, followed with subsequent drying, equilibrating and frying. The final fried masa products are then cooled, salted and packaged.

The conventional masa flour preparation technique presents a number of serious difficulties. First of all, the time required to process the flour is considerable, owing principally to the need for extended steeping. Secondly, the established method has serious ecological consequences, in that the steeping water contains considerable quantities of objectionable dissolved pericarp and soluble starches. Removal of these organic substances from the steeping water is an expensive proposition for masa flour producers, and some flour plants are reported to incur expenses of many thousand dollars per month simply to remove these pollutants from their process streams.

There is accordingly a real and unsatisfied need in the art for an improved masa production method which

avoids the long processing times typical of prior methods while reducing concomitant pollution problems.

SUMMARY OF THE INVENTION

The present invention overcomes the problems outlined above and provides a significantly improved method for the production of masa flour from grains such as wheat and corn. Broadly speaking, the method involves first providing a quantity of debranned grain having a moisture content of from about 15-35% by weight, followed by subjecting the debranned, moisturized grain to near infrared radiation to effect partial cooking thereof. The partially cooked grain can then be reduced by conventional milling techniques to masa flour having desired particle sizes.

In preferred forms, the process includes an alkali treatment of starting whole grain followed by abrasion of the alkali-treated grain in order to remove a substantial proportion of the pericarp fraction, without the need for lime water cooking and extended steeping times. The alkali treatment advantageously comprises the steps of forming an aqueous solution of alkali metal hydroxide (e.g., from about 2-20% alkali metal hydroxide), heating the solution to a temperature of from about 100°-160° F., and contacting the whole grain with the heated alkali solution for a period sufficient to loosen the pericarp fraction. Thereafter, the grain may be abraded and washed to substantially remove all pericarp.

The preferred near infrared treatment of the debranned grain comprises subjecting the grain to near infrared radiation having a wavelength of from about 1.8-3.4 microns for a period of from about 10-270 seconds, until the grain has a temperature from about 140°-260° F. and a moisture content of from about 7-20% by weight.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic process flow diagram setting forth the preferred masa preparation method of the present invention;

FIG. 2 is a portion of an amylograph obtained using conventional, commercially obtained masa flour; and

FIG. 3 is a portion of an amylograph obtained using masa flour prepared in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning first to FIG. 1, a process flow diagram setting forth the preferred steps in the production of corn masa flour is provided. The method involves first providing an appropriate quantity of whole food grade yellow or white corn which typically has a moisture content of from about 9-15% by weight. This corn is then subjected to an alkali treatment process of the type described by Mistry, et al. in a paper entitled "Dry Milling and Physical Characteristics of Alkali-Debranned Yellow Dent Corn", appearing in *Cereal Chemistry*, 69 (1):82-84 (1992). This paper is incorporated by reference herein. Similar alkali treatments are disclosed in U.S. Pat. Nos. 3,264,113, 3,031,305 and 2,472,971.

In more detail, the preferred alkali treatment comprises first preparing an alkali metal hydroxide solution, such as a 6% NaOH solution. This solution is then heated to a temperature of from about 100°-160° F., more preferably from about 120°-150° F., and most

preferably about 135° F. At this point, the corn is added to the heated solution at a level of from about 1:1-4:1 solution:corn on a weight/weight basis. Most preferably, the corn is added at a level of about 2:1 solution:corn. The corn is allowed to remain in the alkali solution for a period of from about 2-12 minutes, more preferably of from about 5-10 minutes, and most preferably about 7 minutes. The corn is then removed from the alkali solution.

The corn may be allowed to set and equilibrate for any convenient time (e.g., 24-72 hours), if desired. However, for the most efficient production, little or no equilibration time is required, and the alkali-treated corn may be directly passed into a rotary grain abrasion device. Such a device is conventional in the milling industry, and serves to mechanically remove pericarp from the whole kernel corn. One useful abrading unit consists of a plastic bristle brush rotating at 160 rpm over a 12-mesh, 150 mm (in diameter) circular screen with a continuous water spray. The peeled pericarp is washed through the 12-mesh screen and collected over a 100-mesh screen below. The process water is recirculated until all of the corn is largely free of pericarp. In practice, the corn should be processed in the abrading device from a period of about 2-10 minutes, typically about 5 minutes.

After abrading, the corn is placed in a continuous corn washer that removes the remainder of any pericarp. The washer includes a rotatable, perforated reel with internal water jets, and has a strainer for catching the removed pericarp.

The debranned corn resulting from this process has a moisture content of from about 15-35% by weight, more preferably from about 20-30% by weight, and most preferably about 25% by weight. The pH of 1:1 (w/w) mixture of water and this debranned corn ranges from about 6.5-7.5.

In the next step as set forth in FIG. 1, the debranned, moisturized corn is subjected to infrared radiation in a micronizer or similar device. The purpose of micronizing is to cause rapid heating of at least the outer portion of the corn while effecting cooking of a fraction of the starch granules therein. In the micronizing process, near infrared or micron sized wavelength radiation is employed, basically in the range of from about 1.8-3.4 microns. This near infrared radiation penetrates the grain, causing constituent molecules to vibrate at a frequency on the order of 8.8×10^8 MHz, up to 1.7×10^9 MHz. The resultant inter-molecular friction causes rapid internal heating and a rise in water vapor pressure.

Micronizing is a relatively simple process, wherein the corn is conveyed along a moving belt or vibrating pan over which a near infrared manifold is suspended. The belt is normally vibrated to insure that the corn is constantly turned over, thus exposing all surfaces to the radiation. The rate of flow, and therefore the residence time in the micronizer, is controlled by adjusting the angle of the conveyor. Micronizing is described in U.S. Pat. No. 3,694,220 as well as in a 1989 thesis by Kay Timmins entitled "The Microscopic Examination of Micronized and Extruded Cereals and Cereal Products", both of the latter being incorporated by reference herein.

In the context of the present invention, the near infrared processing should be carried out for a period of from about 10-270 seconds, more preferably from about 50-150 seconds, and most preferably about 90 seconds. The near infrared radiation should have a wavelength

of from about 1.8-3.5 microns, and most preferably is in the range from about 2.5 to 3.4 microns. The temperature of the corn exiting the near infrared processor should be from about 140°-260° F., more preferably from about 150°-225° F., and most preferably about 185° F. The moisture of this exiting corn should be from about 7-20% by weight MCWB, more preferably from about 10-15% by weight MCWB, and most preferably about 14% by weight MCWB.

As further illustrated in FIG. 1, following near infrared treatment, the corn should be cooled to ambient using any conventional and expedient technique such as an ambient air cooler. Alternately, the micronized corn may be directed to a holding tank wherein additional cooking will occur by virtue of the elevated temperature of the corn. Such a set period could range up to about 60 minutes, and provide whatever additional cooking may be desired by the processor. After such set time, the corn would then be directed to a cooler as described. At this point, the corn is cooked to the desired extent and fully debranned. The final step involves simply milling the corn to a desired particle size specification, the latter being dictated by the desired end use. Such specifications are well known in the art and vary from customer to customer.

The final corn masa flour is normally used by rehydrating the flour with water, and commonly a 1:1 (w/w) flour:water ratio is used. After such rehydration, the masa flour of the invention will exhibit a moisture level of from about 45-55%, and more preferably from about 48-52%. Microscopic examination of the masa flours produced in accordance with the invention show that they are very similar to conventional flours of this character. Specifically, such examinations demonstrate that the masa flours hereof exhibit substantially intact starch granules with the greatest proportion of these granules non-gelatinized, and respective smaller proportions thereof partially and fully gelatinized. Typical conventional masa flour will have 55% of the starch granules non-gelatinized, 25% partially gelatinized, and 20% fully gelatinized, and the processing steps of the present invention can be selected to essentially duplicate these percentages.

Similar techniques can be employed in the production of masa-type flours from other grains, most notably wheat.

The following examples describe the preferred techniques for producing masa flour in accordance with the invention. It is to be understood, however, that the examples are presented by way of illustration only, and nothing therein should be taken as a limitation upon the overall scope of the invention.

EXAMPLE 1

In this example, cleaned, whole kernel food grade corn (yellow or white) is treated to produce precooked masa flour.

In the first step, fifty pounds of a 6% sodium hydroxide solution is made and heated to a temperature of 135° F. Twenty-five pounds of the food grade corn is next added to the heated solution, and allowed to stand for about 7 minutes in order to break the chemical bonds between the pericarp and endosperm fractions of the corn, thus loosening the pericarp without substantial dissolution thereof.

After this alkali treatment is completed, the corn is removed from the hydroxide solution and placed in a conventional rotary grain abrasion unit of the type de-

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scribed previously. This device serves to further mechanically loosen the pericarp from the whole kernel corn. In practice, the corn is processed in the abrasion unit for about 5 minutes.

The debranned corn is then placed in a continuous grain washer having a perforated, rotatable reel with water jets. The washer serves to detach the loosened pericarp from the kernel corn. The detached pericarp is caught in the strainer of the washing device for subsequent processing or disposal (e.g., neutralize with acid to yield an approximately 92% dietary fiber), and the resultant debranned corn is ready for near infrared treatment. As it emerges from the washer, the debranned corn has a moisture content of approximately 25% by weight MCWB and a pH of from about 6.5-7.5 in a 1:1 (w/w) corn/water mixture. In this example, the debranned corn is allowed to set undisturbed for over 24 hours, inasmuch as the micronizing equipment was physically separated from the alkali treatment and washing apparatus. It is believed, however, that such set time is not required to obtain the desirable results of the invention.

The debranned and moisturized kernel corn is next directed to a micronizer apparatus for near infrared treatment. The micronizer is operated to give a retention time of approximately 90 seconds, resulting in a grain temperature at the exit of the micronizer of 185° F. and a moisture content of 14% by weight MCWB. The wavelength of the near infrared radiation used is in the range of 2.5-3.4 microns. The pan transporting the debranned corn under the infrared burners is vibrated at 60 Hz, and the inclined setting of the main vibrator was 1", in decline.

The effect of micronizing is to gelatinize (i.e., cook) a minor fraction of the starch granules in the corn, to partially gelatinize a greater percentage thereof, and to leave at least about 50% of the granules not gelatinized. The starch granules also retain their identity by virtue of the near infrared treatment. This substantially duplicates the cooked condition of traditional masa flour.

In the next step, the micronized corn is directed to a conventional ambient air cooler where the corn kernels are cooled to ambient. At this point, the corn is milled to desired specifications for a particular masa flour. In this case, the corn was ground to the following sieve profile, typical for use in making tortilla chips:

U.S. Mesh	% By Weight
-20	7.04
-30	8.46
-40	18.78
-60	26.00
-80	38.00
-100	1.67
<100	.05

EXAMPLE 2

In the following example, white and yellow corn samples were treated as set forth in Example 1. The alkali treatment, abrading and washing steps were carried out as in Example 1, followed by micronizer treatment and subsequent cooling. The following table summarizes the micronizer conditions.

TABLE

	RUN #		
	1	2	3
Grain	Debranned Yellow Corn	Debranned Yellow Corn	Debranned Yellow Corn
Near IR Wave-length μ	2.5-3.4	3.0-3.4	3.0-3.4
Temperature, C.			
Vibration Frequency of Main Pan	60 Hz	60 Hz	60 Hz
Incline of Main Pan	1" Decline	1" Decline	1" Decline
Retention Time	85 sec.	85 sec.	85 sec.
Main Gas Air	2.5	2.75	2.75
Butterfly Setting			
Rate Entering	16.2 lb/min	16.2 lb/min	16.2 lb/min
Micronizer			
Grain Moisture	18.33%	18.33%	17.01%
Entering Micronizer	by weight	by weight	by weight
Grain Moisture	12.36%	14.02%	15.78%
Exiting Micronizer	by weight	by weight	by weight
Grain Temperature	—	185° F.	193° F.
Exiting Micronizer			

These three grain products were then milled to an appropriate size for masa flour. They were each tested qualitatively by mixing flour and water 1:1 (w/w), and it was found that the flour products of the invention "balled up" in the same fashion as traditional masa flour. Moreover, the moisturized flours of the invention did not stick to the hands when manipulated, which is an important equivalent characteristic of masa flour.

The Run #1 masa flour was also tested using an amylograph, and compared to conventional, commercially available masa flour. Specifically, 45 g of the Run #1 flour was ground through a UDY mill and mixed with 375 ml of water. The mixture was heated for 45 minutes, held for 10 minutes, and cooled for 45 minutes in the amylograph. An identical quantity of commercial flour sold under the name "Masa Mixta" was UDY mill ground, mixed with 375 ml of water and run through the amylograph under the identical conditions set forth above.

The relevant portion of the amylograph obtained using the Masa Mixta flour is shown in FIG. 2, where the hold time is from 16-6 minutes. FIG. 3 illustrates the same portion of the amylograph obtained using the Run #1 flour, where again the hold time is from 16-6 minutes. It will be observed that these amylographs are very similar to each other, further confirming the fact that the masa flour of the present invention is very similar, if not functionally identical, with conventional masa flour.

The Run #3 flour was also tested for water absorption. The standard for commercial masa flour is that a 1:1 H₂O:flour mixture gives 52±2% water moisture. The Run #3 flour gave a water moisture of 52.5%, well within the commercial standard.

A microscopic examination of the flours produced in these three runs demonstrates that they are similar to conventional masa flour, by having intact starch granule structure and a substantial proportion of non-gelatinized starch granules. In order to more closely simulate the conventional flour, the near infrared treatment conditions should be altered to increase the proportion of fully and partially gelatinized starch granules. Such would involve increasing the micronizer residence time and/or increasing the process temperature.

I claim:

1. A method of producing masa flour, comprising the steps of:

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providing a quantity of whole grain;
 contacting said whole grain with an aqueous alkali metal hydroxide solution for a relatively short period of time sufficient to loosen the bran, removing the bran fraction of said grain, and adjusting the moisture content of the debranned grain as necessary until the debranned grain has a moisture content of from about 15-35% by weight;
 subjecting said debranned grain to near infrared radiation, for partial cooking thereof; and
 reducing the partially cooked, debranned grain to masa flour.
 2. The method of claim 1, said grain being selected from the group consisting of wheat and corn.
 3. The method of claim 2, said grain being corn.
 4. The method of claim 1, said partial cooking step comprising subjecting said grain to near infrared radiation for a period of from about 10-270 seconds.
 5. The method of claim 1, said partial cooking step being carried out until the grain has a temperature of from about 140°-260° F. and a moisture content of from about 7-20% by weight.
 6. The method of claim 1, wherein said bran removal step comprises abrasion of the alkali metal hydroxide-

treated grain in order to remove a substantial proportion of the bran from the grain.
 7. The method of claim 6, said alkali metal hydroxide contacting comprising the steps of forming an aqueous solution of sodium hydroxide and heating the solution to a temperature of from about 100°-160° F., contacting said whole grain with said heated solution for a period sufficient to loosen said bran.
 8. The method of claim 1, a 1:1 (w/w) dispersion of said debranned grain in water having a pH from about 6.5-7.5.
 9. The method of claim 1, including the step of cooling said cooked grain prior to said reduction step.
 10. The method of claim 1, said contacting step being carried out for a period of from about 2-12 minutes.
 11. The method of claim 10, said period being from about 5-10 minutes.
 12. The method of claim 9, including the step of directing said grain to a holding tank for additional cooking thereof prior to said cooling step.
 13. The method of claim 9, wherein said cooling is carried out until the grain is cooled to about ambient temperature.
 14. The method of claim 1, said aqueous alkali metal solution being heated.

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Corrected Version / Version Corrigée

From the INTERNATIONAL BUREAU

PCTNOTICE 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 South 23rd Street
Second Floor
Arlington, Virginia 22202
ETATS-UNIS D'AMERIQUE

Date of mailing(day/month/year)

07 August 2003 (07.08.03)

Applicant's or agent's file reference

9002-1001-1

IMPORTANT NOTICE

International application No.

PCT/US03/02756

International filing date(day/month/year)

31 January 2003 (31.01.03)

Priority date(day/month/year)

31 January 2002 (31.01.02)

Applicant

GONZALEZ BARRERA, Roberto

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, CO, DE, DZ, GH, HU, 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, BR, BZ, CA, CN, CR, CU, CZ, DK, DM, EA, EC, EE, EP, ES, FI, GB, GD, GE, GM, HR, ID, IL, IN, IS, JP, KE, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MG, MN, MW, MX, 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 07 August 2003 (07.08.03) under No. 03/063594.

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 applicant is hereby notified that, at the time of establishment of this Notice, the time limit under Rule 46.1 for making amendments under Article 19 has not yet expired and the International Bureau had received neither such amendments nor a declaration that the applicant does not wish to make amendments.

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

Authorized officer

Judith Zahra

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REQUISITOS NECESARIOS PARA PRESENTACION Y AGILIZACION DEL TRAMITE

	USUARIO	RADICADOR
PATENTE DE INVENCION	()	()
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.	()	()
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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:

SUPERINDUSTRIA Y COMERCIO
Radicacion : 04039348 00000000 Folios: 77
Fecha (AHD): 2004-04-30 16:49:39
Tramite : 011 PCT-PATENT 379 FASE NACI 411 PRESENTAR
Dependencia: 2020 DIVISION DE NUEVAS CREACIONES



2020
Bogotá, D.C.,

05215

Doctor:
RAMIRO CASTRO DUQUE
Apoderado

Oficio N°

ASUNTO:	Radicación N°	04-39948
	Solicitud internacional	PCT/US03/2756
	Fecha inicio fase nacional	31/08/2004
	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).
- ☐ La solicitud no contiene el poder debidamente otorgado, con el lleno de los requisitos exigidos por los artículos 63 y subsiguientes del Código de Procedimiento Civil. Adicionalmente, deberá presentar el documento que acredita la existencia y representación legal de la sociedad solicitante, cuando ésta fuere persona jurídica.
- ☐

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.

21 MAYO 2004

El anterior requerimiento fue notificado por fijación en lista de fecha, _____.