



INVENTARIO

DVN
NOV

DELEGATURA PROPIEDAD INDUSTRIAL

División de Nuevas Creaciones

PCT

SOLICITUD

PATENTE DE INVENCION

ENTRADA EN FASE NACIONAL

21. EXPEDIENTE No.

07-116567

54. TITULO

PRODUCCION CONTINUA DE HARINAS DE MAIZ PRE-GELATINIZADO PARA
ALIMENTOS A BASE DE LÁCTEOS Y A BASE DE CEREALES.

51. CLASIFICACION INTERNACIONAL

71. SOLICITANTE

INVESTIGACION DE TECNOLOGIA AVANZADA, S.A. DE CV.

DOMICILIO

GUADALUPE, N.L., MÉXICO.

74. APODERADO

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22. SANTAFE DE BOGOTA, D.C.

PETITORIO

AS: 105.619



SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO



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Tra. 11 PATENTEIYII

Eve: 379 FASENACIONALII

Act. 411 PRESENTACION

Folios: 116

FORMULARIO ÚNICO DE SOLICITUD DE PATENTE
PCT
ENTRADA EN FASE NACIONAL

OT Dic 2007

1

SOLICITUD DE:



Patente de Invención.



Patente de Modelo de Utilidad.



Capítulo I.



Capítulo II.

2

SOLICITANTE
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Carretera Migual Alemán, Guadalupe, N.L., 67110,
México.

Nacionalidad o Domicilio: México.

Lugar de Constitución: México.

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IDENTIFICACIÓN

C.C.



NIT



C.E.



Otro



Cual

Número

3

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Otro



Cual

Número 80.410.337 TP 57492

4

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33139, US; 501 W. Chapin, Edinburg, TX 78539, US; 1159 Cottonwood Lane, Irving, TX
75038, US; R. Cortines 2002 Ote, Guadalupe, N.L., 67110, MX; R. Cortines 2002 Ote,
Guadalupe, N.L., 67110, MX; R. Cortines 2002 Ote, Guadalupe, N.L., 67110, MX
(Respectivamente).

Nacionalidad o Domicilio: Estados Unidos de América y México (Respectivamente).

5 PCT (86)

Solicitud Internacional No. PCT/US2006/014335

Fecha 17-04-2006

Publicación Internacional No. WO 2006/118778 A3

Fecha 09-11-2006

6 Título (54): PRODUCCIÓN CONTINUA DE HARINAS DE MAÍZ PRE-GELATINIZADO PARA
ALIMENTOS A BASE DE LÁCTEOS Y A BASE DE CEREALES

7 Clasificación Internacional (51):

8 Prioridad

SI ☒NO ☐

(33) País de Origen

US

(32) Fecha

05-05-2005

(31) Número de Solicitud

11/122,106

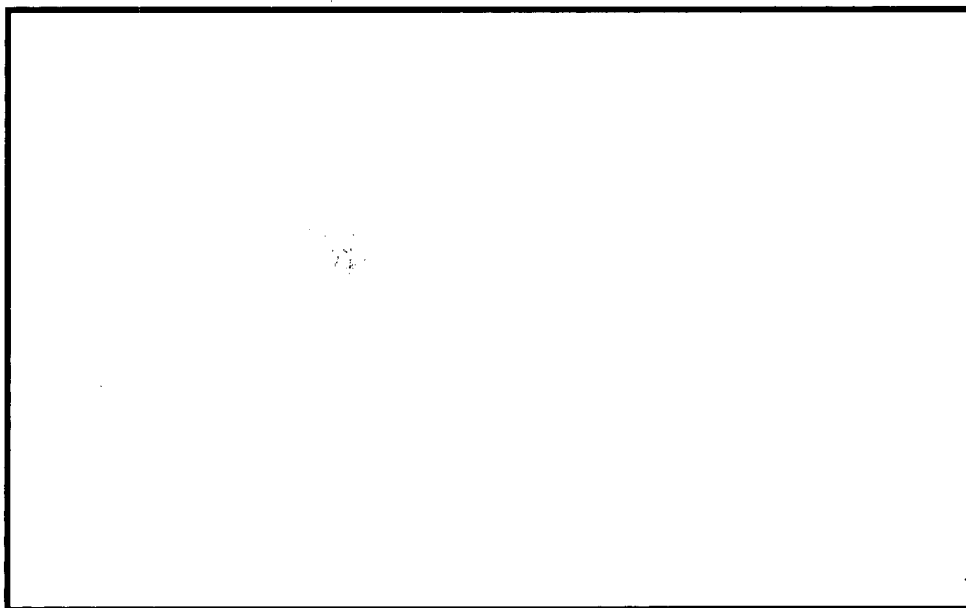
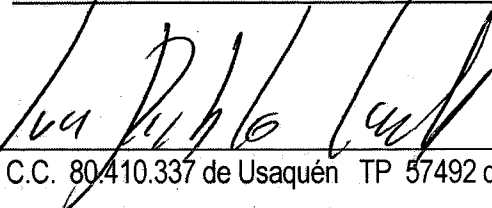
9 Comprobante de pago No. 07- 79,191

Fecha 02-11-2007

Instrucciones para el diligenciamiento del presente formulario, ver reverso de esta página.

2020-F06 (01-11-15)

- ☒ Comprobante de pago de la tasa de presentación de la solicitud. \$482.000
- ☐ Documento que acredite la existencia y representación legal cuando el solicitante sea persona jurídica.
- ☐ Poderes, si fuere el caso. **Fotocopia autenticada**
- ☐ Documento de cesión del inventor al solicitante o a su causante.
- ☐ Declaraciones.
- ☒ Copia de la solicitud internacional. (Resumen, descripción, reivindicaciones, dibujos)
- ☒ Traducción de la solicitud internacional al castellano. (Resumen, descripción, reivindicaciones, dibujos)
- ☐ 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
Reivindicaciones Modificadas
Documentos PCT

11 FIGURA CARACTERÍSTICA:**12** Solicito la concesión de la patente,**NOMBRE:** JUAN PABLO CADENA SARMIENTO**FIRMA:**
C.C. 80410.337 de Usaquén TP 57492 del C.S.J.

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
DIVISION DE NUEVAS CREACIONES

PATENTE ☒ PCT/US2006/014335

MODELO DE UTILIDAD ☐

DISEÑO INDUSTRIAL ☐

SOLICITANTE/S. RAZON SOCIAL O APELLIDOS Y NOMBRES INVESTIGACION DE TECNOLOGIA AVANZADA, S. A. DE C. V.

DOMICILIO GUADALUPE, N.L., MÉXICO.

APODERADO JUAN PABLO CADENA SARMIENTO

TITULO PRODUCCIÓN CONTINUA DE HARINAS DE MAÍZ PRE-GELATINIZADO PARA ALIMENTOS A BASE
DE LÁCTEOS Y A BASE ... CLASIFICACION _____

EXPEDIENTE No. _____ FECHA DE SOLICITUD _____ ROLLO MICROFILM _____

CERTIFICADO No. _____ FECHA DE CONCESION _____ VIGENCIA DESDE _____ HASTA _____

PRORROGA _____ CAMBIO DE NOMBRE _____

TRASPASO A _____

INVENTOR (ES) FELIPE A. RUBIO, MANUEL J. RUBIO, FRANCISCO ARROYO, RICK NORTON, ROBERTO

OTROS CONTRERAS, MIGUEL ARCE, FERNANDO J. RAMIREZ.

4

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

NIT : 800176089-2

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO



No. 07-116567- -00000-0000

RECIBO OFICIAL DE CAJA : 07 - 79,191
FECHA : SEPTIEMBRE 28 DE 2007

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Tra. 11 PATENTEIYII Eve: 379 FASENACIONALII
Act. 411 PRESENTACION Folios: 116

***** CONSIGNACION *****

DEPOSITANTE	TIPO PAGO	BANCO	CUENTA	No. PAGO	FECHA PAGO	Vr. PAGO
BRIGARD & CASTRO LTDA	CONSIGNACION	BANCO POPULAR	050-00110-6	62761542	28/09/2007	30,065,000.00

***** CONCEPTO *****

CANT.	RENTISTICO	CONCEPTO	TOTAL CONCEPTO
1	50005-01-01	SOLICITUDES	
		1 TRAMITES DE SOL. DE PATENTE DE IN	482,000.00
		TOTAL :	\$ 482,000.00

SON: CUATROCIENTOS OCHENTA Y DOS MIL PESOS

RESPONSABLE : _____

RECIBO DE CAJA APLICADO AL EXPEDIENTE No. _____

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International Bureau



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A23L 1/10 (2006.01)

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(25) Filing Language: English

(26) **Publication Language:** English

(30) Priority Data: 11/122,106 5 May 2005 (05.05.2005) US

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(72) Inventors; and

(75) Inventors/Applicants (for US only): RUBIO, Felipe, A.

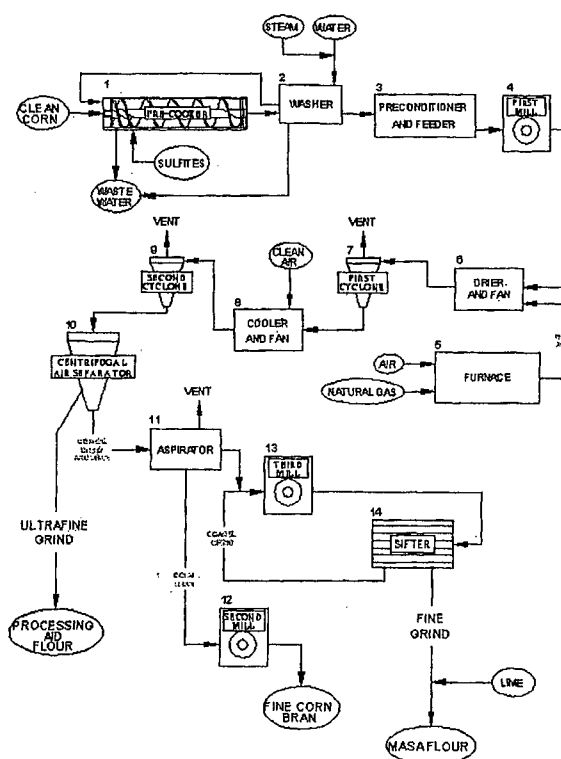
[US/US]; 1319 Ivy Lane, Edinburg, TX 78539 (US). **RUBIO, Manuel, J.** [US/US]; 1621 Collins Avenue, Miami Beach, FL 33139 (US). **ARROYO, Francisco** [US/US]; 501 W. Chapin, Edinburg, TX 78539 (US). **NORTON, Rick** [US/US]; 1159 Cottonwood Lane, Irving, TX 75038 (US). **CONTRERAS, Roberto** [MX/MX]; R. Cortines 2002 Ote, Guadalupe, N.L., 67110 (MX). **ARCE, Miguel** [MX/MX]; R. Cortines 2002 Ote, Guadalupe, N.L., 67110 (MX). **RAMIREZ, Fernando, J.** [MX/MX]; R. Cortines 2002 Ote, Guadalupe, N.L., 67110 (MX).

(74) Agents: JENSEN, Eric et al.; c/o Young & Thompson,
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(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG,

[Continued on next page]

(54) Title: CONTINUOUS PRODUCTION OF PREGELATINIZED CORN FLOURS FOR DAIRY-BASED AND CEREAL-BASED FOODS



(57) Abstract: A process and apparatus for the continuous production of pregelatinized corn flours for dairy-based and cereal-based foods, includes an acid precooking with a sodium metabisulfite, or sodium hydrogen sulfite or sodium sulfite solution as a food processing aid for partial hydrolysis of insoluble fiber, starch and protein, along with a controlled pregelatinization and denaturation, kernel washing, stabilizing moisture content for grinding, milling and drying preconditioned kernel to produce a partial gelatinization, cooling and drying the dry-ground particle, separation and recovery of the ultrafine grind from the coarser grind while the latter is further aspirated to remove a light corn bran and further reground to produce bran flour, remilling and sieving the isolated coarser grind to obtain fine corn flour for cereal-based foods, and admixing only fine flour with lime to produce a masa flour. An ultrafine corn flour is used as an aid or adjuvant flour for dairy-based foods.



SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US,
UZ, VC, VN, YU, ZA, ZM, ZW.

Published:

- with international search report
- with amended claims and statement

(84) **Designated States** (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(88) **Date of publication of the international search report:**
7 June 2007

Date of publication of the amended claims and statement:
26 July 2007

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.

AMENDED CLAIMS
received by the International Bureau on
11 June 2007 (11.06.07)

CLAIMS:

1. A physicochemical process for the production of pregelatinized corn flours for various food products, comprising the steps of:

precooking cleaned corn kernel with steam in a sulfiting solution comprising at least one acid component selected from the group consisting of sodium metabisulfite, sodium hydrogen sulfite and sodium sulfite;

washing said sulfite-precooked corn kernel to remove soluble solids into wastewater and stabilizing a moisture content of said precooked corn kernel;

milling said precooked and washed corn kernel and drying said milled corn kernel for partial gelatinization;

cooling and further drying said milled and dried corn kernel with clean air; and

separating said milled corn to recover an ultrafine grind under 60 to 325 mesh to obtain an ultrafine corn flour suitable for dairy-based foods;

wherein the separating step is performed using an air separator, and comprises subjecting the milled corn to a rising stream of air, and separating the ultrafine corn flour from non-ultrafine said milled corn based on differences between effects of aerodynamic drag forces imparted by the rising stream of air on the ultrafine corn flour as opposed to said non-ultrafine milled corn.

2. The method of claim 1 wherein said precooking step uses sulfites in an amount of about 0.02% to about 0.15% by weight of the cleaned corn kernel.

3. The method of claim 1, wherein the separating step separates the ultrafine grind from a coarse grind, the ultrafine grind comprising low-fiber endosperm and germ fractions, the coarse grind comprising high-fiber endosperm, germ and bran fractions.

4. The method according to claim 3, comprising the further steps of:

aspirating the coarse grind to remove a light corn bran fraction;

remilling the aspirated coarse grind; and

recycling the aspirated and remilled high-fiber endosperm and germ fractions of the coarse grind.

5. The method according to claim 4, wherein the recycling step comprises sifting the aspirated and remilled coarse grind into a finer fraction, under 45 to 80 mesh, to produce a fine corn flour suitable for cereal-based foods.

6. The method of claim 5, wherein said ultrafine and fine corn flours represent a 91% to 96% yield of the total weight of corn kernel.

7. The method of claim 5, comprising the further step of regrinding the light corn bran fraction produced by the aspirating step under 45 mesh to produce a bran flour.

8. The method of claim 7, wherein said light corn bran fraction comprises about 3% to 8% flour per kilogram of corn kernel.

9. The method according to claim 7, comprising the further step of mixing said fine corn flour with 5% to 10% by weight of said bran flour to produce a whole-corn flour with increased dietary fiber content.

10. The method of claim 9, further comprising the steps of:

admixing said bran flour with 45% to 49% by weight wheat flour, to produce a partial whole-grain flour with decreased total calorie content; and

manufacturing at least one of wheat-based and cereal-based foods using both the partial whole-grain flour and the whole-corn flour.

11. The method of claim 7, further comprising admixing said bran flour with 45% to 49% by weight wheat flour, to produce a partial whole-grain flour with decreased total calorie content.

STATEMENT UNDER ARTICLE 19 (1)

W

The International Search Report and Written Opinion accurately notes that the Rubio et al. reference identifies use of a cyclone in connection with a comparable process for producing corn flour. This fact is readily conceded by the Applicant. Moreover, in the Background section of the present specification, the discussion of air classifiers beginning on page 11 and continuing on to page 12 freely acknowledges use of such devices in the prior art.

Also described, however, are the fundamental characteristics that separate the operation of the cyclone of the prior art from the air separator of the claimed method. The first full paragraph on page 12 of the present specification makes the point that cyclones operate based only on gravitational-inertia force. Additionally, the immediately following paragraph points out the discovery that, while large corn flour particles are mostly affected by gravity and centrifugal forces, the ultrafine particles are affected by aerodynamic drag forces.

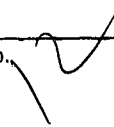
Neither the applied Rubio et al. reference nor any other reference known to the Applicant teaches this characteristic of corn flour. Therefore, while the air separator was itself known, the fact that a device of this type has any effect whatsoever on the method of separating different particle sizes of corn flour from one another was completely unknown. Until the present inventive method was arrived at through experimentation, there was

no indication in any known prior art that any separation approach other than by cyclone would offer any improvement. Nowhere is there any indication that any shortcoming in the cyclone approach was known, let alone any indication that use of the considerably more complex air separator that separates based on the effect of fluid drag forces would address such shortcoming.

These characteristics of the present invention are now explicitly recited in amended claim 1, and implicitly recited in the claims that depend therefrom.

In light of the present changes to the claims, Applicant respectfully requests reconsideration of the characterization of the claims as failing to meet the PCT requirement of novelty in light of the applied references.

INTERNATIONAL SEARCH REPORT

International application No. 

PCT/US06/14335

A. CLASSIFICATION OF SUBJECT MATTER

IPC: A23L 1/10(2006.01)

USPC: 426/472,473,481,482,518,520,618,622,626,640

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. : 426/472, 473, 481, 482, 518, 520, 618, 622, 626, 640

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
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 4,350,714 A (DUVALL) 21 September 1982, col. 2, lines 65-68, col. 3, lines 1-10.	24
Y	US 4,777,045 A (VANDERVEER et al.) 11 October 1988, col. 21, lines 64-68, col. 22, lines 10-13).	10, 11, 26
Y	US 6,068,873 A (DELRUE et al.) 30 May 2000, abstract and col. 2, lines 10-15, 49-50, col. 4, lines 30-50, col. 6, lines 4-9.	9, 25
Y	US 6,322,836 B1 (RUBIO et al.) 27 November 2001, abstract and col. 6, lines 10-33, col. 4, lines 5-10, col. 3, lines 25-70.	1-8, 21, 22, 23, 29, 30



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

"&"

document member of the same patent family

Date of the actual completion of the international search

15 March 2007 (15.03.2007)

Date of mailing of the international search report

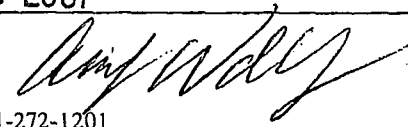
10 APR 2007

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Facsimile No. (571) 273-3201

Authorized officer

Helen F. Pratt 

Telephone No. 571-272-1201

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US06/14335

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

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

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

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

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
 2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of any additional fees.
 3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.: 1-11, 21-26, 29 and 30
 4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
- Remark on Protest ☒ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US06/14335

BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

Group I claim(s) 1-11, 21, 22 drawn to a process of making a coarse ground pregelatinized corn flour and product thereof..

Group II claim(s) 1-5, 12-20, drawn to a method of making a masa flour and a fat and protein substitute.

Group III, claim(s) 23-26, 29, 30, drawn to a process for making a coarse ground corn flour for cereals.

Group IV, claims 23, 27, 28, drawn to a process of making masa flour from corn flour and bran.

The inventions listed as Groups I-IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: a method of making a masa flour and fat and protein substitute is not required of Group I.

Further processing the coarse ground flour as in Group III into cereal, is not required of Groups I, II and IV. Making a masa flour from the corn flour is not required of groups I-III.

Continuation of B. FIELDS SEARCHED Item 3:

WEST search terms: bran, whole wheat, corn, pregelatinized, flour, sulfite, washing, milling, cooling, separating, coarse grind, recycle, regrind, remilling, air separator, endosperm, germ fiber, bran, aspirate, mesh, corn flour.



Handwritten signature

SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT,
TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

Publicado:

- con informe internacional de búsqueda
- con reivindicaciones corregidas y declaración

(84) Países designados (a menos que se indique lo contrario para cada clase de protección disponible): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasiática (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), Europea (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(88) Fecha de publicación del informe de búsqueda internacional:

7 de junio de 2007

Fecha de publicación de las reivindicaciones corregidas y declaración:

26 de julio de 2007

Para códigos de dos letras y otras abreviaturas, remítase a las "Notas Guía sobre Códigos y Abreviaturas" que aparece al comienzo de cada edición regular del Boletín Oficial PCT.

REIVINDICACIONES CORREGIDAS**Recibidas por la Oficina Internacional el****11 de junio de 2007 (11.06.07)****REIVINDICACIONES:**

1. Un proceso fisicoquímico para la producción de harinas de maíz pregelatinizado para varios productos alimenticios, que comprende los pasos de:

precocer el grano de maíz limpio con vapor en una solución sulfitante que contiene por lo menos un componente ácido seleccionado del grupo conformado por metabisulfito de sodio, bisulfito de sodio y sulfito de sodio;

lavar dicho grano de maíz precocado con sulfito para eliminar los sólidos solubles en el agua residual y estabilizar un contenido de humedad de dicho grano de maíz precocado;

moler dicho grano de maíz precocado y lavado y secar dicho grano de maíz molido para gelatinización parcial;

enfriar y, seguidamente, secar dicho grano de maíz secado y molido con aire limpio; y

separar dicho maíz molido para recuperar un molido ultrafino con una abertura de malla < 60 a 325 para obtener una harina ultrafina de maíz, apropiada para alimentos a base de lácteos; en donde el paso de separación se realiza usando un separador de aire, y comprende someter el maíz molido a una corriente ascendente de aire, y separar la harina ultrafina de maíz de dicho maíz molido no ultrafino, con base en diferencias entre efectos de fuerzas aerodinámicas de arrastre, impartidas por la corriente ascendente de aire sobre la harina ultrafina de maíz, por oposición a dicho maíz molido no ultrafino.

2. El método de la reivindicación 1, en donde dicho paso de precocción utiliza sulfitos en una cantidad de alrededor de 0.02% a alrededor de 0.15% en peso del grano de maíz limpio.

3. El método de la reivindicación 1, en donde el paso de separación separa el molido ultrafino de un molido grueso, comprendiendo el molido ultrafino fracciones de endospermo y germen, con bajo contenido de fibra, comprendiendo el molido grueso fracciones de endospermo, germen y salvado con alto contenido de fibra.

4. El método de acuerdo con la reivindicación 3, que comprende los pasos adicionales de:

aspirar el molido grueso para eliminar una fracción liviana de salvado de maíz;

volver a moler el molido grueso aspirado; y

reciclar las fracciones de germen y endospermo con alto contenido de fibra, vueltas a moler y aspiradas, del molido grueso.

5. El método de acuerdo con la reivindicación 4, en donde el paso de reciclado comprende cernir el molido grueso vuelto a moler y aspirado en una fracción más fina, con una abertura de malla < 45 a 80 , para producir una harina fina de maíz, apropiada para alimentos a base de cereales.

6. El método de la reivindicación 5, en donde dichas harinas de maíz finas y extrafinas representan un rendimiento de 91% a 96% del peso total del grano de maíz.

7. El método de la reivindicación 5, que comprende el paso adicional de volver a moler la fracción liviana de salvado de maíz producida por el paso de aspiración con una abertura de malla < 45 para producir una harina de salvado.

8. El método de la reivindicación 7, en donde dicha fracción liviana de salvado de maíz comprende alrededor de 3% a 8% de harina por kilogramo de grano de maíz.

9. El método de acuerdo con la reivindicación 7, que comprende el paso adicional de mezclar dicha harina fina de maíz con 5% a 10% en peso de dicha harina de salvado para producir una harina de maíz entero con un mayor contenido de fibra dietética.

10. El método de la reivindicación 9, que comprende además los pasos de:

mezclar dicha harina de salvado con 45% a 49% en peso de harina de trigo, para producir una harina parcial de grano entero con un menor contenido total de calorías; y

fabricar por lo menos uno de los alimentos a base de cereales y a base de trigo, usando tanto la harina parcial de grano entero como la harina de maíz entero.

11. El método de la reivindicación 7, que comprende además mezclar dicha harina de salvado con 45% a 49% en peso de harina de trigo, para producir una harina parcial de grano entero con un menor contenido total de calorías.

DECLARACIÓN BAJO EL ARTÍCULO 19 (1)

El Informe de Búsqueda Internacional y el Dictamen Escrito anotan exactamente que la referencia Rubio *et al.* identifica el uso de un ciclón en conexión con un proceso comparable para producir harina de maíz. Este hecho es voluntariamente admitido por el solicitante. Más aún, en la sección Antecedentes de la presente especificación, la discusión de los clasificadores de aire, que comienza en la página 11 y continúa en la página 12, reconoce libremente el uso de tales mecanismos en el arte previo.

Sin embargo, se describen también las características fundamentales que separan la operación del ciclón del arte previo del separador de aire del método reivindicado. El primer párrafo completo en la página 12 de la presente especificación puntualiza que los ciclones operan con base únicamente en la fuerza gravitacional/inercia. Además, el párrafo inmediatamente siguiente destaca el descubrimiento que, mientras las partículas grandes de harina de maíz se afectan principalmente por la gravedad y fuerzas centrífugas, las partículas ultrafinas se afectan por fuerzas de arrastre aerodinámicas.

Ni la referencia utilizada Rubio *et al.* ni cualquier otra referencia conocida por el solicitante enseña esta característica de la harina de maíz. Por lo tanto, aunque el separador de aire era conocido en sí mismo, el hecho de que un mecanismo de este tipo tenga un efecto sobre el método de separar unos de otros los diferentes tamaños de partícula de harina de maíz era completamente desconocido. Hasta el momento en que, mediante experimentación, se llegó al presente método inventivo, no existía indicio en cualquier arte conocido en el sentido de que un método de separación distinto de la separación por ciclón ofreciera una mejora. En ninguna parte hay una indicación en el sentido de que se conociera una desventaja en el método del ciclón, y menos aún una indicación en el sentido de que el empleo del separador de aire, considerablemente más complejo, que separa basándose en el efecto de fuerzas de arrastre de fluidos, abordara tal desventaja.

Estas características de la presente invención se exponen ahora explícitamente en la reivindicación corregida 1, y se exponen implícitamente en las reivindicaciones que dependen de ella.

A la luz de las presentes modificaciones a las reivindicaciones, el solicitante respetuosamente pide reconsiderar la caracterización de las reivindicaciones como no satisfactorias del requerimiento PCT de novedad, a la luz de las referencias empleadas.

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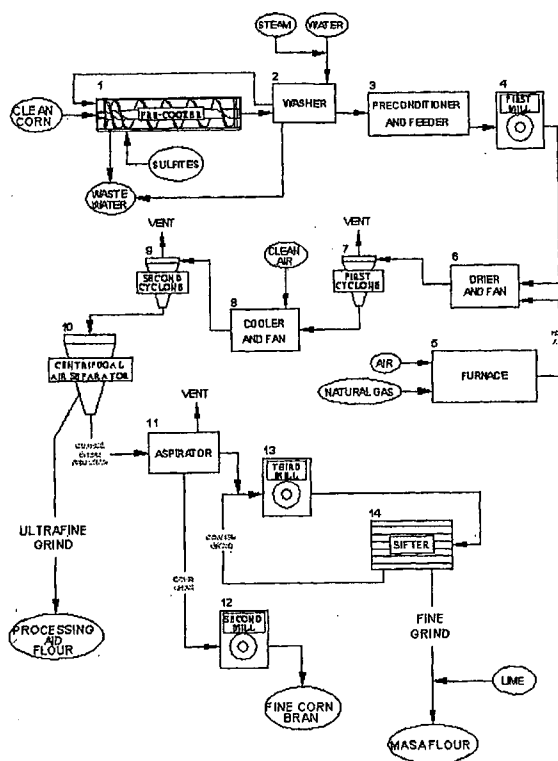
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[Continued on next page]

(54) Title: CONTINUOUS PRODUCTION OF PREGELATINIZED CORN FLOURS FOR DAIRY-BASED AND CEREAL-BASED FOODS



(57) Abstract: A process and apparatus for the continuous production of pregelatinized corn flours for dairy-based and cereal-based foods, includes an acid precooking with a sodium metabisulfite, or sodium hydrogen sulfite or sodium sulfite solution as a food processing aid for partial hydrolysis of insoluble fiber, starch and protein, along with a controlled pregelatinization and denaturation, kernel washing, stabilizing moisture content for grinding, milling and drying preconditioned kernel to produce a partial gelatinization, cooling and drying the dry-ground particle, separation and recovery of the ultrafine grind from the coarser grind while the latter is further aspirated to remove a light corn bran and further reground to produce bran flour, remilling and sieving the isolated coarser grind to obtain fine corn flour for cereal-based foods, and admixing only fine flour with lime to produce a masa flour. An ultrafine corn flour is used as an aid or adjuvant flour for dairy-based foods.

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CONTINUOUS PRODUCTION OF PREGELATINIZED CORN FLOURS FOR DAIRY-BASED AND CEREAL-BASED FOODS

BACKGROUND OF INVENTION

1. Field of the invention

The present invention relates to an acid precooking process for the production of pregelatinized corn flours and, more particularly, to one that achieves continuous partial hydrolysis of insoluble fiber and avoids excessive pregelatinization and denaturation with a sulfiting reducing agent as a food processing aid used during the manufacture of ultrafine corn and fine flour for the elaboration of dairy-based and cereal-based foods.

2. Description of the Related Art

The production of high-quality masa and corn flours can be achieved by conventional techniques only if the food-grade corn has the following characteristics: uniformity in kernel size and hardness, a low number of stress-cracks and kernel damage, and ease of pericarp removal during the lime-water cooking process. The five general classes of corn—flint, popcorn, flour, dent and sweet—are based on kernel characteristics. Since dent corn is a derivative of flint-flour crosses, it can show significant differences in the ratio of horny to floury endosperm caused by genotype and environmental factors. The ratio of horny (hard and translucent) to floury (soft and opaque) endosperm may average about 2:1 in dent corn. It is known that the food grade corn (U.S. No.2: USFGC, 1996) should be partially cooked before it is formed into the end products, so as to cause it to be a precooked corn flour. White-kernel corn may contain: 11.0-11.5% moisture, 72.2-73.2% starch/non-starch polysaccharides, 9.8-10.5% protein, 3.7-4.6% fat and 1.1-1.7% ash. For example, a dry-milled corn sample might yield, on a dry weight basis, 74.8-76.2% total endosperm, 18.9-20.5% germ and 3.3-6.3%

bran. The mature dent kernel (Watson, 1987; FAO, 1993) has four separable components, on a dry weight basis: tip cap (0.8-1.1%), pericarp (5.1-5.7%) and aleurone (2.0-3.0 %), endosperm (78.3-81.9%), and germ (10.2-11.9%). In dry or wet-milling processes, the separated bran includes the pericarp, tip cap, aleurone layer (isolated with bran) and adhering pieces of starchy endosperm as well. A native corn bran contained some starch (4-22%) and proteins (5-8%) arising from endosperm tissue and glycoprotein as well (Saulnier et al. 1995 and Hromadkova et al. 1995). In the dry-milling process, the primary product is isolated pieces of floury and horny endosperm, which are recovered by progressive milling, sieving (or classifying) and aspiration process. To recover starch by wet-milling, the granules within the endosperm cells must be released from the protein matrix (gluten) by treating corn (or endosperm) with alkali or a reducing agent (preferably sulfur dioxide) in a steeping process.

Nixtamalized corn flour (NCF) is produced by the steps of alkaline cooking (heating and steeping) of corn, washing, milling the nixtamal, and drying, thereby producing corn masa flour. This precooked flour is sieved and blended for different product applications and it is usually supplemented with additives before packaging for commercial table or packaged-tortilla and corn-based foods. Although the pericarp or bran is partially removed during the alkaline-cooking and washing process steps, there is still fiber left from the corn kernel (U.S. Patent 4,513,018).

The Mexican Masa Flour and Wheat Milling Industry signed a federal agreement in 1999 to add micronutrients to staple flours such as nixtamalized corn for tortillas and wheat flours for bread and flour tortillas. About 66% of the wheat flour brands are enriched with ferrous-iron and folic acid whereas all masa flour is further enriched (representing at least 30% of the tortilla consumption) with reduced-iron, zinc and B-complex vitamins.

There are marked differences between corn tortillas versus wheat tortilla and bread in relation to: their physico-chemical flour composition, ingredients, dough making and baking process. Cereal-based products use a debranned and degermed wheat flour (forming ingredient). The dough used for making bread and similar products always contains more ingredients than does corn tortilla dough. Examples include texture modifiers (shortening, salt and sugar/syrup), leavening agents (sodium bicarbonate and/or yeast) and characterizing agents (flavor/spice, gums and antimicrobial additives). The base ingredients for corn tortilla include a nixtamalized whole-corn or limed-precooked corn flour, with water and antimicrobial or functional additives that can be mixed prior to dough making for baking and packaging (U.S. Patent 3,730,732).

Most micronutrient losses occur during milling, which is one of the early steps in the refining process. During grinding, the bran and germ layers are removed, and the remaining starchy endosperm, which contains few antioxidants compounds, is ground into flour to make cereal-based foods (bread and tortillas). Whole-grain products retain the bran and germ, which provide phenolic acids (ferulic/diferulic, p-coumaric and vanillic) and phytic acid that may act independently or synergistically with dietary fiber (heteroxylan) to reduce the risk of coronary artery disease, colon cancer and type-2 diabetes (insulin resistance). About 69% of the total phenolics present in corn are insoluble bound forms (b-glycosides), with ferulic acid being the major compound. Feruloylated oligosaccharides from the side chains of corn heteroxylan can be isolated by acid hydrolysis or solubilized as ferulic acid sugars esters following heat-treatment of sweet-corn (115° C and 25 minutes have the effect of elevating total phenolics by 54%) and having a better suppressive effect on low-density lipoprotein oxidation than free ferulic acid. Consuming the recommended minimum of three servings of whole grains a day would increase the antioxidant and dietary fiber intake and lower the risk of heart disease by 25-36% (Decker et al. 2002). The top grain crops produced in the world are wheat, rice and corn.

New baked foods containing whole grains may qualify to carry labels with the following or other related health claims: a) "Development of cancer depends on many factors. Eating a diet low in fat and high in grain products, fruits and vegetables that contain dietary fiber may reduce your risk of some cancers" (21 CFR 101.76); and b) "Development of heart diseases depends on many factors. Eating a diet low in saturated fat and cholesterol and high in fruits, vegetables and grain products that contain fiber may lower blood cholesterol levels and reduce your risk of heart disease" (21 CFR 101.77 and 81: FDA/DHHS, 2004).

According to current trends, obesity will become the first cause of death by 2005 rivaling the annual deaths from cancer. Conditions of overweight and obesity are associated with type-2 diabetes, hypertension, hypercholesterolemia, asthma, arthritis, and poor health status. Some individuals might do best on a very-low-fat, high-carbohydrate diet, whereas others may respond to lowering carbohydrate intake (Atkins Foundation, 2005). The WHO (DHHS, 2003) considers that unhealthy diets and physical inactivity are the leading causes of the major chronic diseases with 60% of deaths and 47% of illness worldwide. These problems are not restricted to affluent nations but are rapidly gaining ground in the developing world, particularly among the young population.

A WHO (2003) report (Integrated prevention of noncommunicable diseases-cardiovascular, type-2 diabetes and certain cancers: Draft global strategy on Diet, Physical Activity and Health) recommended a diet limiting fat to between 15% to 30% of total energy intake and saturated fats to less than 10%. Carbohydrates (whole grains) should account for the bulk requirements-between 55% and 75%-but free sugars should stay below a 10%-. Protein intake should remain at about 10% to 15%. Most diseases are caused by an incorrect lifestyle and diet. Current habits of eating make people ill and weak, shorten their lifespans, and impair mental and spiritual health (Know Thyself-prevention is better than cure and health is wealth: SSSB, 1995).

The cell walls or non-starch polysaccharides (NSP) are the major corn dietary fiber components and are composed of hemicellulose (heteroxylan or pentosan and β -glucan: 4.4-6.2%), cellulose (2.5-3.3%) and some lignin (0.2%). According to Watson (1987: Tables IV and VII), the corn pericarp/tip cap makes up 6-7% and the aleurone-endosperm has about 2-3% of the kernel dry weight. This pericarp also contains 90% insoluble fiber (67% hemicellulose and 23% cellulose) and only 0.6% soluble-fiber (soluble-arabinoxylan and β -glucan). It is estimated that dietary fiber in both bran (4.9%) and endosperm (2.6%) make up 80% of the total dietary fiber. The corn insoluble fiber is mainly found in the bran and endosperm (aleurone and starchy), which make up 68% of the total dietary fiber (9.5% on a dry-weight basis).

All corn bran layers comprise the outer (beeswing or hull), inner (cross and tube cells), nucellar and endosperm (aleurone and starchy) cell-walls. Unlike corn endosperm (corn grits), in which soluble fiber amounts to 12% of the total fiber (4.1%), in whole wheat, soluble fiber represents 22% of total fiber (about 20% of the flour water-uptake is bound to the soluble pentosan fraction). The heteroxylan polymer is apparently linked to the cellulose skeleton in the corn cell wall by ester linkage cross-bonding through ferulic (3.1% or 31,000 ppm dry weight) and diferulic acid (0.5%). However, heteroxylan insolubility in corn bran might be due to protein-polysaccharide linkages (pericarp glycoprotein) and a highly branched structure (23% linear) as opposed to wheat bran (Saulnier et al. 1995). In the United States, the use of sterols in vegetable oils, margarines and spreads, yogurt, snack bars, salad dressings, dietary supplements and health drinks has received a GRAS status from the FDA. At least 0.65 grams of sterol esters (0.4 grams of free sterols) and 1.7 grams of stanol esters per serving (50 grams) may include a health claim that the consumption of phytosterols (vegetable oil byproducts) may reduce cholesterol and coronary heart disease. An industrial lime-treated corn bran (Maseca ®) contained 4-5% alcohol-toluene extract (unsaponifiable matter) with a total sterol content of 860-900 ppm (GRAS Notice-61, 2000) and this represents about 50% of a dry-milled

corn germ content (Arbokem-Canada, 2000). Functional foods, which may be known as designer foods or medical foods, are defined as processed foods containing ingredients that aid specific bodily functions in addition to being nutritious. Dietary supplement or adjunct marketers who want to sell a "new dietary ingredient" have to give FDA advance notice of their plans and provide evidence that the product is safe, but in most cases, they are not made with new dietary ingredients. When a manufacturer wants to make a labeling claim of effect on the structure or the function of the body, then they require scientific evidence for a claim.

During alkali cooking and/or steeping, there are chemical and physical changes such as nutrient losses along with partial pericarp or bran removal, degradation of the endosperm periphery with starch gelatinization/swelling and protein denaturation in the precooked corn kernel. The most important nutritional modifications are: an increase in the calcium level with improvement in the Ca to P ratio; a decrease in insoluble dietary fiber and zein-protein; a reduction in thiamin and riboflavin; an improvement of the leucine to isoleucine ratio, reducing the requirement for niacin; niacin-release from pericarp/aleurone/endosperm; and leaching of ferulic-acid (Sanchez, Ramirez and Contreras, 2005), residual insecticides, fungicides and micotoxins into the alkaline steep-liquor or "nejayote" (FAO, 1993 and Sustain, 1997).

In a commercial operation, corn solid loss has been estimated at 5-14% depending on the type of corn (hard or soft) and on the severity of the cooking, washing and drying process. Tortilla quality was not directly related to solid loss (bran removal) and acceptable tortillas had < 4% loss. Properly processed industrial corn or masa flour simplifies the production of tortilla products, because the customer eliminates management techniques required for wastewater treatment, securing, handling and processing corn into masa for tortillas and snacks. However, a pregelatinized corn flour might have the following quality and cost limitations: high cost, lack of flavor, and poor texture in cereal-based snacks or maize-flour raviolis

prepared from nixtamalized corn flours (U.S. Patent 6,491,959 and Erempoc et al. 1997).

The third-generation (3G) cereal foods include the steps of extrusion cooking, followed by cooling, holding and drying to make "cereal pellets" which are expanded by frying or baking to make nixtamalized corn-based foodstuffs (novel masa-based snack in U.S. Patent 5,120,559 and hypercholesterolemia-reducing snack in U.S. 20040086547). Another example is breakfast cereals made by cooking whole grains or grits (wheat, barley, rye, oats, rice or corn), followed by cooling, tempering, shredding, forming into "biscuits" and baking or toasting the cereal-based foods (CA 2015149).

Sulfiting agents have been used around the world for technological functions that include: a) inhibiting oxidation (enzymatic browning) of fruits (dried fruits:<600 ppm)), vegetables (dehydrated potatoes:<250 ppm) and carbonated beverages (bulk-wine:<350 ppm), b) preventing melanosis (melanin pigments) on shrimp and lobster, c) providing antimicrobial growth during winemaking (50-100 ppm), d) conditioning wheat dough (disulphide-bond reduction) and e) bleaching/modifying of food starches (FDA 121.1031 with <500 ppm).

When the Federal Food, Drug, and Cosmetic Act was amended in 1958 to regulate preservatives and other food additives, FDA considered sulfites (any sulfiting agent: sulfur dioxide, sodium/potassium metabisulfite, sodium/potassium bisulfite and sodium sulfite) to be generally recognized as safe (GRAS). However, all GRAS substances produced through recombinant-DNA that were widely consumed prior to 1958, and which have been modified and commercially introduced afterwards must comply with regulatory requirements proposed in 21 CFR 170.36 (GRAS Notice-60 for potassium bisulfate when used as a food processing aid in cheeses at <3 ppm, alcoholic beverages at <140 ppm and cake mixes at 0.1-1.0%). In 1985, the FDA concluded that sulfites are safe for most

people, but pose a hazard of unpredictable severity to asthmatics and others who are sensitive or allergic (1% in USA) to these ingredients.

These secondary additives, a sub-class of direct additives (21 CFR 172, 170.36 and 101.1), are primarily Processing Aids which are used to accomplish a technical effect during food processing but are not intended to serve as a functional additive or preservative in the finished food if no detectable amount of the agent is present. A detectable amount of sulfiting agent is 10 ppm or more of the sulfite-as sulfur dioxide- in the finished food (21 CFR part 101.1 Food; exemptions from labeling). Finally, the list of some potential allergenic ingredients (E.U. food labeling regulations by 2005) includes: Cereals containing gluten and products thereof (celiac disease provokes a chronic intestinal inflammation that is induced by cereal prolamins-rich in proline and glutamine- from wheat, barley, rye and oats); soybeans and soybean products; Milk and Dairy products, including lactose and Sulphur dioxide and Sulphites at concentrations higher than 10 ppm.

With the escalation of health care costs around the world, especially in North America, Japan and Europe (8% of the gross domestic product), the focus has shifted from treatment to prevention. Approximately 11 million people in the USA suffer from food allergies, and in Europe it is estimated that 8% of children and 3% of adults are also affected.

Biotherapy of gastrointestinal disorders is not yet accepted in clinical practice to treat food allergies. However Prebiotic- and Probiotic-based therapies may have the potential for the treatment of particular conditions. Prebiotics are nondigestable dietary components that pass through the digestive tract to the colon and selectively stimulate proliferation and/or activity of populations of desirable bacteria in situ. Probiotics, on the other hand, are microorganisms that are used as dietary supplements with the aim of benefiting the consumer's health by positively influencing the intestinal microbial balance. Lactic acid bacteria species are increasingly being used as functional ingredients, particularly in dairy products such

as yogurts and fermented milk. Due to the potential synergy between prebiotics and probiotics, foods containing a combination of these functional ingredients are often referred to as synbiotics.

Tortillas are the main edible corn product in North and Central America. It is a flat, round, unleavened and baked thin-pancake (flat-cornbread) made from fresh masa or corn dough prepared from industrial nixtamalized corn flour (NCF). It should be mentioned that a tortilla, when manually or mechanically elaborated and without additives of any kind, has a maximum shelf life of 12 hours at room temperature. Afterwards they are spoiled by contaminating microorganisms (ropy and spore-forming bacteria) and become hard or stale due to a physicochemical change in the starch constituent of either stored or reheated tortillas (starch retrogradation/annealing). It is known that tortillas, even when kept under conditions in which no moisture is lost (as in a plastic package), nevertheless become stiff with time and break or crumble easily when bent. The addition of edible water-soluble edible substances ($<1\%$; $\text{pH}=7.5-9.5$) to the lime-treated corn dough markedly retarded the tortilla spoilage (U.S. Pat. 3,730,732).

In northern South America, particularly in Colombia and Venezuela, food-grade corn is processed with dry milling technology without wastewater and it is further converted into a precooked, degermed and debranned flour for traditional corn foods. Its consumption is mainly in the form of an "arepa", which is a flat or ovoid-shaped, unleavened, and baked thick-pancake made from dry-milled corn flour. In other South American countries, corn meal (polenta) and corn flour are used for different bakery (empanada and pancake mixes), gruel (atole) and snack foods (FAO, 1993).

A corn wet-milling process for starch production involves an acidic fermentation ($\text{pH} < 5$) during steeping or soaking whole kernels counter-currently (1-2 days at $45-50^{\circ}\text{C}$). The technical or functional effect is to soften the endosperm and to break the disulfide-bonds holding the protein matrix together. It involves a

diffusion limited unit operation where two processing aids are required: with 0.10-0.25% sulfur dioxide and 0.50-2.0% lactic acid usually produced by endogenous or exogenous *Lactobacillus* spp. (Watson, 1987). The microflora of fermented nixtamalized corn can yield a spontaneous solid-state fermentation to produce a corn sour-dough such as "Pozol" consumed as a gruel/beverage by the indigenous population in S.E. Mexico (Ramirez and Steinkraus, 1986). *Lactobacilli* identified in the lab-fermented nixtamalized dough (pH < 4) were *L. plantarum*, *L. fermentum* and *Pediococcus* spp. (Sefa-Dedeh et al. 2003). The main result of a lactic fermentation is a dispersion of endosperm protein/zein and an enhancement of starch release during subsequent milling for acid-fermented corn gruels/porridges such as: Ghanaian kenkey, Nigerian ogi (industrial), Kenyan uji and South African mahew (Steinkraus, 2004). Novel dry sour-doughs or fermented cereal-based ingredients or compositions (containing wheat, oat, barley, rye and rice) have been innovated with commercial lactic-acid starters for products such as wheat/rye bread (DE 4308707) and wheat-based cracker (U.S. Pat. 6,649,197) or low-fat fermented milk foods (EP 0663153) and low-fat dairy spreads (WO 9808400) as well.

Other unfermented materials such as potato starch, pregelatinized starches and flours, vegetable gums and grain-based fibers are also used to bind and reduce water migration in dairy products. A commercial gum preparation (0.15-0.25%) added before milk pasteurization for cheese making effected an increased yield with additional desirable textural and sensory characteristics (NZ 507104). A microbial gum (<1%-3%) was also used to recover dairy protein from cheese-whey and the protein-gum precipitate used as food additive (EP 0471408). Finally, physically-modified/pregelatinized starches or cereal-based ingredients have been designed on their technical or processing-aid properties as well (U.S. Pat. Nos.: 5,061,104 and 6,861,081). By adjuvant materials or food processing aids as used herein is meant the materials and substances selected from the group consisting of cereal, starch, vegetable flour, soy flour; edible gums, pectins, hydrocolloids and dietary fibers; or

mixtures thereof. Granule size is a characteristic property for commercial wheat, potato and corn starches. Reduced sizing is reported to have better water absorption and enzyme susceptibility during food processing. It can also be used as a potential fat substitute in foodstuffs due to an ability to provide fat-like texture or mouthfeel and increase moisture retention during cereal-based and dairy processing.

Classification is the separation of a particulate material into a coarse and fine fraction. The separation has always been by size in flour production. At various stages of production, the flour is sifted using a mesh of a size that allows only particles of a predetermined maximum size to pass through. Until now, separation of flour by size alone has been adequate for flour production.

Other, non-food industries have historically used other mechanisms for sorting particulate matter, taking into consideration other particle properties such as density. For example, density is insignificant when using screen or sifters but is a major factor in centrifugal air classifiers where fluid drag forces are mainly involved. Depending on the equipment used, classification might also be affected by particle shape, electric, magnetic and surface properties. It requires increasingly more energy if ultrafine particles are to be produced. With decreasing size the homogeneity of the particles also generally increases..

Air classifiers (also called air separators) include any gas, but clean air is used preferably and the classification in the medium to submicrometer particle range (1000 to 0.1 micron) is effected in a stream of air, using a combination of any of the following forces: gravity, drag, collision and centrifugal. Other classifier devices such as grates and screens/sieves operate in the large to medium range (500 mm down to 0.15 mm or 150 μ m: 100 U.S. Standard Mesh). Density is insignificant when using screens or sieves, but is a major factor in air classifier where fluid drag forces are involved.

Centrifugal separators (or cyclones) are widely used in the chemical/pharmaceutical industry and for the removal of solid and liquid (aerosol or

ultrafine particles) matter from gas streams. Cyclones are considered separation equipment even though a superfine (ultrafine) fraction entrained in the outlet gas which must be recovered in another separation step-as in a cyclone downstream. They have a medium collection efficiency (80-95% for 15 to 50 μm size: 325 Mesh) and a high throughput (Theodore et al. 1976).

The Mumford-Moodie Separator, patented in 1885, is similar to the Sturtevant Whirlwind (Klumpar et al. 1986). Solids are fed into a rising clean air stream, using a rotating distributor plate that imparts a centrifugal force. Large particles drop into an inner cone (tails or fine discharge); the ultrafine fraction (10 to 420 μm : 40 Mesh) is swept upward by the action of an internal fan, separated from air between vanes in the expansion section of the outer cone, and collected at its bottom. The air, separated from the ultrafine in the outer cone, is recirculated continuously up to the distributor which spreads the incoming feed into the ascending air. Thus, the updraft classifier incorporates almost all the key forces, whereas a cyclone only uses the gravitational-inertia force.

The magnitude of these forces is highly dependent upon the diameter of the particle, either through its dependence on the mass of the particle, or through the drag coefficient and characteristic area. Large particles are mostly affected by gravity and centrifugal forces, whereas intermediate-sized and small-sized/ultrafine particles will be affected mostly by aerodynamic drag force. Industrial air classifiers (centrifugal) are made by Sturtevant Inc., C.E. Raymond, Humboldt Wedag, Polysius, Smidth Sepax, Hardinge Gyrotor and Onoda.

Corn flour processors can generate added value from their industrial operations in one of three approaches: developing new products from new hybrids, increasing the yield of traditional products from corn, and improving process efficiency at a lower unit cost. In the past, this has been done by methods and using an apparatus in which the grain is cooked and/or steeped in a lime-water solution such as those disclosed in U.S. Patents Nos. 2,584,893, 2,704,257, 3,194,664, and

4,513,018. These prior art methods for the industrial production of masa flour involve accelerated lime precooking and steeping times with large amounts of soluble-waste (1.2-2.0% COD: Alvarez and Ramirez, 1995) and corn solid loss (~1.5-2.5%: 50-60% dietary fiber, 15-20% ash, 15% starch, 5-10% protein and <5% fat).

Many and varied methods for the production of instant corn flour for food products involving lower amounts of water with low-temperature precooking for a high yield of the end product have been developed, as reflected by the following U.S. Patents: 4,594,260, 5,176,931, 5,532,013, 6,387,437 and 6,638,554. In this connection, reference is made to U.S. Patent Nos. 4,594,260, 5,176,931, 5,532,013, and 6,265,013, which also require low-temperature drying. On the contrary, U.S. Patent Nos. 4,513,018, 5,447,742, 5,558,898, 6,068,873, 6,322,836, and 6,344,228 have used a high-temperature dehydration or rapid cooking in place of a low-temperature cooking.

Having in mind the disadvantages of the prior art methods, several studies not only have used a low-temperature and rapid precooking with minimum wastewater, but also separate corn fractions as reflected by the following U.S. Patents Nos. 4,594,260, 5,532,013, 6,025,011, 6,068,873, 6,265,013, 6,326,045 and 6,516,710.

A few applications for acidic steeping or precooking were also tested to convert a traditional corn processing into a novel chemical or biochemical process with reduced wastewater (U.S. Patent Nos. 1,045,490 and 6,322,836 or WO Pat. 00/45647). Three recent innovations have been published (WO Patents: 00/45647, 01/98509 and WO 2004/023892 A1) for the preparation of a modified corn foodstuff using either a reducing agent (metabisulfite), or an acidic reductase enzyme or hydrosulphite as processing aids and added during the corn cooking stages such that its native protein was partially modified.

Although the above described prior art methods are capable of partial precooking of corn for a modified masa foodstuff, corn grit and broken corn, a

continuous industrial application using not only a sulfiting precooking but also a centrifugal separator yielding ultrafine and fine corn flours for dairy and cereal-foods was still unavailable in the market at the time of the invention.

SUMMARY AND OBJECTS OF THE INVENTION

Accordingly, it is an object of this invention to provide a complete departure from the prior art and rapid precooking methods of thermal, mechanical, chemical and biochemical or enzymatic processing of whole corn in order to control starchy endosperm pregelatinization and protein denaturation using a sulfite precooking during the continuous production of ultrafine and fine corn flours for dairy-based and cereal-based foodstuffs.

It is another object of this invention to use a centrifugal air separator not only to continuously produce an ultrafine corn flour used as a food processing aid in dairy foods but also to yield a fine corn and bran flour as a cereal-base ingredient.

Another object is to achieve this objective using an industrial method and apparatus involving an acid precooking with sulfites for a partial hydrolysis of corn cell-walls, starch and proteins along with a water diffusion effecting a controlled starch pregelatinization and protein denaturation with a reduced corn loss during the production of pregelatinized corn flours.

The above and other objects and advantages of the invention are achieved through a continuous process applied to the production of pregelatinized corn flours for dairy and cereal-based foods, embodiments of which include a precooking with a sodium metabisulfite, or sodium hydrogen sulfite or sodium sulfite solution as a processing aid so as to effect a partial hydrolysis of insoluble fiber, starch and protein along with a controlled pregelatinization and denaturation, reduced kernel washing and solid loss into wastewater, stabilization of the moisture content to a desired optimum level for grinding, milling and drying the preconditioned kernel to produce a uniform partial cooking, cooling and further drying the dry-ground particle,

centrifugal separating and recovering the ultrafine grind so produced from the coarser grind while the latter is further aspirated to remove a corn bran fraction and further milling it to produce a fine bran for whole-corn and partial whole- flour, remilling the isolated coarser grind and further sieving it to obtain a fine corn flour for cereal-based foods, and admixing only a fine flour with lime to produce a masa flour for tortilla. An ultrafine corn flour is used as an aid or adjuvant for the dairy-based foodstuffs.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more fully understood from the description, which follows, and from the appended drawing in which the sole drawing figure depicts an embodiment of this invention in a block-type flowchart illustrating the continuous and industrial process using an acid-precooking with sulfites as a processing aid and a centrifugal air separator to recover an ultrafine corn grind from a coarse corn grind.

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 precooker 1; a washer 2; a preconditioner 3 with a feeder; a primary mill 4; a furnace 5; a dryer 6 with a fan; a first cyclone separator 7; a cooler 8 with a clean air fan; a second cyclone separator 9; a centrifugal air separator 10 with an internal fan; an aspirator system 11; a secondary mill 12; a tertiary mill 13 and a sifter 14.

The precooker 1, whose design is known per se, is fed with cleaned corn and a sodium metabisulfite solution along with hot steep-water (60°C to 70°C) recycled from the washer 2 to form an sulfiting aqueous suspension (corn to water ratio of about 1:1 to about 1:1.5). The solids content of the acidic solution is regulated in the range from about 0.5% to about 0.7%. By controlling the steam heating and the kernel residence time, it is possible to precook corn under atmospheric pressure. The

corn suspension is heated with saturated steam to a temperature of from about 75° to about 90° C for a period of 25 to 45 minutes. This allows the sulfiting-precooked kernel to be produced at moisture contents of between 32% and 35%, while the pH is lowered to about 6.2 to about 6.7 with the addition of a 10% acidic sulfiting solution to supply a 0.05% to 0.15% by weight processing aid (based on corn).

The precooker with the sulfites solution causes a partial hydrolysis of fiber, starch and protein that promotes a rapid and uniform diffusion of the cooking water through the base end of the tip cap, move through the pericarp cell-walls up to the kernel crown, and then down into the endosperm and germ components. Saturated steam and sulfites solution also effect a controlled solubilization, pregelatinization and swelling in the corn kernel, allowing a 60% to 70% waste solids reduction as well as a 10% to 20% decrease in wastewater effluent (with a lower sewage cost) as compared to the continuous alkali-cooking process (Alvarez and Ramirez, 1995). This wastewater loss in the precooker can be replaced with recycled steep-water from the washer 2.

The partially precooked corn suspension is then passed to a washer 2 where it is sprayed with steam-heated water at a temperature of about 60° to about 70°C for 30 to 60 seconds, which also serves to increase water absorption and wash off sulfiting aid and soluble solids into wastewater.

The precooked and washed corn is thereafter passed to a preconditioner 3, where the precooked kernel is equilibrated to obtain a residual moisture content of about 34% to about 37% for about 210 to about 340 minutes.

Thereafter, the preconditioned and washed corn is fed through a feeder to a primary mill 4, whose design is known per se, such that the premilled corn and hot air coming from a furnace 5, is mixed and partially precooked by an industrial dryer 6 whose design is known per se. The premilled kernel is thereby flash dried at a high-temperature from 190°C to about 230°C for a short time of 10 sec to about 30

sec. Its starchy endosperm is partially gelatinized to yield a moisture content of 16% to about 18% depending on the granulation being produced.

Moisture laden-hot air (130°C to 180°C, and 11% to 13% moisture) is extracted with a first cyclone separator 7, whose design is known per se, so that further moisture extraction may take place by impelling the drier material through a cooler 8 with clean air sucked by an associated fan, thus further decreasing the moisture content from 16-18% to about 9-12% (similar to incoming corn).

After further extraction of moisture laden-hot air (100°C to 110°C) with a second cyclone separator 9, the precooked dry particle or grind is directed to a centrifugal air separator 10 with a specially designed internal fan. The large-sized portion is known as the coarse grind composed of high-fiber endosperm, germ and bran fractions, while the small-sized portion is described as the ultrafine grind made of low-fiber endosperm and germ fractions.

As the centrifugal fan moves upwardly the ascending air with entrained small-sized particles, then a fine grind is separated as an ultrafine corn flour (under 60 to 325 Mesh) and the coarse grind (under 40 to 80 Mesh) is further separated. The ultrafine grind will be affected most by drag forces whereas the coarse grind by gravity, centrifugal and collision forces produced by the action of an internal fan. This ultrafine corn flour with a moisture content between 9% to 12% is produced from about 30% to about 60% of the total weight of incoming corn. If desired, the ultrafine corn flour can be used either as a processing aid or mixed with adjuvant materials for novel dairy-based foods.

The latter coarse grind is further separated in the aspirator system 11, whose design is known per se, wherein two fractions are obtained, a light bran-fraction which is isolated from a heavy coarser fraction that is further remilled in a tertiary mill 13. The aspirated light fraction is further remilled in a secondary mill 12 as a bran flour (under 45 Mesh) for whole-corn and partial whole-grain flour with a moisture content between 9% to 12% (representing from about 3% to about 8% of

the total weight of incoming corn). The remilled heavy product from a tertiary mill 13 is sent to the sifter 14 for sieving and producing a homogeneous fine corn flour (under 45 to 80 Mesh) with a moisture content from about 9% to 12% (representing a 30% to about 60% of the total weight of incoming corn). If desired, the fine corn flour can be admixed with food-grade lime (0.05%-0.15% weight based on pregelatinized flour) to produce a masa flour for making tortillas otherwise the corn flour can be used as a cereal-base ingredient for cereal foods.

The following table gives a nutrient average composition of pregelatinized corn flours for dairy (ultrafine: <60-325) and cereal-base foods (fine: <45-80 and bran: <45 Mesh):

Nutritional content (g/100 g): Pregelatinized Flours			
Nutrient	Ultrafine-corn	Fine-corn	Bran
<i>Water</i>	11.0	11.0	11.0
<i>Protein</i>	7.7	8.4	4.0
<i>Fat</i>	5.2	3.7	1.4
<i>Ash</i>	1.5	1.2	2.5
<i>Calcium</i>	0.033	0.022	0.015
<i>Dietary fiber:</i>	3.7	5.2	63.2
<i>Crude fiber</i>	0.7	1.2	13.6
<i>Starch</i>	70.9	70.5	17.9
<i>Total Calories:</i>	350	340	95

The ultrafine and fine flours contain particles either from a low-fiber or a high-fiber endosperm with germ fractions, whereas the bran flour mainly includes a pericarp with starchy-endosperm fractions. Therefore the pregelatinized corn flours produced by the present method have a higher nutritional value as compared to the conventional methods, with a higher fat (>140%), dietary fiber (20%) and protein (10%) composition than the industrial dry-milled (coarse-meal/fine-flour) corn flours (INCAP, 1961).

EXAMPLE 1

Preparation of dairy-based foods using an ultrafine corn flour (particles with a low-fiber endosperm and germ fractions) as a processing aid.

1) For use during cheese-processing: Prepare a 10 % dispersion by mixing 4.5 kilos of processing aid or adjuvant corn flour (containing about 5% fat and about 4% dietary fiber) in 40 kilos hot water or hot whole-milk (from 3.0% to about 3.3% fat) with continuous mixing (A tri-blender or milk powder horn provides adequate mixing). Mix until the ultrafine flour dispersion is smooth and homogeneous in appearance. Target a heating temperature from 60°C to about 85°C for 10 minutes to about 30 minutes. Cool down to 30°-32° C and add a cooled 2.5% flour dispersion to the cheese milk-vat in order to obtain from about 0.10% to about 0.25% flour solids in the milk-vat (200 kilos per batch). Follow standard manufacturing procedures for hard (cheddar) or soft (mozzarella, fresh-cheese and processed-spread) cheese foodstuffs (Food Processing Center-pilot plant, University of Nebraska-Lincoln, 2004). The addition of this ultrafine corn flour dispersion instead of using other dispersive hydrocolloids resulted in an increased cheese yield from about 3% to about 15% in both total solids and moisture.

If other cultured-cheese products are prepared a higher addition is needed to achieve a 0.25% to about 0.6% flour solids. An enhanced acid development and firmness was improved when applied as an aid or adjuvant corn flour with the starter culture system. These American (hard) and Italian (soft) cheeses will have a higher whey-recovery (from 1% to about 2%) than those reported where expression of whey solids has been practiced traditionally. Sanchelima International Inc. has a patented process (continuous heat-gelation treatment) to incorporate a portion of soluble whey proteins into the cheese curd for Latin fresh and cheddar (~20% to ~13% yield). A real yield gain, as opposed to water yield, will incorporate water and fat almost proportionally to the initial protein to fat ratio in the whole-milk (from about 1.0 to about 1.2) for every kilo of recovered-whey. If all production procedures are maintained to produce the same type of cheese, the cheese yield will change

according to the percentage of moisture and precipitated whey-protein in the final product. Therefore, the ultrafine corn flour used as an aid during cheese making appears to maintain the total-protein to fat ratio (from about 0.8 to about 1.1) in a physical functionality (water and fat-holding effect) with a unique starch-protein complex being formed above the gelatinization/gelation temperature (from about 60° to 85° C for 10 to 30 minutes) of this binding-gel or texturizing aid. Only a few polysaccharides (guar, alginate, carrageenan, xanthan and starch) with a few proteins (gelatin, soya-globulin, casein and whey) have been used to form gels or food-additives (U.S. Pat. No. 4,159,982, EP 0471408 and NZ 507,104).

2) For use in reduced-fat processed cheese and spreads: Prepare a 5% ultrafine flour dispersion and add to the starting skim-milk (from 1% to about 2% fat) as previously explained. Follow standard processed cheese-making methods and the processing aid not only reduced the fat content from 30% to about 45% but also acted like a fat substitute/mimetic and protein substitute/extender. Moreover, texture and appearance are improved in the cheese matrix and less fat separation.

3) For use in low-fat dairy foods. Prepare a 1% to 5% ultrafine flour dispersion and add to the pre-pasteurized skim-milk as earlier described. Apply standard making procedures for the following dairy-foods:

- a) Low-fat sour cream: Reduced fat and calories (66%) with enhanced mouthfeel, smooth texture and good emulsified flavor. Whey syneresis and ropiness defects are also reduced.
- b) Yogurt plain: Enhanced texture and mouthfeel with reduced whey separation in food.
- c) Low-fat cottage cheese dressing: Reduced whey syneresis as well as building viscosity and enhancing texture similar to a smooth full-fat and emulsified food (reduced-fat: 50%).
- d) Low-fat ice cream mix/chocolate or vanilla: The gelatinized ultrafine particles (with a low-fiber endosperm and germ fractions containing about 5% fat and 3.5

kcal/gram) provided a rich/smooth texture to a low/full-fat ice cream (2.7% fat) free of flavor notes.

EXAMPLE 2

Preparation of cereal-based foods using a fine corn (particles with high-fiber endosperm and germ fractions) and bran flour (particles with pericarp and starchy-endosperm fractions) as a cereal-base ingredient.

1) For use in novel snacks and tortilla manufacture: Either the fine corn or masa flour (with a high-fiber endosperm and germ fractions) made from the presented method can be rehydrated with warm water from a 1:1.0 to about 1:1.3 weight ratio for a corn and masa dough (50% to 55% final moisture content) used in the preparation of industrial third-generation snacks and commercial tortilla-baked foods.

If a whole-corn or integral flour is prepared for cereal-based foods, then about 5% to about 10% bran flour by weight can be uniformly admixed with a fine corn or masa flour in order to increase its dietary fiber composition from about 3% to about 6% (with 7% to 9% dietary fiber as reported in nixtamalized corn flour: U.S. Patent 6,764,699). An AACC whole-grain definition (2004) requires the same relative proportions of bran, germ and endosperm as the original grain or kernel. Whole-grain ingredients may be used whole, cooked, milled into flour and used to make baked-foods and other products, or extruded or flaked to make breakfast cereals. A challenge is to make these products more appealing than refined-grain products and communicate to the general population their healthier attributes.

The FDA (1999 and 2002) and AACC (2003) have recognized a new health claim for whole-grain foods and baked goods which may qualify to carry the following labels: a) foods high in insoluble fiber (hemicellulose A/C, cellulose, resistant starch and lignin) and low in fat may reduce colorectal cancer risk (21 CFR 101.76) and b) those foods high in soluble fiber (branched-hemicellulose B or corn-

hull gum, b-glucan and hydrocolloid) and low-fat/cholesterol may also lower cholesterol and reduce heart disease risk (21 CFR 101.77 and 81). Cereal-baked products and Functional foods can further lead to a reduction of chronic-disease risk or an improved state of body health to whereby their scientific benefits is communicated to the public and they must achieve their effects in amounts that could normally be expected to be consumed in a standard-diet. Therefore, the food industry has an opportunity to provide function-based (FDA/DHHS-Food Labeling, 2004: 21 CFR 101.54) rather than product-based claim while keeping its shelf-life. The FDA has been petitioned to separate dietary fiber from total carbohydrate declaration on nutrition labels to reduce confusion (Mehta, 2005).

A Mision light ® labeling claim reported about 3.2 dietary-fiber grams/serving (2 corn tortillas or 23 grams on a dry-basis) while adding a GRAS-fiber ingredient provided a 25% reduced-calorie tortilla (light-tortilla). Three enhanced-fiber tortilla servings (made with enriched Maseca ® flour) should provide about 30% of the FDA daily value (DV). On the other hand, a nixtamalized corn tortilla will provide about 1.8 to 2.2 fiber grams/serving. It is estimated that corn tortilla per capita consumption in Mexico and Central America is around 240 grams/day (10 tortillas or 125 flour grams) accounting for at least a 40% of the daily calorie intake.

2) For use in reduced-calorie and reduced-gluten wheat foods: Either the bran flour or fine corn obtained from the aforementioned process can be uniformly mixed with 45% to 49% by weight wheat flour in order to increase its ingredient formulation from about 3% to about 30% dietary fiber content and from 2% to about 5% non-gluten protein, respectively. Several epidemiological studies have consistently defined whole grains as those food products that comprise more than 25% whole-grain content or bran by weight. Other grain products include dark-bread, popcorn, cooked oatmeal, wheat germ, bran, breakfast-cereals, brown rice, and wheat-bulgur. In the USA, however, the FDA specifies whole-grain products as

those meeting the criterion of 51% whole-grain content by weight (Liu, 2003 and Anderson, 2004). This reduced-calorie and reduced-gluten flour can be further used as a cereal-base ingredient during the standard manufacture of wheat-based foods such as: cookie, biscuit, cracker, snack-bar (granola or fruit), flat-bread, flour-tortilla, crumpet, muffin, empanada, pancake, bulgur, dumpling and noodle. Therefore, a daily intake of wheat-based and cereal-based foods higher in non-starch polysaccharides (from bran flour containing 63% dietary fiber and 4% protein) and high-fiber endosperm (from fine corn flour containing 5% dietary fiber and 8% protein) can contribute to a reduction in total calorie-intake (from 25% to about 30%) and to a lesser extent to an allergenic-gluten consumption (from 15 %to about 40%). Nixtamalized corn bran (Maseca ®) used in a low-content carbohydrate/gluten cookie (60% and 15%, respectively) not only decreased LDL-cholesterol in guinea pigs but also reduced the LDL and serum-cholesterol levels in normal (14%) and hypercholesterolaemic (11%) adult men from northern Mexico. They consumed corn-bran cookies during a 6-week study (70 cookie-grams/day with 55% added fine bran containing 64% total fiber, 4% protein, 2% fat and 2% ash). According to the FDA (21 CFR 101.9) the caloric daily value depends on each adult (2,500 kcal to 2,000 kcal) including from about 30 to 25 grams of dietary fiber (food-guide pyramid: 6 to 11 grains-servings/day: DHHS/USDA-Dietary guidelines, 1995). Furthermore, a lower consumption of energy-dense foods (high-fat/protein and high-sugar or high-starch) and soft-drinks (high-free sugar) will also reduce the total daily calories to maintain a healthy-weight.

In this method, the novel physicochemical precooking results in a reduction of 50% to 70% in wastewater solids (0.5% to about 0.7%) with correspondingly lower sewage costs, as compared to the industrial methods (1.5%-2.5%). The bisulfite and sulfite ions in the processing aid solution aids in preventing undesired spore-forming bacterial growth and browning-pigment reactions during the precooked-corn preconditioning. The low-temperature precooking (75°C-90°C)

using a sulfites solution (0.05%-0.15%) not only aids in hydrolyzing the insoluble fiber, starch and protein but also improves its bran removal for integral flour. It also dissolves bran, endosperm and germ components without using a low-lime (U.S. Patent Nos. 6,344,228, 6,387,437 and 6,428,828) or a high-sulfite concentration (U.S. Pat. No. 6,322,836 and WO 2004/023892).

There is furthermore a higher than 90% yield of ultrafine and fine corn flours per kilogram of cleaned corn, the meal and flour produced by corn dry-milling obtains only a 65% to 70% yield, or a 80% to 85% yield for an integral arepa flour (U.S. Pat. No. 6,326,045).

From the foregoing, it will be apparent that it is possible to manufacture pregelatinized corn flours with a novel continuous process which is efficient because of sulfites corn-precooking and centrifugal air-separation yielding ultrafine flour for dairy-based and fine flour for cereal-based foods, wherein some of the nutrients and solid losses that would have been present but for the features of this invention are prevented.

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.

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CLAIMS:

1. A physicochemical process for the production of pregelatinized corn flours for various food products, comprising the steps of:

precooking cleaned corn kernel with steam in a sulfiting solution comprising at least one acid component selected from the group consisting of sodium metabisulfite, sodium hydrogen sulfite and sodium sulfite;

washing said sulfite-precooked corn kernel to remove soluble solids into wastewater and stabilizing a moisture content of said precooked corn kernel;

milling said precooked and washed corn kernel and drying said milled corn kernel for partial gelatinization;

cooling and further drying said milled and dried corn kernel with clean air; and

separating said milled corn to recover an ultrafine grind under 60 to 325 mesh to obtain an ultrafine corn flour suitable for dairy-based foods;

wherein the separating step is performed using an air separator.

2. The method of claim 1 wherein said precooking step uses sulfites in an amount of about 0.02% to about 0.15% by weight of the cleaned corn kernel.

3. The method of claim 1, wherein the separating step separates the ultrafine grind from a coarse grind, the ultrafine grind comprising low-fiber endosperm and germ fractions, the coarse grind comprising high-fiber endosperm, germ and bran fractions.

4. The method according to claim 3, comprising the further steps of:
aspirating the coarse grind to remove a light corn bran fraction;
remilling the aspirated coarse grind; and

recycling the aspirated and remilled high-fiber endosperm and germ fractions of the coarse grind.

5. The method according to claim 4, wherein the recycling step comprises sifting the aspirated and remilled coarse grind into a finer fraction, under 45 to 80 mesh, to produce a fine corn flour suitable for cereal-based foods.

6. The method of claim 5, wherein said ultrafine and fine corn flours represent a 91% to 96% yield of the total weight of corn kernel.

7. The method of claim 5, comprising the further step of regrinding the light corn bran fraction produced by the aspirating step under 45 mesh to produce a bran flour.

8. The method of claim 7, wherein said light corn bran fraction comprises about 3% to 8% flour per kilogram of corn kernel.

9. The method according to claim 7, comprising the further step of mixing said fine corn flour with 5% to 10% by weight of said bran flour to produce a whole-corn flour with increased dietary fiber content.

10. The method of claim 9, further comprising the steps of:
admixing said bran flour with 45% to 49% by weight wheat flour, to produce a partial whole-grain flour with decreased total calorie content; and
manufacturing at least one of wheat-based and cereal-based foods using both the partial whole-grain flour and the whole-corn flour.

11. The method of claim 7, further comprising admixing said bran flour with 45% to 49% by weight wheat flour, to produce a partial whole-grain flour with decreased total calorie content.

12. The process of claim 5, comprising the further step of adding lime to the fine corn flour to obtain a masa flour suitable for preparation of corn-based foods.

13. The process of claim 12, wherein the lime represents about 0.05% to about 0.15% of the fine corn flour by weight, and comprising the further step of rehydrating said fine corn flour and masa flour with warm water from a 1:1 to about 1:1.3 weight ratio to form a corn and masa dough.

14. The method in accordance with claim 1, further comprising mixing said ultrafine corn flour with one of hot water and milk to form a flour dispersion from about 0.1% to about 10% solids.

15. The method of claim 14, comprising the further step of using the flour dispersion as a processing aid for making at least one of cheese, cheese-spread, sour-cream, yogurt, cottage cheese-dressing and ice cream mix.

16. The method of claim 15 wherein said flour dispersion is heat treated at a temperature from about 60°C to about 85°C for 10 minutes to about 30 minutes.

17. The method according to claim 16 wherein said heated dispersion is added to the starting whole milk in order to obtain from about 0.10% to 0.6% flour solids.

18. The method of claim 17, wherein an increased cheese-yield from about 3% to 15% is effected with the adjuvant.

19. The method of claim 15 wherein said flour dispersion is added to pre-pasteurized skim milk in order to achieve from about 1% to 5% flour solids.

20. The method of claim 19, wherein a reduced-fat content is obtained from about 30% to about 70% in cheese-spread and dairy foods with the processing aid acting as a fat and protein substitute.

21. The method of claim 1, wherein the separating step is performed using a centrifugal air separator.

22. The method of claim 21, wherein the centrifugal air separator is constructed and arranged to isolate the ultrafine grind by producing an environment in which the particles of the ultrafine grind are affected more by drag forces created within the centrifugal air separator than by gravity.

23. A physicochemical process for the production of pregelatinized corn flours for various food products, comprising the steps of:

precooking cleaned corn kernel with steam in a sulfiting solution comprising at least one acid component selected from the group consisting of sodium metabisulfite, sodium hydrogen sulfite and sodium sulfite;

washing said sulfite-precooked corn kernel to remove soluble solids into wastewater and stabilizing a moisture content of said precooked corn kernel;

milling said precooked and washed corn kernel and drying said milled corn kernel for partial gelatinization;

cooling and further drying said milled and dried corn kernel with clean air;

separating said milled corn to recover a coarse grind;
aspirating and remilling said coarse grind; and
sifting said aspirated and remilled coarse grind into a finer fraction, under 45 to 80 mesh, to produce a fine corn flour suitable for cereal-based foods;
wherein the separating step is performed using an air separator.

24. The process of claim 23, wherein the step of aspirating the coarse grind removes a light corn bran fraction, and comprising the further step of regrinding the light corn bran fraction under 45 mesh to produce a bran flour.

25. The process of claim 24, comprising the further step of mixing said fine corn flour with 5% to 10% by weight of said bran flour to produce a whole-corn flour with increased dietary fiber content.

26. The method of claim 24, further comprising admixing said bran flour with 45% to 49% by weight wheat flour, to produce a partial whole-grain flour with decreased total calorie content.

27. The process of claim 23, comprising the further step of adding lime to the fine corn flour to obtain a masa flour suitable for preparation of corn-based foods.

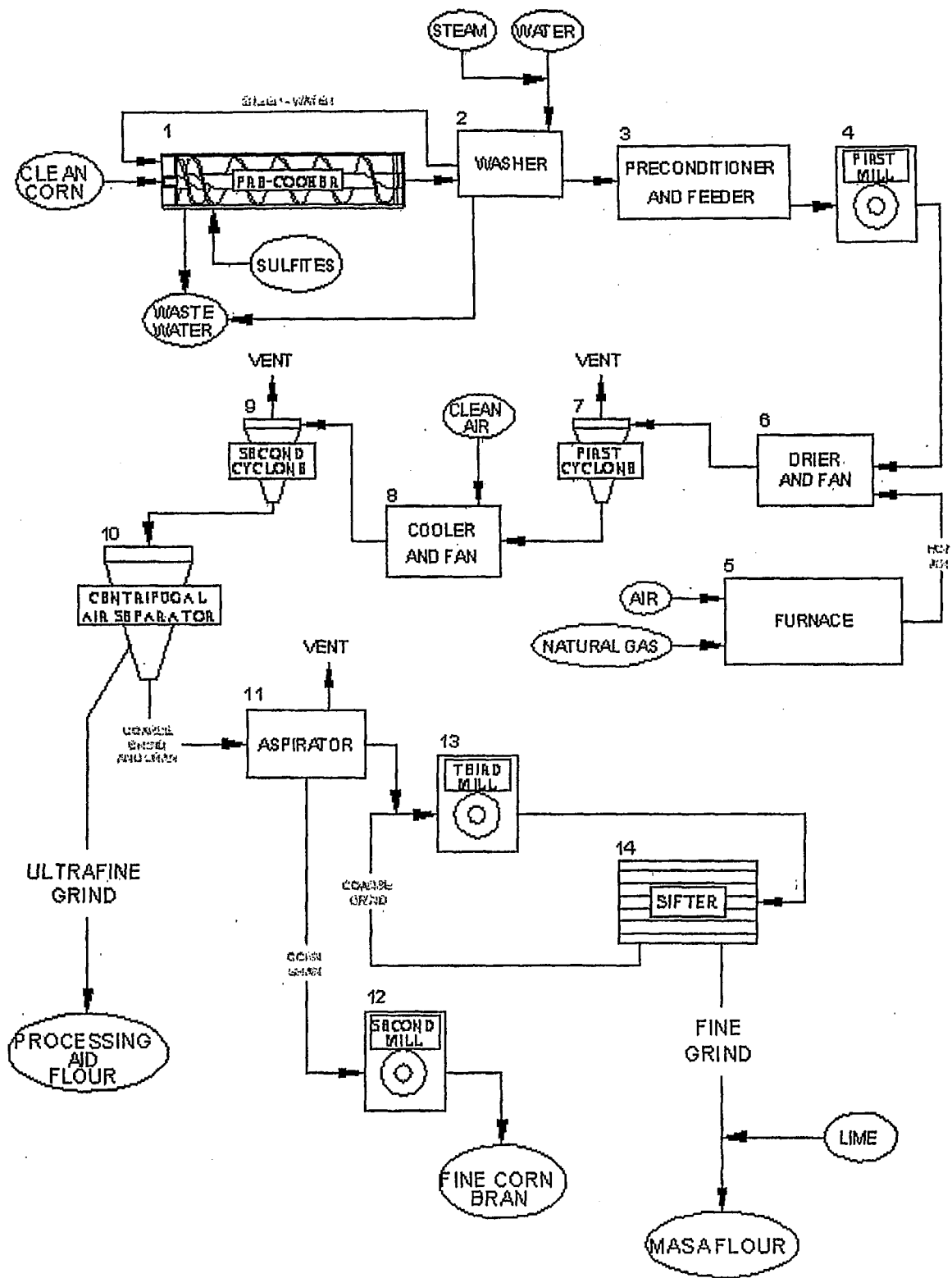
28. The process of claim 27, wherein the lime represents about 0.05% to about 0.15% of the fine corn flour by weight, and comprising the further step of rehydrating said fine corn flour and masa flour with warm water from a 1:1 to about 1:1.3 weight ratio to form a corn and masa dough.

29. The method of claim 23, wherein the separating step is performed using a centrifugal air separator. 7

30. The method of claim 29, wherein the centrifugal air separator is constructed and arranged to isolate the fine corn flour producing an environment in which the particles of the fine corn flour are affected more by gravity than by drag forces created within the centrifugal air separator.

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FIG. 1



PRODUCCIÓN CONTINUA DE HARINAS DE MAÍZ PRE-GELATINIZADO PARA ALIMENTOS A BASE DE LÁCTEOS Y A BASE DE CEREALES

ANTECEDENTES DE LA INVENCION

1. Campo de la invención

La presente invención se refiere a un proceso de precocción ácida para la producción de harinas de maíz pregelatinizado y, más particularmente, a uno que logre una hidrólisis parcial continua de fibra insoluble y evite la pregelatinización y desnaturalización excesiva con un agente reductor sulfitante como auxiliar de procesamiento de alimentos, utilizado durante la fabricación de harina fina y ultrafina de maíz para la elaboración de alimentos a base de lácteos y a base de cereales.

2. Descripción del Arte Relacionado

La producción de harinas de maíz y masa de alta calidad puede lograrse por técnicas convencionales sólo si el maíz de grado alimenticio tiene las siguientes características: Uniformidad y dureza en el tamaño de grano, un bajo número de fisuras por tensión y daño del grano, y facilidad de eliminación del pericarpio durante el proceso de cocción con cal y agua. Las cinco clases generales de maíz – duro, de palomitas, de harina, dentado y dulce – se basan en las características del grano. Puesto que el maíz dentado es un derivado de cruces de maíz duro-maíz de harina, puede exhibir diferencias significativas en la relación de endospermo córneo a harinoso, causadas por el genotipo y factores ambientales. La relación de endospermo córneo (duro y translúcido) a harinoso (blando y opaco) puede variar alrededor de 2:1 en el maíz dentado. Se sabe que el maíz de grado alimenticio (U.S. No. 2: USFGC, 1996) debe cocerse parcialmente antes de transformarse en los productos finales, con el fin de convertirlo en una harina de maíz precocido. El



maíz de grano blanco puede contener: 11.0-11.5% de humedad, 72.2-73.2% de polisacáridos de almidón/distintos de almidón, 9.8-10.5% de proteína, 3.7-4.6% de grasa y 1.1- 1.7% de cenizas. Por ejemplo, una muestra de maíz molido en seco podría proporcionar, sobre una base en peso seco, 74.8-76.2% de endospermo total, 18.9-20.5% de germen y 3.3-6.3% de salvado. El grano dentado maduro (Watson, 1987; FAO, 1993) tiene cuatro componentes separables, sobre una base en peso seco: casquete de la punta (0.8-1.1%), pericarpio (5.1-5.7%) y aleurona (2.0-3.0%), endospermo (78.3-81.9%), y germen (10.2-11.9%). En procesos de molienda en seco o en húmedo, el salvado separado incluye el pericarpio, el casquete de la punta, la capa de aleurona (aislada con el salvado) y también porciones de endospermo amiláceo. Un salvado de maíz nativo contenía algo de almidón (4-22%) y proteínas (5-8%) resultantes del tejido de endospermo, al igual que glucoproteína (Saulnier et al. 1995 y Hromadkova et al. 1995). En el proceso de molienda en seco, el producto primario son porciones aisladas de endospermo córneo y harinoso, que se recuperan mediante molienda progresiva, cernido (o clasificación) y un proceso de aspiración. Para recuperar almidón mediante molienda en húmedo, los gránulos en las células del endospermo tienen que liberarse de la matriz proteínica (gluten) tratando el maíz (o endospermo) con un agente alcalino o reductor (preferiblemente dióxido de azufre) en un proceso de remojo.

La harina de maíz nixtamalizado (NCF, por sus siglas en inglés) se produce mediante los pasos de cocción alcalina (calentamiento y remojo) del maíz, lavado, molienda del nixtamal, y secado, produciendo así harina de masa de maíz. Esta harina precocida se cierne y se mezcla para diferentes aplicaciones de productos y, usualmente, se suplementa con aditivos antes de empacarla para elaborar alimentos comerciales a base de maíz para consumo en la mesa o como tortillas empacadas. Aunque el pericarpio o salvado se eliminan parcialmente durante los pasos del proceso

de cocción alcalina y lavado, queda todavía un residuo de fibra del grano de maíz (Patente de los Estados Unidos 4,513,018).

La industria molinera de trigo y harina de masa de México suscribió un convenio federal en 1999 para agregar micronutrientes a las harinas de dieta básica, tales como maíz nixtamalizado para tortillas, y harinas de trigo para pan y tortillas de harina. Alrededor del 66% de las marcas de harina de trigo se enriquecen con óxido de hierro ("*ferrous-iron*") y ácido fólico, en tanto que toda la harina de masa se enriquece adicionalmente (representando por lo menos 30% del consumo de tortillas) con hierro reducido, zinc y vitaminas de complejo B.

Existen marcadas diferencias entre las tortillas de maíz versus la tortilla y pan de trigo en relación con: su composición fisico-química de la harina, ingredientes, elaboración de la masa y proceso de horneado. Los productos a base de cereales utilizan una harina de trigo de la que se han eliminado el salvado y germen (ingrediente de formación). La masa usada para elaborar pan y productos similares contiene más ingredientes que la masa de la tortilla de maíz. Los ejemplos incluyen modificadores de textura (manteca vegetal, sal y azúcar/jarabe), agentes leudantes (bicarbonato de sodio y/o levadura) y agentes caracterizantes (sabor/especias, gomas y aditivos antimicrobianos). Los ingredientes básicos para tortilla de maíz incluyen una harina de maíz entero nixtamalizado o precocido con cal, con agua y aditivos funcionales y antimicrobianos, que pueden mezclarse antes de la elaboración de la masa para horneado y empaçado (Patente de los Estados Unidos 3,730,732).

La mayor parte de las pérdidas de micronutrientes ocurre durante la molienda, que es uno de los pasos previos en el proceso de refinación. Durante la trituración, se eliminan las capas de germen y salvado, y el endospermo amiláceo restante, que contiene pocos compuestos antioxidantes, se transforma en harina para preparar alimentos a base de cereales (pan y tortillas). Los productos de grano entero retienen el germen y el salvado, que proporcionan ácidos fenólicos (ferúlico/diferúlico, p-cumárico y vainíllico) y ácido fítico, que pueden actuar independiente o

sinérgicamente con fibra dietética (heteroxilana) para reducir el riesgo de arteriopatía coronaria, cáncer de colon y diabetes tipo 2 (resistencia a la insulina). Alrededor del 69% de los fenólicos totales presentes en el maíz son formas ligadas insolubles (β -glucósidos), siendo el ácido ferúlico el principal compuesto. Oligosacáridos tratados con ácido ferúlico de las cadenas laterales de la heteroxilana de maíz pueden aislarse mediante hidrólisis ácida o solubilizarse como ésteres de azúcares de ácido ferúlico, luego del tratamiento térmico de maíz dulce (115°C y 25 minutos tienen el efecto de elevar los fenólicos totales en 54%) y tener un mejor efecto supresor sobre la oxidación de lipoproteína de baja densidad que el ácido ferúlico libre. Consumir el mínimo recomendado de tres porciones de granos enteros al día aumentaría la ingesta de antioxidantes y fibra dietética y reduciría el riesgo de cardiopatía en 25-36% (Decker et al. 2002). Los principales cultivos de granos producidos en el mundo son trigo, arroz y maíz.

Nuevos alimentos horneados que contienen granos enteros pueden calificar para portar etiquetas con las siguientes referencias a cualidades terapéuticas o similares: a) "El desarrollo del cáncer depende de muchos factores. Consumir una dieta baja en grasa y con alta en granos, frutas y vegetales con contenido de fibra dietética puede reducir su riesgo de algunos tipos de cáncer" (21 CFR 101.76); y b) "El desarrollo de cardiopatías depende de muchos factores. Consumir una dieta baja en grasa saturada y colesterol y alta en frutas, vegetales y granos con contenido de fibra, puede reducir los niveles de colesterol en la sangre y disminuir su riesgo de cardiopatía" (21 CFR 101.77 y 81; FDA/DHHS, 2004).

De acuerdo con las tendencias actuales la obesidad se convertirá en la primera causa de muerte hacia el 2005 rivalizando con las muertes anuales por cáncer. Enfermedades de sobrepeso y obesidad se asocian con diabetes tipo 2, hipertensión, hipercolesterolemia, asma, artritis, y una salud deficiente. Algunos individuos se beneficiarán más de una dieta muy baja en grasa y una dieta alta en carbohidratos, mientras que otros pueden responder a una ingesta baja en carbohidratos (Atkins Foundation, 2005).

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La Organización Mundial de la Salud (OMS) (DHHS, 2003) considera que las dietas poco sanas y la inactividad física son las causas principales de las enfermedades crónicas más importantes, constituyendo el 60% de las muertes y el 47% de las enfermedades en todo el mundo. Estos problemas no se restringen a los países ricos, sino que ganan terreno rápidamente en el mundo en desarrollo, particularmente entre la población joven.

Un informe de la OMS (2003) (Prevención integral de enfermedades cardiovasculares no transmisibles, diabetes tipo 2 y ciertos tipos de cáncer: Borrador Estrategia Global sobre la Dieta, la Actividad Física y la Salud) recomendaba una dieta que limitaba la grasa a una cifra entre 15% a 30% de la ingesta total de energía y las grasas saturadas a menos del 10%. Los carbohidratos (granos enteros) deben corresponder a los requerimientos generales – entre 55% y 75% – pero los azúcares libres deben estar por debajo del 10%. La ingesta de proteína debe permanecer a alrededor de 10% a 15%. La mayoría de las enfermedades es causada por un estilo de vida y una dieta incorrectos. Los hábitos actuales de alimentación enferman y debilitan a las personas, acortan su esperanza de vida, y deterioran la salud mental y espiritual (Conócete a ti mismo – la prevención es mejor que la curación y salud es riqueza: SSSB, 1995).

Las paredes celulares de polisacáridos no amiláceos (NSP, por sus siglas en inglés) son los principales componentes de la fibra dietética del maíz y se componen de hemicelulosa (heteroxilana o pentosana y β -glucana: 4.4-6.2%), celulosa (2.5-3.3%) y algo de lignina (0.2%). De acuerdo con Watson (1987: Tablas IV y VII), el pericarpio/casquete de la punta del maíz constituye el 6-7% y la aleurona-endosperma tiene alrededor del 2-3% del peso seco del grano. Este pericarpio contiene además 90% de fibra insoluble (67% de hemicelulosa y 23% celulosa) y únicamente 0.6% de fibra soluble (arabinoxilana soluble y β -glucana). Se calcula que la fibra dietética en el salvado (4.9%) y el endospermo (2.6%) constituyen el 80% de la fibra dietética total. La fibra insoluble del maíz se encuentra principalmente en el salvado y el endospermo (aleurona y amiláceo), que

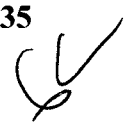
conforman hasta el 68% de la fibra dietética total (9.5% sobre una base de peso seco).

Todas las capas de salvado del maíz comprenden las paredes celulares externas (velo o cáscara), internas (células tubulares y cruzadas), de la nucela y el endospermo (aleurona y amiláceas). A diferencia del endospermo del maíz (sémola de maíz), en el cual la fibra soluble asciende a 12% de la fibra total (4.1%), en el trigo entero la fibra soluble representa 22% de la fibra total (alrededor del 20% de la absorción de agua de la harina se liga a la fracción pentosana soluble). El polímero heteroxilana se enlaza aparentemente al esqueleto de celulosa en la pared celular del maíz mediante enlazamiento cruzado del enlace éster a través del ácido ferúlico (3.1% ó 31.000 ppm peso seco) y diferúlico (0.5%). No obstante, la insolubilidad de la heteroxilana en el salvado del maíz podría deberse a los enlaces proteína-polisacárido (glucoproteína del pericarpio) y a una estructura altamente ramificada (23% lineal), por contraposición al salvado de trigo (Saulnier et al. 1995). En los Estados Unidos, el uso de esteroides en aceites vegetales, margarinas y cremas para untar, yogur, pasabocas, aderezos para ensaladas, suplementos dietéticos y bebidas saludables ha recibido por parte de la FDA la calificación GRAS (reconocido generalmente como seguro). Por lo menos 0.65 gramos de ésteres de esteroles (0.4 gramos de esteroides libres) y 1.7 gramos de ésteres de estanol por porción (50 gramos) pueden incluir referencia a cualidades terapéuticas en el sentido de que el consumo de fitoesteroides (subproductos de aceites vegetales) puede reducir el colesterol y la cardiopatía coronaria. Un salvado de maíz industrial tratado con cal (Maseca®) contenía 4-5% de extracto de alcohol-tolueno (materia no saponificable) con un contenido total de esteroides de 860-900 ppm (Directiva GRAS - 61, 2000) y esto representa alrededor del 50% de un contenido de germen de maíz molido en seco (Arbokem - Canadá, 2000). Los alimentos funcionales, que pueden conocerse como alimentos saludables ("*designer foods*") o alimentos medicinales, se definen como alimentos procesados con contenido de ingredientes que contribuyen a funciones corporales específicas, además de

ser nutritivos. Los vendedores de suplementos o coadyuvantes dietéticos que quieren comercializar un "ingrediente dietético nuevo" tienen que dar aviso por anticipado a la FDA de sus planes y aportar evidencia de que el producto es seguro; pero, en la mayoría de los casos, éstos no se elaboran con ingredientes dietéticos novedosos. Cuando un fabricante quiere hacer una referencia a cualidades terapéuticas en una etiqueta sobre la estructura o función del organismo, entonces éstas requieren evidencia científica de una referencia a cualidades terapéuticas.

Durante la cocción alcalina y/o remojo, surgen cambios químicos y físicos tales como pérdidas de nutrientes junto con la eliminación parcial del pericarpio o salvado, degradación de la periferia del endospermo con gelatinización/hinchamiento del almidón y desnaturalización de proteínas en el grano de maíz precocido. Las modificaciones nutricionales más importantes son: Un aumento en el nivel de calcio con una mejora en la relación de Ca a P; una disminución en fibra dietética insoluble y zeína-proteína; una reducción en tiamina y riboflavina; una mejora de la relación de leucina a isoleucina, reducción del requerimiento de niacina; liberación de niacina del pericarpio/aleurona/endosperma; y lixiviación de ácido ferúlico (Sánchez, Ramírez y Contreras, 2005), insecticidas, fungicidas y micotoxinas residuales el agua de remojo alcalina o "nejayote" (FAO, 1993 y Sustain, 1997).

En una operación comercial, los sólidos de maíz se calcularon en 5-14% dependiendo del tipo de maíz (duro o blando) y de la intensidad de la cocción y el proceso de lavado y secado. La calidad de la tortilla no se relacionó directamente con la pérdida de sólidos (eliminación del salvado), y tortillas aceptables tuvieron < 4% de pérdida. La harina de maíz o masa industrial adecuadamente procesada simplifica la producción de productos de tortilla, porque el comprador elimina las técnicas de manejo requeridas para el tratamiento de aguas residuales, de seguridad, manejo y procesamiento del maíz en masa para tortillas y pasabocas. Sin embargo, una harina de maíz pregelatinizado podría tener las siguientes limitaciones de calidad y costo: Costos elevados, falta de sabor y escasa textura en



pasabocas a base de cereales o raviolis de harina de maíz, preparados de harinas de maíz nixtamalizado (Patente de los Estados Unidos 6,491,959 y Erempoc et al. 1997).

Los alimentos cereales de tercera generación (3G) incluyen los pasos de cocción por extrusión, seguida por enfriamiento, retención y secamiento para fabricar "gránulos de cereal" que se expanden friéndolos u horneándolos para elaborar productos alimenticios a base de maíz nixtamalizado (pasabocas novedosos a base de masa en la Patente de los Estados Unidos 5,120,559 y pasabocas que reducen la hipercolesterolemia en U.S. 20040086547). Otro ejemplo lo constituyen los cereales para el desayuno preparados cociendo granos enteros o sémola (trigo, cebada, centeno, avena, arroz o maíz), seguido por enfriamiento, atemperamiento, desmenuzamiento, compactación en "bizcochos" y horneado o tostado de los alimentos a base de cereales (CA 2015149).

Los agentes sulfitantes se han usado en todo el mundo para funciones tecnológicas que incluyen: a) inhibir la oxidación (pardeamiento enzimático) de frutas (frutas secas: <600 ppm)), vegetales (papas deshidratadas: <250 ppm) y bebidas carbonatadas (vino a granel: <350 ppm), b) prevenir la melanosis (pigmentos de melanina) en camarones y langostas, c) favorecer el crecimiento antimicrobiano durante la elaboración del vino (50-100 ppm), d) acondicionar la masa de trigo (reducción de enlaces disulfuro) y e) blanqueo/modificación de almidones alimenticios (FDA 121.1031 con < 500 ppm).

En 1958, cuando se reformó la Ley Federal de Alimentos, Medicamentos y Cosméticos para regular los preservantes y otros aditivos de alimentos, la FDA consideró que los sulfitos (cualquier agente sulfitante: dióxido de azufre, metabisulfito de sodio/potasio, bisulfito de sodio/potasio y sulfito de sodio) debían reconocerse como generalmente seguros (GRAS). Sin embargo, todas las sustancias GRAS producidas mediante ADN recombinante, que se consumieron ampliamente antes de 1958 y que, más tarde, se han modificado e introducido comercialmente, tienen que cumplir con los requerimientos regulatorios propuestos en 21 CFR 170.36

(Directiva GRAS - 60 para bisulfato de potasio cuando se utiliza como auxiliar de procesamiento de alimentos en quesos a < 3 ppm, bebidas alcohólicas a < 140 ppm y mezclas para pasteles a 0.1-1.0%). En 1985, la FDA concluyó que los sulfitos son seguros para la mayoría de las personas, pero plantean un riesgo de gravedad impredecible a los asmáticos y a otras personas que son sensibles o alérgicas (1% en USA) a estos ingredientes. 9

Estos aditivos secundarios, una sub-clase de aditivos directos (21 CFR 172, 170.36 y 101.1), son principalmente auxiliares de procesamiento que se emplean para lograr un efecto técnico durante el procesamiento de alimentos, pero no pretenden servir como aditivos o preservantes funcionales en el alimento terminado, si no está presente una cantidad detectable del agente. Una cantidad detectable de un agente sulfitante es 10 ppm o más del sulfito – en la forma de dióxido de azufre – en el alimento terminado (21 CFR parte 101.1 Alimentos; exenciones a la obligación de etiqueta). Finalmente, el listado de algunos ingredientes alérgenos potenciales (regulaciones de etiquetado de los Estados Unidos en 2005) incluye: Cereales que contienen gluten y sus productos (la enfermedad celíaca provoca una inflamación intestinal crónica que es inducida por prolaminas de los cereales – ricas en prolina y glutamina – de trigo, cebada, centeno y avena); soya y productos de soya; leche y productos lácteos, incluidos lactosa y dióxido de azufre y sulfitos en concentraciones superiores a 10 ppm.

Con el incremento de los costos de la asistencia médica en todo el mundo, especialmente en América del Norte, Japón y Europa (8% del Producto Interno Bruto), el foco se ha desplazado del tratamiento a la prevención. Aproximadamente 11 millones de personas en los Estados Unidos de América sufren de alergias a los alimentos, y en Europa se calcula que el 8% de los niños y el 3% de los adultos están igualmente afectados.

La bioterapia de los trastornos gastrointestinales no se acepta aún en la práctica clínica para tratar las alergias a los alimentos. No obstante, las terapias a base de prebióticos y pro-bióticos pueden tener el potencial para

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el tratamiento de trastornos particulares. Los prebióticos son componentes dietéticos no digeribles que atraviesan el tubo digestivo al colon y selectivamente estimulan la proliferación y/o actividad de poblaciones de bacterias deseables *in situ*. Los pro-bióticos, por otro lado, son microorganismos que se utilizan como suplementos dietéticos con el fin de beneficiar la salud del consumidor, influyendo positivamente en el balance microbiano intestinal. Especies de bacterias de ácido láctico se emplean cada vez más como ingredientes funcionales, particularmente en productos lácteos tales como yogures y leche fermentada. Debido a la sinergia potencial entre prebióticos y pro-bióticos, los alimentos que contienen una combinación de estos ingredientes funcionales se designan a menudo como simbióticos.

Las tortillas son el principal producto de maíz comestible en América del Norte y Centroamérica. Es una tortita delgada, plana, redonda, sin levadura y horneada (pan plano de maíz), elaborada de masa fresca o pasta de maíz, preparada de harina de maíz nixtamalizado (NCF). Debe mencionarse que una tortilla, cuando se elabora manual o mecánicamente y sin aditivos de cualquier clase, tiene una vida útil máxima de 12 horas a temperatura ambiente. Pasado ese tiempo, las tortillas se dañan por la acción de microorganismos contaminantes (bacterias que causan viscosidad y forman esporas) y se endurecen o se enrancian debido a un cambio fisico-químico en el constituyente almidón de las tortillas almacenadas o recalentadas (retrogradación/recocido del almidón). Se sabe que las tortillas, incluso si se mantienen bajo condiciones en las cuales no haya pérdida de humedad (como en una bolsa plástica), se endurecen no obstante con el tiempo y se parten o desmoronan fácilmente si se doblan. La adición de sustancias comestibles solubles en agua (<1%; pH=7.5-9.5) a la masa de maíz tratado con cal retarda notoriamente la descomposición de la tortilla (Patente de los Estados Unidos 3,730,732).

En el norte de Sur América, particularmente en Colombia y Venezuela, el maíz grado alimenticio se procesa con tecnología de molienda en seco sin la generación de aguas residuales y se convierte

posteriormente en una harina precocida, sin germen y sin salvado para alimentos de maíz tradicionales. Su consumo se da principalmente en la forma de una "arepa", que es una tortita gruesa plana o de forma ovoide, sin levadura, y horneada, elaborada de harina de maíz molida en seco. En otros países suramericanos, la comida de maíz (polenta) y la harina de maíz se utilizan para diferentes productos de panadería (empanadas y mezclas de tortitas), bebida hervida de maíz (atole) y pasabocas (FAO, 1993).

Un proceso de molienda húmeda para la producción de almidón implica una fermentación ácida ($\text{pH} < 5$) durante el remojo o humedecimiento de granos enteros contra-corriente (1-2 días a 45-50°C). El efecto técnico o funcional es ablandar el endospermo y romper los enlaces disulfuro que sostienen la matriz proteínica. Implica una operación unitaria limitada de difusión donde se requieren dos auxiliares de procesamiento: con 0.10- 0.25% de dióxido de azufre y 0.50-2.0% de ácido láctico producido usualmente por *Lactobacillus* spp. endógeno o exógeno (Watson, 1987). La microflora de maíz nixtamalizado fermentado puede proporcionar una fermentación espontánea de estado sólido para producir una masa ácida de maíz tal como "pozol" consumido como una bebida hervida de maíz por la población indígena en el sureste de Méjico (Ramírez y Steinkraus, 1986). *Lactobacilos* identificados en la masa nixtamalizada fermentada en laboratorio ($\text{pH} < 4$) fueron *L. plantarum*, *L. fermentum* y *Pediococcus* spp. (Sefa-Dedeh et al. 2003). El principal resultado de la fermentación láctica es una dispersión de proteína/zeína del endospermo y una mejora de la liberación de almidón durante la molienda subsiguiente para bebidas hervidas/potajes de maíz ácidos-fermentados tales como: kenkey de Ghana, ogi de Nigeria (industrial), uji de Kenia y mahew de Sur África (Steinkraus, 2004). Masas ácidas secas novedosas o ingredientes o composiciones fermentados a base de cereales (que contienen trigo, avena, cebada, centeno y arroz) se han innovado con iniciadores comerciales de ácido láctico para productos tales como pan de trigo/centeno (DE 4308707) y galletas crocantes a base de trigo (Patente de los Estados Unidos

6,649,197) o alimentos de leche fermentada baja en grasa (EP 0663153) y cremas lácteas para untar, bajas en grasa (WO 9808400).

Otros materiales no fermentados tales como almidón de papa, almidones pregelatinizados y harinas, gomas vegetales y fibras a base de granos se utilizan igualmente para aglutinar y reducir la migración del agua en los productos lácteos. Una preparación comercial a base de goma (0.15-0.25%), agregada antes de la pasteurización para la fabricación de queso, produjo un mayor rendimiento con características adicionales deseables de textura y organolépticas (NZ 507104). Asimismo, se empleó una goma microbiana (<1%-3%) para recuperar proteína láctea de precipitado de suero de queso, y proteína-goma se utilizaron como aditivo de alimentos (EP 0471408). Por último, se han diseñado almidones físicamente modificados/pregelatinizados o ingredientes a base de cereales, basándose también en sus propiedades técnicas o de los auxiliares de procesamiento (Patentes de los Estados Unidos No. 5,061,104 y 6,861,081). Por materiales coadyuvantes o auxiliares para el procesamiento de alimentos, tal como se emplean en esta solicitud, se dan a entender los materiales y sustancias seleccionados del grupo conformado por cereal, almidón, harina vegetal, harina de soya; gomas comestibles, pectinas, hidrocoloides y fibras dietéticas; o mezclas de los mismos. El tamaño del gránulo es una propiedad característica de los almidones comerciales de trigo, papa y maíz. Se informa que la menor granulometría tiene una mejor absorción de agua y susceptibilidad enzimática durante el procesamiento de alimentos. Puede emplearse igualmente como sustituto potencial de grasa en productos alimenticios, debido a una capacidad de proporcionar una textura similar a la grasa o tacto en la boca, e incrementar la retención de humedad durante el procesamiento de productos a base de cereales y lácteos.

La clasificación es la separación de un material particulado en una fracción gruesa y fina. En la producción de harina, la separación se ha realizado siempre por tamaño. En varias etapas de la producción, la harina se cierne usando una abertura de malla de un tamaño que sólo permite el paso de partículas de un tamaño máximo predeterminado. Hasta ahora, la

separación de la harina por tamaño únicamente ha sido adecuada para la producción de harina.

Otras industrias, distintas de la de alimentos, han empleado históricamente diferentes mecanismos para clasificar material particulado, tomando en consideración otras propiedades de las partículas, tales como la densidad. Por ejemplo, la densidad es insignificante cuando se utilizan tamices o cernidores, pero es un factor esencial en los clasificadores centrífugos de aire donde se encuentran implicadas principalmente fuerzas de arrastre de fluidos. Dependiendo del equipo utilizado, la clasificación podría afectarse igualmente por la forma de la partícula y las propiedades eléctricas, magnéticas y superficiales. Se requiere cada vez más energía si se van a producir partículas ultrafinas. Por lo general, con un tamaño decreciente, aumenta también la homogeneidad de las partículas.

Los clasificadores de aire (también llamados separadores de aire) incluyen cualquier gas, pero preferiblemente se emplea aire limpio, y la clasificación en el rango de partículas medio a inferior a micras (1.000 a 0.1 micrones) se efectúa en una corriente de aire, usando una combinación de cualquiera de las siguientes fuerzas: gravedad, arrastre, colisión y centrífuga. Otros mecanismos clasificadores tales como rejillas y tamices/cernidores operaran en el rango de grande a medio (500 mm a 0.15 mm ó 150 μm : Abertura de Malla Estándar 100 Estadounidense). La densidad es insignificante cuando se usan tamices o cernidores, pero es un factor importante en un clasificador de aire donde están implicadas fuerzas de arrastre.

Separadores centrífugos (o ciclones) se usan ampliamente en la industria química/farmacéutica y para la eliminación de materia sólida y líquida (partículas en aerosol o ultrafinas) de corrientes de gas. Los ciclones se consideran equipo de separación, incluso si arrastran una fracción superfina (ultrafina) en el gas de salida, la cual tiene que recuperarse en otro paso de separación – como corriente abajo del ciclón. Los ciclones tienen una eficiencia media de recolección (80-95% para un

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tamaño de 15 a 50 μm : abertura de malla 325) y un rendimiento elevado (Theodore et al. 1976).

El separador Mumford-Moodie, patentado en 1885, es similar al ciclón Sturtevant (Klumpar et al. 1986). Los sólidos se alimentan en una corriente ascendente de aire limpio, utilizando una placa distribuidora rotatoria que imparte una fuerza centrífuga. Las partículas grandes caen dentro de un cono interior (colas o descarga fina); la fracción ultrafina (10 a 420 μm : abertura de malla 40) se arrastra hacia arriba por la acción de una sopladora interior, se separa del aire entre álabes en la sección de expansión del cono exterior y se recoge en su fondo. El aire, separado de los ultrafinos en el cono exterior, se recircula continuamente al distribuidor que dispersa la carga entrante en el aire ascendente. Por lo tanto, el clasificador de corriente ascendente incorpora casi todas las fuerzas claves, mientras que un ciclón utiliza únicamente la fuerza gravitacional/inercia.

La magnitud de estas fuerzas depende en gran medida del diámetro de la partícula, sea a través de su dependencia de la masa de la partícula, o sea a través del coeficiente de arrastre y el área característica. La mayoría de las veces, las partículas grandes se afectan por la gravedad y las fuerzas centrífugas, mientras que las partículas de tamaño intermedio y tamaño pequeño/ultrafinas se verán afectadas en su mayor parte por la fuerza de arrastre aerodinámica. Los clasificadores de aire industriales (centrífugos) son fabricados por Sturtevant Inc., CE. Raymond, Humboldt Wedag, Polysius, Smidth Sepax, Hardinge Gyrotor y Onoda.

Los procesadores de harina de maíz pueden generar valor agregado de sus operaciones industriales en uno de tres enfoques: desarrollar nuevos productos de nuevos híbridos, aumentar el rendimiento de productos tradicionales del maíz y mejorar la eficiencia del proceso con un costo unitario más bajo. En el pasado, esto se ha hecho por métodos y utilizando un aparato en el cual el grano se cuece y/o se remoja en una solución de agua y cal, tales como los divulgados en las Patentes de los Estados Unidos No. 2,584,893, 2,704,257, 3,194,664, y 4,513,018. Estos métodos del arte previo para la producción industrial de harina de masa implican tiempos de

precocción acelerada con cal y de remojo con grandes cantidades de desecho soluble (1.2-2.0% COD: Álvarez y Ramírez, 1995) y pérdida de sólidos de maíz (~1.5-2.5%: 50-60% de fibra dietética, 15-20% de ceniza, 15% de almidón, 5-10% de proteína y < 5% de grasa).

Se han desarrollado muchos y variados métodos para la producción de harina de maíz instantánea para productos alimenticios, que implican cantidades menores de agua con precocción a baja temperatura para un rendimiento elevado del producto final, como se refleja por las siguientes Patentes de los Estados Unidos: 4,594,260, 5,176,931, 5,532,013, 6,387,437 y 6,638,554. En conexión con esto, se hace referencia a las Patentes de los Estados Unidos No. 4,594,260, 5,176,931, 5,532,013, y 6,265,013, que requieren igualmente secamiento a baja temperatura. Por el contrario, las Patentes de los Estados Unidos No. 4,513,018, 5,447,742, 5,558,898, 6,068,873, 6,322,836, y 6,344,228 han utilizado una deshidratación a alta temperatura o cocción rápida en lugar de una cocción a baja temperatura.

Teniendo en mente las desventajas de los métodos del arte previo, varios estudios han empleado no sólo una precocción rápida y a baja temperatura con un mínimo de aguas residuales, sino separan igualmente fracciones de maíz como se refleja por las siguientes Patentes de los Estados Unidos No. 4,594,260, 5,532,013, 6,025,011, 6,068,873, 6,265,013, 6,326,045 y 6,516,710.

Se evaluaron asimismo unas cuantas aplicaciones para el remojo y la precocción ácida para convertir un procedimiento tradicional del maíz en un proceso químico o bioquímico novedoso, con aguas residuales reducidas (Patentes de los Estados Unidos No. 1,045,490 y 6,322,836 o Patente WO 00/45647). Se han publicado tres innovaciones recientes (Patentes WO: 00/45647, 01/98509 y WO 2004/023892 A1) para la preparación de un producto alimenticio de maíz modificado, usando o bien un agente reductor (metabisulfito), o bien una enzima reductasa ácida o hidrosulfito como auxiliares de procesamiento, y agregados durante las etapas de cocción del maíz, de manera que su proteína natural se modifique parcialmente.



Aunque los métodos ya descritos del arte previo están en capacidad de precocer parcialmente el maíz para un producto alimenticio de masa modificada, sémola de maíz y maíz partido, hasta ahora no ha estado disponible en el mercado, al momento de la invención, una aplicación industrial continua, que utilice no sólo una precocción sulfitante sino también un separador centrífugo, lo cual proporciona harinas de maíz finas y ultrafinas para alimentos lácteos y cereales.

SUMARIO Y OBJETOS DE LA INVENCION

En consecuencia, es un objeto de esta invención ofrecer una completa desviación del arte previo y métodos de precocción rápida de procesamiento térmico, mecánico, químico y bioquímico o enzimático de maíz entero, con el fin de controlar la pregelitinización del endospermo amiláceo y la desnaturalización de la proteína, utilizando una precocción con sulfito durante la producción continua de harinas de maíz finas y ultrafinas para productos alimenticios a base de lácteos y a base de cereales.

Es otro objeto de la invención usar un separador de aire centrífugo no sólo para producir continuamente una harina ultrafina, usada como auxiliar de procesamiento de alimentos en alimentos lácteos, sino también para proporcionar una harina fina y una harina de salvado como ingrediente a base de cereal.

Otro objeto es lograr este objetivo utilizando un método y aparato industrial, que implican una precocción ácida con sulfitos para una hidrólisis parcial de las paredes celulares del maíz, almidón y proteínas, junto con una difusión de agua que efectúa una pregelatinización controlada del almidón y una desnaturalización de la proteína, con una pérdida reducida del maíz durante la producción de harinas de maíz pregelatinizado.

Los anteriores y otros objetos y ventajas de la invención se logran mediante un proceso continuo, aplicado a la producción de harinas de maíz pregelatinizado para alimentos a base de lácteos y cereales, cuyas incorporaciones incluyen una precocción con una solución de metabisulfito

de sodio, o bisulfito de sodio o sulfito de sodio como auxiliar de procesamiento, con el fin de efectuar una hidrólisis parcial de fibra insoluble, almidón y proteína junto con una pregelatinización y desnaturalización controladas, lavado reducido del grano y menor pérdida de sólidos en el agua residual, estabilización del contenido de humedad a un nivel óptimo deseado para la triturar, moler y secar el grano pre-acondicionado para producir una cocción parcial uniforme, enfriar y secar posteriormente la partícula molida en seco, separar centrífugamente y recuperar el molido ultrafino así producido del molido más grueso, mientras que el último se aspira de nuevo para eliminar una fracción de salvado de maíz y volver a molerla para producir un salvado fino para harina de grano entero y harina entera parcial, volver a moler el molido más grueso aislado y cernerlo nuevamente para obtener una harina de maíz fina para alimentos a base de cereales, y mezclar únicamente una harina fina con cal para producir una harina de masa para tortilla. Una harina de maíz ultrafina se usa como auxiliar o coadyuvante para los productos alimenticios a base de lácteos.

BREVE DESCRIPCIÓN DE LOS DIBUJOS

La invención se entenderá más completamente con base en la siguiente descripción y del dibujo adjunto, en el cual la figura única describe una incorporación de esta invención en un diagrama de flujo en bloques, que ilustra el proceso continuo e industrial utilizando una precocción ácida con sulfitos como auxiliar de procesamiento, y un separador de aire centrífugo para recuperar un molido de maíz ultrafino de un molido de maíz grueso.

DESCRIPCIÓN DETALLADA DE LAS INCORPORACIONES PREFERIDAS

Con referencia a FIG. 1, se ilustra, en forma de diagrama de flujo, una incorporación de la presente invención. Ésta incluye una unidad de

precocción 1; una unidad de lavado 2; un pre-acondicionador 3 con un alimentador; un molino primario 4; un horno 5; un secador 6 con una sopladora; un primer separador de ciclón 7; un enfriador 8 con una sopladora de aire limpio; un segundo separador de ciclón 9; un separador centrífugo de aire 10 con una sopladora interna; un sistema aspirador 11; un molino secundario 12; un molino terciario 13 y un tamizador 14.

La unidad de precocción 1, cuyo diseño es conocido *per se*, se alimenta con maíz limpio y una solución de metabisulfito de sodio junto con agua de remojo (60°C a 70°C) reciclada de la unidad de lavado 2 para formar una suspensión acuosa sulfitante (relación de maíz a agua de alrededor de 1:1 a alrededor de 1:1.5). El contenido de sólidos de la solución ácida se regula en el rango desde alrededor de 0.5% a alrededor de 0.7%. Controlando el calentamiento con vapor y el tiempo de permanencia del grano, es posible precocer maíz bajo presión atmosférica. La suspensión de maíz se calienta con vapor saturado a una temperatura desde alrededor de 75° a alrededor de 90° C durante un período de 25 a 45 minutos. Esto permite que el grano precocido con sulfitante se produzca con contenidos de humedad de entre 32% y 35%, mientras que el pH se reduce a alrededor de 6.2 a alrededor de 6.7 con la adición de una solución sulfitante ácida al 10% para proporcionar un auxiliar de procesamiento 0.05% a 0.15% en peso (basada en el maíz).

La unidad de precocido con la solución de sulfitos ocasiona una hidrólisis parcial de fibra, almidón y proteína que promueve una difusión rápida y uniforme del agua de cocción a través del extremo base del casquete de la punta, se desplaza a través de las paredes celulares del pericarpio hasta la corona del grano, y luego desciende a los componentes del endospermo y el germen. El vapor saturado y la solución de sulfitos realizan también una solubilización, pregelatinización e hinchamiento controlados en el grano de maíz, permitiendo una reducción de los sólidos de desecho del orden del 60% al 70%, así como una disminución del 10% al 20% del agua residual efluente (con un menor costo de alcantarillado), comparado con el proceso de cocción con álcali (Álvarez y Ramírez, 1995).

Esta disminución del agua residual en la unidad de precocción puede reemplazarse con el agua de remojo reciclada de la unidad de lavado 2.

La suspensión de maíz parcialmente precocido se pasa entonces a la unidad de lavado 2 donde se rocía con agua calentada con vapor a una temperatura de alrededor de 60° a alrededor de 70°C durante 30 a 60 segundos, lo cual sirve también para aumentar la absorción de agua y eliminar por lavado en el agua residual el auxiliar sulfitante y los sólidos solubles.

El maíz precocido y lavado se pasa seguidamente a un pre-acondicionador 3, en donde el grano precocido se equilibra para obtener un contenido de humedad residual de alrededor de 34% a alrededor de 37% durante alrededor de 210 a alrededor de 340 minutos.

A continuación, el maíz pre-acondicionado y lavado se alimenta a través de un alimentador a un molino primario 4, cuyo diseño es conocido *per se*, de modo que el maíz premolido y el aire caliente proveniente de un horno 5, se mezcle y se precueza por un secador industrial 6, cuyo diseño es conocido *per se*. El grano premolido se seca así en forma instantánea a una temperatura elevada desde 190°C a alrededor de 230°C durante un tiempo corto de 10 segundos a alrededor de 30 segundos. Su endospermo amiláceo se gelatiniza parcialmente para proporcionar un contenido de humedad del 16% a alrededor del 18%, dependiendo de la granulación que se está produciendo.

Aire caliente cargado de humedad (130°C a 180°C, y 11% a 13% de humedad) se extrae con un primer separador de ciclón 7, cuyo diseño es conocido *per se*, de modo que la extracción adicional de humedad puede tener lugar impeliendo el material del secador a través de un enfriador 8 con aire limpio aspirado por una sopladora asociada, disminuyendo así aún más el contenido de humedad desde 16-18% a alrededor de 9-12% (similar al maíz que entra).

Luego de la extracción adicional de aire caliente cargado de humedad (100°C a 110°C) con un segundo separador de ciclón 9, la partícula o molido seco precocido se dirige a un separador centrífugo de aire 10 con

una sopladora interna especialmente diseñada. La porción de tamaño grande es conocida como el molido grueso, compuesto de fracciones de endospermo, germen y salvado con alto contenido de fibra, mientras que la porción de tamaño pequeño se describe como el molido ultrafino, compuesto de fracciones de endospermo y germen, con bajo contenido de fibra.

A medida que la sopladora centrífuga desplaza hacia arriba el aire ascendente con partículas arrastradas de tamaño pequeño, entonces se separa un molido fino como harina de maíz ultrafina (abertura de malla < 60 a 325), y se separa adicionalmente el molido grueso (abertura de malla < 40 a 80). El molido ultrafino se afectará en su mayor parte por fuerzas de arrastre, mientras que el molido grueso se afectará por las fuerzas de gravedad, centrífugas y de colisión, producidas por la acción de una sopladora interna. Esta harina de maíz ultrafina, con un contenido de humedad entre el 9% al 12%, se produce desde alrededor de 30% a alrededor de 60% del peso total del maíz que entra. Si se desea, la harina de maíz ultrafina puede utilizarse o bien como auxiliar de procesamiento o bien se mezcla con materiales coadyuvantes para alimentos novedosos a base de lácteos.

El último molido grueso se separa luego en un sistema aspirador **11**, cuyo diseño es conocido *per se*, en donde se obtienen dos fracciones, una fracción liviana de salvado que se aísla de una fracción pesada más gruesa que luego se vuelve a moler en un molino terciario **13**. La fracción liviana aspirada se vuelve a moler en un molino secundario **12** como harina de salvado (abertura de malla < 45) para harina de maíz entero y grano entero parcial con un contenido de humedad entre el 9% al 12% (representando desde alrededor de 3% a alrededor de 8% del peso total del maíz que entra). El producto pesado remolido de un molino terciario **13** se envía al tamizador **14** para cernir y producir una harina de maíz fina y homogénea (abertura de malla < 45 a 80) con un contenido de humedad desde alrededor del 9% al 12% (representando un 30% a alrededor de 60% del peso total del maíz que entra). Si se desea, la harina fina de maíz puede mezclarse con cal

de grado alimenticio (0.05%-0.15% en peso basado en la harina pregelatinizada) para producir una harina de masa para elaborar tortillas; de lo contrario, la harina de maíz puede utilizarse como ingrediente a base de cereales para alimentos cereales.

La siguiente Tabla presenta una composición nutritiva promedio de harinas de maíz pregelatinizado para alimentos a base de lácteos (ultrafina: abertura de malla < 60-325) y cereales (fina: abertura de malla < 45-80 y salvado: abertura de malla < 45):

Contenido Nutricional (g/100 g): Harinas Pregelatinizadas			
Nutriente	Ultrafina-de maíz	Fina-de maíz	Salvado
Agua	11.0	11.0	11.0
Proteína	7.7	8.4	4.0
Grasa	5.2	3.7	1.4
Ceniza	1.5	1.2	2.5
Calcio	0.033	0.022	0.015
Fibra Dietética	3.7	5.2	63.2
Fibra Cruda	0.7	1.2	13.6
Almidón	70.9	70.5	17.9
Total Calorías:	350	340	95

Las harinas finas y ultrafinas contienen partículas de endospermo con bajo contenido de fibra o alto contenido de fibra con fracciones de germen, mientras que la harina de salvado incluye principalmente un pericarpio con fracciones de endospermo amiláceo. En consecuencia, las fracciones de maíz pregelatinizado, producidas por el presente método tienen un valor nutricional más alto, comparado con los métodos convencionales, con una composición de grasa (>140%), fibra dietética (20%) y proteína (10%) más altas que las harinas industriales de maíz molidas en seco (harina gruesa/fina) (INCAP, 1961).



EJEMPLO 1

Preparación de alimentos a base de lácteos usando una harina de maíz ultrafina (partículas con fracciones de endospermo y germen con bajo contenido de fibra) como auxiliar de procesamiento.

1) Para uso durante el procesamiento de queso: Preparar un dispersión al 10% mezclando 4.5 kilos de auxiliar de procesamiento o harina de maíz coadyuvante (que contiene alrededor de 5% de grasa y alrededor de 4% de fibra dietética) en 40 kilos de agua caliente o leche entera caliente (desde 3.0% a alrededor de 3.3% de grasa) con mezclado continuo (un mezclador triple o cuerno de leche en polvo proporciona un mezclado adecuado). Mezclar hasta que la dispersión de harina ultrafina sea suave y homogénea en apariencia. Ajustar una temperatura de calentamiento desde 60°C a alrededor de 85°C durante 10 minutos a alrededor de 30 minutos. Enfriar a 30°-32°C y agregar una dispersión de harina 2.5% enfriada a la tina de leche para queso, con el fin de obtener desde alrededor de 0.10% a alrededor de 0.25% de sólidos de harina en la tina de leche (200 kilos por lote). Seguir los procedimientos de fabricación estándar para productos alimenticios de queso duro (cheddar) o blando (mozzarella, queso fresco y queso proceso para untar) (Food Processing Center-pilot plant, University of Nebraska-Lincoln, 2004). La adición de esta dispersión de harina de maíz ultrafina en lugar de usar otros hidrocolides dispersantes resultó en un rendimiento mayor de queso desde alrededor de 3% a alrededor de 15% tanto en sólidos totales como en humedad.

Si se preparan otros productos de queso de cultivo, se requiere una adición más alta para lograr 0.25% a alrededor de 0.6% de sólido de harina. Se lograron un mayor desarrollo ácido y solidez cuando se aplicó como auxiliar o coadyuvante harina de maíz con el sistema de cultivo iniciador. Estos quesos americanos (duros) e italianos (blandos) tendrán una recuperación de suero más alta (desde 1% a alrededor de 2%) que los divulgados donde la extracción de sólidos de suero se ha practicado de manera tradicional. Sanchelima International Inc. tiene un proceso

patentado (tratamiento continuo calor-gelatinización) para incorporar una porción de proteínas de suero solubles en la cuajada de queso para italiano fresco y cheddar (~20% a ~13% de rendimiento). Una ganancia en rendimiento real, por oposición a rendimiento de agua, incorporará agua y grasa casi proporcionalmente a la relación inicial de proteína a grasa en la leche entera (desde alrededor de 1.0 a alrededor de 1.2) por cada kilo de suero recuperado. Si se observan todos los procedimientos de producción para producir el mismo tipo de queso, el rendimiento del queso variará de acuerdo con el porcentaje de humedad y proteína-suero precipitados en el producto final. En consecuencia, la harina ultrafina de maíz utilizada como auxiliar durante la fabricación de queso parece mantener la relación proteína total a grasa (desde alrededor de 0.8 a alrededor de 1.1) en una funcionalidad física (efecto de retención de agua y grasa) formándose un solo complejo almidón-proteína por encima de la temperatura de gelatinización/gelación (desde alrededor de 60° a 85°C durante 10 a 30 minutos) de este gel de aglutinación o auxiliar para impartir textura. Sólo unos cuantos polisacáridos (goma de guar, alginato, carragenina, goma xantana y almidón) con unas pocas proteínas (gelatina, globulina de soya, caseína y suero) se han utilizado para formar geles o aditivos de alimentos (Patente de los Estados Unidos No. 4,159,982, EP 0471408 y NZ 507,104).

2) Para uso en quesos y cremas de untar procesados, bajos en grasa: Preparar una dispersión de harina ultrafina al 5% y agregar a la leche descremada iniciadora (desde 1% a alrededor de 2% de grasa) como se explicó anteriormente. Observar los métodos estándar para elaboración de queso procesado y (sic) el auxiliar de procesamiento no sólo redujo el contenido de grasa desde 30% a alrededor de 45%, sino que actuó además como un sustituto/mimético de la grasa y un sustituto/extensor de proteína. Más aún, se mejoraron la textura y la apariencia en la matriz del queso y una menor separación de grasa.

3) Para uso en alimentos lácteos bajos en grasa. Preparar una dispersión de harina ultrafina de 1% a 5% y agregar a la leche descremada pre-pasteurizada como se describe anteriormente. Aplicar los

procedimientos estándar de fabricación para los siguientes alimentos lácteos:

- a) Crema agria baja en grasa: Se reducen la grasa y las calorías (66%) con un mayor tacto en la boca, textura suave y excelente sabor emulsionado. Se redujeron igualmente las deficiencias de sinéresis y viscosidad.
- b) Yogur bajo en grasa: Mayor textura y tacto en la boca con separación reducida del suero en el alimento.
- c) Aderezo de queso blanco grumoso, bajo en grasa: Menor sinéresis del suero, así como formación de viscosidad formación y mejora de la textura similar a un alimento emulsionado y suave con toda su crema (grasa reducida: 50%).
- d) Mezcla de helado/chocolate o vainilla baja en grasa: Las partículas ultrafinas gelatinizadas (con fracciones de endospermo y germen con bajo contenido de fibra, que contienen alrededor de 5% de grasa 3.5 kcal/g) proporcionaron una textura rica/suave a una crema de helado con contenido pleno/bajo de grasa (2.7% de grasa) libre de notas de sabor.

EJEMPLO 2

Preparación de alimentos a base de cereales usando una harina fina de maíz (partículas con fracciones endospermo y germen con alto contenido de fibra) y harina de salvado (partículas con fracciones de endospermo amiláceo y pericarpio) como ingrediente a base de cereales.

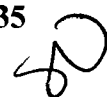
1) Para uso en la fabricación de pasabocas y tortillas novedosos: Cualquiera de las harinas finas de maíz o harinas de masa (con fracciones de endospermo y germen con alto contenido de fibra) elaboradas por el presente método puede rehidratarse con agua caliente en una relación de peso 1:1.0 a alrededor de 1:1.3 para una masa de maíz y pasta de masa (50% a 55% de contenido final de humedad) utilizadas en la preparación de pasabocas industriales y alimentos horneados comerciales a base de tortillas de tercera generación.

Si se prepara una harina integral o de maíz entero para alimentos a base de cereales, entonces alrededor de 5% a alrededor de 10% en peso de



harina de salvado pueden mezclarse uniformemente con una harina fina de maíz o harina de masa con el fin de aumentar su composición de fibra dietética desde alrededor de 3% a alrededor de 6% (con 7% a 9% de fibra dietética como se divulga en harina de maíz nixtamalizado: Patente de los Estados Unidos 6,764,699). Una definición de grano entero AACC (2004) requiere las mismas proporciones relativas de salvado, germen y endospermo que el grano original. Los ingredientes de grano entero pueden utilizarse enteros, cocidos, molidos en la harina y emplearse para elaborar alimentos horneados y otros productos, o extruirse y formarse en hojuelas para preparar cereales para el desayuno. Un desafío es elaborar estos productos en forma más atractiva que los productos de granos refinados y comunicarle a la población general sus atributos más sanos.

La FDA (1999 y 2002) y la AACC - American Association of Cereal Chemists (2003) han reconocido una nueva referencia a propiedades terapéuticas para alimentos de granos enteros y artículos horneados que pueden calificar para portar las siguientes etiquetas: a) alimentos altos en fibra insoluble (hemicelulosa A/C, celulosa, almidón resistente y lignina) y bajos en grasa pueden reducir el riesgo de cáncer colorrectal (21 CFR 101.76) y b) aquellos alimentos altos en fibra soluble (hemicelulosa B ramificada o goma de cáscara de maíz, β -glucana e hidrocoloide) y bajos en grasa/colesterol pueden reducir igualmente el colesterol y disminuir el riesgo de cardiopatía (21 CFR 101.77 y 81). Los productos a base de cereales y los alimentos funcionales pueden llevar además a una reducción del riesgo de enfermedad crónica o a un estado mejorado de salud corporal, por lo cual sus beneficios científicos se comunican al público pueden lograr sus efectos en cantidades que normalmente se esperaría que se consumen en una dieta estándar. Por lo tanto, la industria de alimentos tiene una oportunidad de ofrecer una referencia a cualidades terapéuticas basadas en la función (FDA/DHHS-Food Labeling, 2004: 21 CFR 101.54) más que en los productos, manteniendo al mismo tiempo su vida útil. Se ha pedido a la FDA separar la declaración de fibra dietética de los carbohidratos totales en etiquetas sobre nutrición con el fin de reducir la confusión (Mehta, 2005).



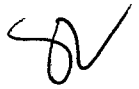
Una referencia en una etiqueta de Mision light ® anunciaba alrededor de 3.2 gramos de fibra dietética/por porción (2 tortillas de maíz ó 23 gramos sobre una base seca), mientras que agregando un ingrediente de fibra GRAS aportaba una tortilla con calorías reducidas en un 25% (tortilla sin grasa). Tres porciones de tortilla con fibra mejorada (elaboradas con harina enriquecida Maseca ®) debían proporcionar alrededor de 30% del valor diario establecido por la FDA (DV). De otro lado, una tortilla de maíz nixtamalizado aportará alrededor de 1.8 a 2.2 gramos de fibra/por porción. Se calcula que el consumo per cápita de tortillas de maíz en Méjico y Centroamérica es de aproximadamente 240 gramos/día (10 tortillas ó 125 gramos de harina) equivalentes a por lo menos un 40% de la ingesta diaria de calorías.

2) Para uso en alimentos de trigo con gluten reducido y calorías reducidas: La harina de salvado o harina fina de maíz obtenidas del proceso ya mencionado puede mezclarse uniformemente con 45% a 49% en peso de harina de trigo con el fin de aumentar su formulación de ingredientes desde alrededor de 3% a alrededor de 30% de contenido de fibra dietética y desde 2% a alrededor de 5% de proteína distinta de gluten, respectivamente. Varios estudios epidemiológicos han definido consistentemente los granos enteros como aquellos productos alimenticios que contienen más del 25% de contenido de grano entero o salvado en peso. Otros productos de granos incluyen pan negro, palomitas de maíz, harina de avena cocida, germen de trigo, salvado, cereales para el desayuno, arroz integral, y trigo integral. En los Estados Unidos de América, sin embargo, la FDA especifica productos de grano entero como aquellos que satisfacen el criterio de 51% de contenido de grano entero en peso (Liu, 2003 y Anderson, 2004). Esta harina con gluten reducido y calorías reducidas puede usarse adicionalmente como un ingrediente a base de cereales durante la fabricación estándar de alimentos a base de trigo tal como: galletas, bizcochos, galletas crocantes, pasabocas (granola o frutas), pan plano, tortillas de harina, buñuelos, pastelitos, empanada, panqueque, trigo integral, bolas de masa y fideos. En consecuencia, una ingesta diaria de

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alimentos a base de cereales y a base de trigo con contenido más alto en polisacáridos distintos a almidón (de harina de salvado que contiene 63% de fibra dietética y 4% de proteína) y endosperma con alto contenido de fibra (de harina fina de maíz que contiene 5% de fibra dietética y 8% de proteína) puede contribuir a una reducción en la ingesta total de calorías (desde 25% a alrededor de 30%) y en una menor medida a un consumo de gluten alérgeno (desde 15% a alrededor de 40%). Salvado de maíz nixtamalizado (Maseca ®) usado en galletas con bajo contenido de gluten/carbohidratos (60% y 15%, respectivamente) no sólo disminuyó el colesterol LDL en conejillos de Indias, sino que redujo también los niveles de colesterol LDL y en el suero en hombres adultos normales (14%) y con hipercolesterolemia (11%) del norte de México. Éstos consumieron galletas de salvado de maíz durante un estudio de 6 semanas (70 gramos de galleta/día con 55% de salvado fino agregado que contenía 64% de fibra total, 4% de proteína, 2% de grasa y 2% de ceniza). De acuerdo con la FDA (21 CFR 101.9), el valor calórico diario depende de cada adulto (2.500 kcal a 2.000 kcal) incluyendo desde alrededor de 30 a 25 gramos de fibra dietética (pirámide de guía de alimentos: porciones de 6 a 11 granos/día: DHHS/USDA-Dietary guidelines, 1995). Más aún, un consumo más bajo de alimentos densos en energía (grasa/proteína alta y azúcar alto o almidón alto) y bebidas sin gas (azúcar libre alto) reducirá igualmente las calorías diarias totales para mantener un peso saludable.

En este método, la precocción fisico-química novedosa resulta en una reducción del 50% al 70% en sólido en aguas residuales (0.5% a alrededor de 0.7%) con costos de alcantarillado correspondientemente menores, comparado con los métodos industriales (1.5%-2.5%). Los iones de sulfito y bisulfito en la solución de auxiliar de procesamiento contribuyen a prevenir el crecimiento bacteriano indeseado de formación de esporas y las reacciones de pardeamiento-pigmentos durante el pre-acondicionamiento del maíz precocido. La precocción a baja temperatura (75°C-90°C) utilizando una solución de sulfitos (0.05%-0.15%) no sólo contribuye a hidrolizar la fibra insoluble, almidón y proteína, sino que también mejora la



eliminación de salvado para la harina integral. Asimismo, disuelve los componentes de salvado, endospermo y germen sin usar una concentración baja en cal (Patentes de los Estados Unidos No. 6,344,228, 6,387,437 y 6,428,828) o una concentración alta en sulfito (Patente de los Estados Unidos No. 6,322,836 y WO 2004/023892).

Existe además un rendimiento superior al 90% de harinas de maíz finas y ultrafinas por kilogramo de maíz limpio; la comida y harina producidas por la molienda en seco del maíz obtiene sólo un rendimiento del 65% al 70%, o un rendimiento del 80% al 85% para una harina de arepa integral (Patente de los Estados Unidos No. 6,326,045).

De lo anterior, será evidente que es posible fabricar harinas de maíz pregelatinizado con un proceso continuo novedoso, que es eficiente en razón de la precocción de maíz con sulfitos y separación centrífuga con aire, que proporciona una harina ultrafina para alimentos a base de lácteos, y harina fina para alimentos a base de cereales, en donde se evitan algunas de las pérdidas de nutrientes y sólidos que se presentarían, a no ser por las características de esta invención.

Hay que entender que las incorporaciones de esta invención, ilustradas y descritas aquí en detalle, son a modo de ilustración y no de limitación. Son posibles otros cambios y modificaciones y se harán ellos mismos evidentes a los expertos en el arte previo.

**REIVINDICACIONES:**

1. Un proceso fisico-químico para la producción de harinas de maíz pregelatinizado para varios productos alimenticios, que comprende los pasos de:

precocer el grano de maíz limpio con vapor en una solución sulfitante, que contiene por lo menos un componente ácido seleccionado del grupo conformado por metabisulfito de sodio, bisulfito de sodio y sulfito de sodio;

lavar dicho grano de maíz precocido con sulfito para eliminar los sólidos solubles en el agua residual y estabilizar un contenido de humedad de dicho grano de maíz precocido;

moler dicho grano de maíz precocido y lavado y secar dicho grano de maíz molido para gelatinización parcial;

enfriar y, seguidamente, secar dicho grano de maíz secado y molido con aire limpio; y

separar dicho maíz molido para recuperar un molido ultrafino con una abertura de malla < 60 a 325 para obtener una harina de maíz ultrafina, apropiada para alimentos a base de lácteos; en donde el paso de separación se realiza usando un separador de aire.

2. El método de la reivindicación 1, en donde dicho paso de precocción utiliza sulfitos en una cantidad de alrededor de 0.02% a alrededor de 0.15% en peso del grano de maíz limpio.

3. El método de la reivindicación 1, en donde el paso de separación separa el molido ultrafino de un molido grueso, comprendiendo el molido ultrafino fracciones de endospermo y germen con bajo contenido de fibra, comprendiendo el molido grueso fracciones de endospermo con alto contenido de fibra, germen y salvado.



4. El método de acuerdo con la reivindicación 3, que comprende los pasos adicionales de: aspirar el molido grueso para eliminar una fracción liviana de salvado de maíz; volver a moler el molido grueso aspirado; y

reciclar las fracciones de germen y endospermo con alto contenido de fibra, vueltas a moler y aspiradas, del molido grueso.

5. El método de acuerdo con la reivindicación 4, en donde el paso de reciclado comprende cernir el molido grueso remolido y aspirado en una fracción más fina, con una abertura de malla < 45 a 80 , para producir una harina fina de maíz apropiada para alimentos a base de cereales.

6. El método de la reivindicación 5, en donde dichas harinas de maíz finas y extrafinas representan un rendimiento del 91% al 96% del peso total del grano de maíz.

7. El método de la reivindicación 5, que comprende el paso adicional de volver a moler la fracción liviana de salvado de maíz producida por el paso de aspiración con una abertura de malla < 45 para producir una harina de salvado.

8. El método de la reivindicación 7, en donde dicha fracción liviana de salvado de maíz comprende alrededor de 3% a 8% de harina por kilogramo de grano de maíz.

9. El método de acuerdo con la reivindicación 7, que comprende el paso adicional de mezclar dicha harina fina de maíz con 5% a 10% en peso de dicha harina de salvado para producir una harina de maíz entero con un mayor contenido de fibra dietética.

10. El método de la reivindicación 9, que comprende además los pasos de:

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mezclar dicha harina de salvado con 45% a 49% en peso de harina de trigo, para producir una harina parcial de grano entero con un menor contenido total de calorías; y

fabricar por lo menos uno de los alimentos a base de cereales y a base de trigo usando tanto la harina parcial de grano entero como la harina de maíz entero.

11. El método de la reivindicación 7, que comprende además mezclar dicha harina de salvado con 45% a 49% en peso de harina de trigo, para producir una harina parcial de grano entero con un menor contenido total de calorías.

12. El proceso de la reivindicación 5, que comprende el paso adicional de agregar cal a la harina fina de maíz para obtener una harina de masa apropiada para preparación de alimentos a base de maíz.

13. El proceso de la reivindicación 12, en donde la cal representa alrededor de 0.05% a alrededor de 0.15% de la harina fina de maíz en peso, y que comprende el paso adicional de re-hidratar dicha harina fina de maíz y harina de masa con agua caliente desde una relación 1:1 a alrededor de 1:1.3 en peso para formar una pasta de maíz y masa.

14. El método de acuerdo con la reivindicación 1, que comprende además mezclar dicha harina de maíz ultrafina con uno de agua caliente y leche para formar una dispersión de harina de alrededor de 0.1% a alrededor de 10% de sólidos.

15. El método de la reivindicación 14, que comprende el paso adicional de usar la dispersión de harina como un auxiliar de procesamiento para preparar por lo menos uno de queso, queso de untar, crema agria, yogur, aderezo de queso blanco grumoso y mezcla de crema de helado.



16. El método de la reivindicación 15 en donde dicha dispersión de harina se trata térmicamente a una temperatura desde alrededor de 60°C a alrededor de 85°C durante 10 minutos a alrededor de 30 minutos.

17. El método de acuerdo con la reivindicación 16 en donde dicha dispersión calentada se agrega a la leche entera iniciadora con el fin de obtener desde alrededor de 0.10% a 0.6% de sólidos de harina.

18. El método de la reivindicación 17, en donde con el auxiliar se produce un mayor rendimiento de queso desde alrededor de 3% a 15%.

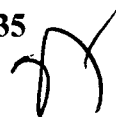
19. El método de la reivindicación 15 en donde dicha dispersión de harina se agrega a leche descremada pre-pasteurizada con el fin de lograr desde alrededor de 1% a 5% de sólidos de harina.

20. El método de la reivindicación 19, en donde se obtiene un contenido de grasa reducido desde alrededor de 30% a alrededor de 70% en queso de untar y alimentos lácteos, actuando el auxiliar de procesamiento como un sustituto de proteína y grasa.

21. El método de la reivindicación 1, en donde el paso de separación se lleva a cabo usando un separador de aire centrífugo.

22. El método de la reivindicación 21, en donde el separador de aire centrífugo se construye y se instala para aislar el molido produciendo un entorno en el cual las partículas del molido ultrafino se afectan más por las fuerzas de arrastre creadas en el separador de aire centrífugo que por la gravedad.

23. Un proceso fisico-químico para la producción de harinas de maíz pregelatinizado para varios productos alimenticios, que comprende los pasos de:



precocer el grano de maíz limpio con vapor en una solución sulfitante que contiene por lo menos un componente ácido seleccionado del grupo conformado por metabisulfito de sodio, bisulfito de sodio y sulfito de sodio;

lavar dicho grano de maíz precocido con sulfito para eliminar los sólidos solubles en el agua residual y estabilizar un contenido de humedad de dicho grano de maíz precocido;

moler dicho grano de maíz precocido y lavado y secar dicho grano de maíz molido para gelatinización parcial;

enfriar y, seguidamente, secar dicho grano de maíz secado y molido con aire limpio; y

separar dicho maíz molido para recuperar un molido ultrafino;

aspirar y volver a moler dicho molido grueso; y cernir dicho molido grueso aspirado y vuelto a moler en una fracción más fina, con una abertura de malla de < 45 a 80 , para producir una harina fina de maíz apropiada para alimentos a base de cereales;

en donde el paso de separación se realiza utilizando un separador de aire.

24. El proceso de la reivindicación 23, en donde el paso de aspirar el molido grueso elimina una fracción liviana de salvado de maíz, y que comprende el paso adicional de volver a moler la fracción liviana con una abertura de malla < 45 para producir una harina de salvado.

25. El proceso de la reivindicación 24, que comprende el paso adicional de mezclar dicha harina fina de maíz con 5% a 10% en peso de dicha harina de salvado para producir una harina de maíz entero con un mayor contenido de fibra dietética.

26. El método de la reivindicación 24, que comprende además mezclar dicha harina de salvado con 45% a 49% en peso de harina de trigo, para producir una harina parcial de grano entero con un menor contenido total de calorías.

27. El proceso de la reivindicación 23, que comprende el paso adicional de agregar cal a la harina fina de maíz para obtener una harina de masa apropiada para la preparación de alimentos a base de maíz.

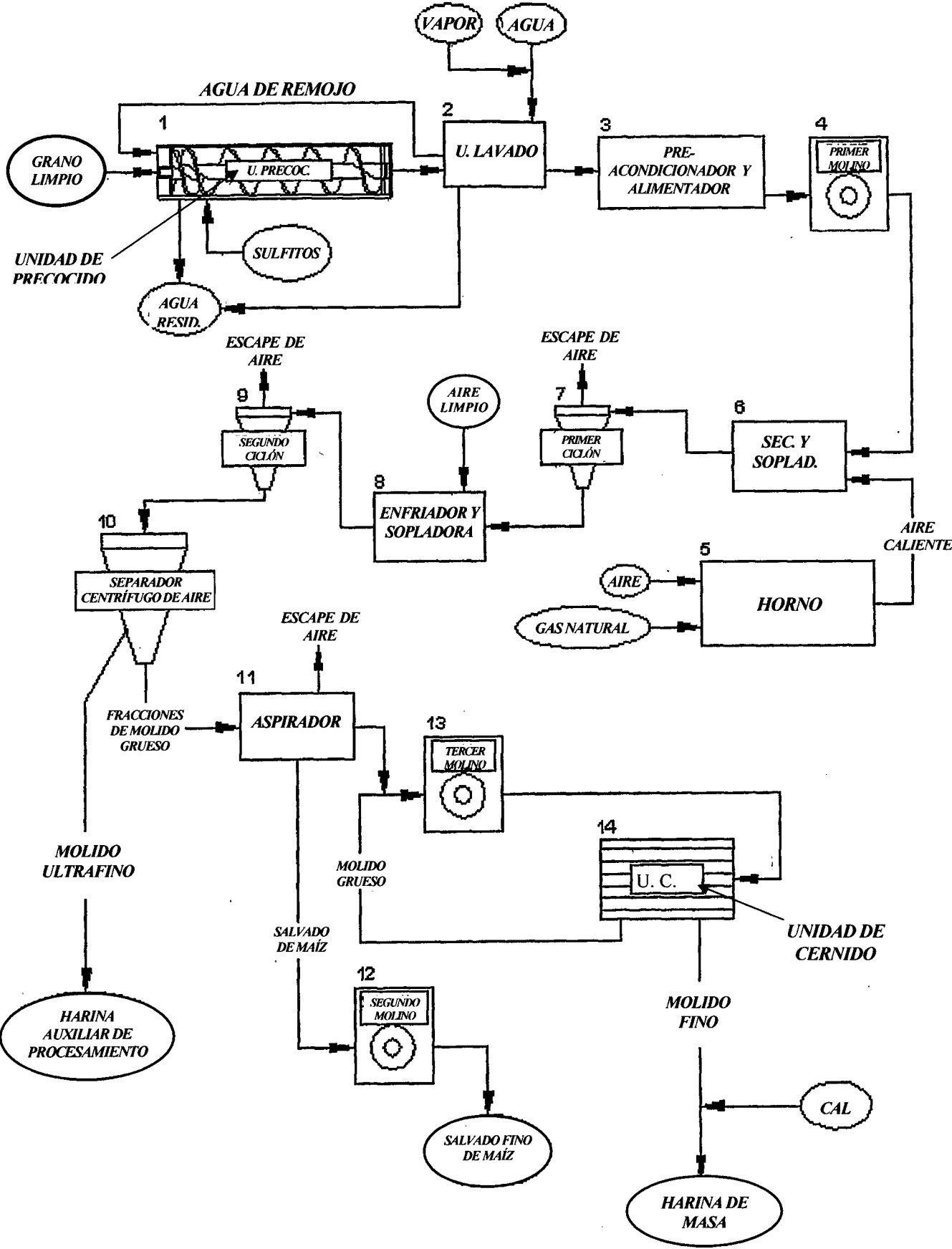
28. El proceso de la reivindicación 27, en donde la cal representa alrededor de 0.05% a alrededor de 0.15% de la harina fina de maíz en peso, y que comprende el paso adicional de re-hidratar dicha harina fina de maíz y harina de masa con agua caliente desde una relación 1:1 a alrededor de 1:1.3 en peso para formar una pasta de maíz y pasta de masa.

29. El método de la reivindicación 23, en donde el paso de separación se realiza utilizando un separador de aire centrífugo.

30. El método de la reivindicación 29, en donde el separador de aire centrífugo se construye y se monta para aislar la harina fina de maíz produciendo un entorno en el cual las partículas de la harina fina de maíz se afectan más por la gravedad que por las fuerzas de arrastre creadas en el separador de aire centrífugo.

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FIG. 1



PATENT COOPERATION TREATY

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 9002-1054WO	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/US06/14335	International filing date (day/month/year) 17 April 2006 (17.04.2006)	(Earliest) Priority Date (day/month/year) 05 May 2005 (05.05.2005)
Applicant RUBIO, FELIPE A.		

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

This international search report consists of a total of 4 sheets.



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

1. Basis of the Report

- a. With regard to the language, the international search was carried out on the basis of:



the international application in the language in which it was filed.



a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

- b. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, see Box No. I.

2. ☐ Certain claims were found unsearchable (See Box No. II)

3. ☒ Unity of invention is lacking (See Box No. III)

4. With regard to the title,



the text is approved as submitted by the applicant.



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

5. With regard to the abstract,



the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the drawings,

- a. the figure of the drawings to be published with the abstract is Figure No. 1



as suggested by the applicant.



as selected by this Authority, because the applicant failed to suggest a figure.



as selected by this Authority, because this figure better characterizes the invention.

- b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US06/14335

al

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

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

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

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

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of any additional fees.
3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.: 1-11, 21-26, 29 and 30
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

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

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US06/14335

A. CLASSIFICATION OF SUBJECT MATTER

IPC: A23L 1/10(2006:01)

USPC: 426/472,473,481,482,518,520,618,622,626,640

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. : 426/472, 473, 481, 482, 518, 520, 618, 622, 626, 640

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

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

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 4,350,714 A (DUVALL) 21 September 1982, col. 2, lines 65-68, col. 3, lines 1-10.	24
Y	US 4,777,045 A (VANDERVEER et al.) 11 October 1988, col. 21, lines 64-68, col. 22, lines 10-13).	10, 11, 26
Y	US 6,068,873 A (DELRUE et al.) 30 May 2000, abstract and col. 2, lines 10-15, 49-50, col. 4, lines 30-50, col. 6, lines 4-9.	9, 25
Y	US 6,322,836 B1 (RUBIO et al.) 27 November 2001, abstract and col. 6, lines 10-33, col. 4, lines 5-10, col. 3, lines 25-70.	1-8, 21, 22, 23, 29, 30

☐ 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

"&"

document member of the same patent family

Date of the actual completion of the international search

15 March 2007 (15.03.2007)

Date of mailing of the international search report

10 APR 2007

Name and mailing address of the ISA/US:

Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Facsimile No. (571) 273-3201

Authorized officer

Helen F. Pratt

Telephone No. 571-272-1201

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US06/14335

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BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

Group I claim(s) 1-11, 21, 22 drawn to a process of making a coarse ground pregelatinized corn flour and product thereof..

Group II claim(s) 1-5, 12-20, drawn to a method of making a masa flour and a fat and protein substitute.

Group III, claim(s) 23-26, 29, 30, drawn to a process for making a coarse ground corn flour for cereals.

Group IV, claims 23, 27, 28, drawn to a process of making masa flour from corn flour and bran.

The inventions listed as Groups I-IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: a method of making a masa flour and fat and protein substitute is not required of Group I.

Further processing the coarse ground flour as in Group III into cereal, is not required of Groups I, II and IV. Making a masa flour from the corn flour is not required of groups I-III.

Continuation of B. FIELDS SEARCHED Item 3:

WEST search terms: bran, whole wheat, corn, pregelatinized, flour, sulfite, washing, milling, cooling, separating, coarse grind, recycle, regrind, remilling, air separator, endosperm, germ fiber, bran, aspirate, mesh, corn flour.

PATENT COOPERATION TREATY

ay

From the
INTERNATIONAL SEARCHING AUTHORITY

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

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Applicant's or agent's file reference: 9002-1054WO		Date of mailing (day/month/year) 10 APR 2007
International application No. PCT/US06/14335		International filing date (day/month/year) 17 April 2006 (17.04.2006)
International Patent Classification (IPC) or both national classification and IPC IPC: A23L 1/10(2006.01) USPC: 426/618,622,626,640,472,473,481,482,518,520		Priority date (day/month/year) 05 May 2005 (05.05.2005)
Applicant RUBIO, FELIPE A.		

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

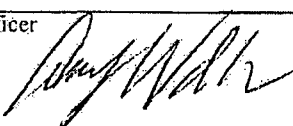
2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/ US Mail Stop PCT, Attn: ISA/US. Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Date of completion of this opinion 15 March 2007 (15.03.2007)	Authorized officer Helen F. Pratt  Telephone No. 571-272-1201
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Form PCT/ISA/237 (cover sheet) (April 2005)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

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International application No.

PCT/US06/14335

Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:

- ☒ the international application in the language in which it was filed
☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. With regard to any nucleotide and/or amino acid sequence disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:

a. type of material

- ☐ a sequence listing
☐ table(s) related to the sequence listing

b. format of material

- ☐ on paper
☐ in electronic form

c. time of filing/furnishing

- ☐ contained in the international application as filed.
☐ filed together with the international application in electronic form.
☐ furnished subsequently to this Authority for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

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International application No.

PCT/US06/14335

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees the applicant has, within the applicable time limit:
- ☐ paid additional fees
 - ☒ paid additional fees under protest and, where applicable, the protest fee
 - ☐ paid additional fees under protest but the applicable protest fee was not paid
 - ☐ not paid additional fees

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is

- ☐ complied with
- ☒ not complied with for the following reasons:

See the lack of unity section of the International Search Report (Form PCT/ISA/210)

4. Consequently, this opinion has been established in respect of the following parts of the international application:

- ☐ all parts.
- ☒ the parts relating to claims Nos. 1-11, 21-26, 29 and 30

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WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US06/14335

Box No. V Reasoned statement under Rule 43 *bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims <u>1-11, 21- 26, 29, 30</u>	YES
	Claims <u>none</u>	NO
Inventive step (IS)	Claims <u>NONE</u>	YES
	Claims <u>1-11, 21- 26, 29, 30</u>	NO
Industrial applicability (IA)	Claims <u>1-11, 21- 26, 29, 30</u>	YES
	Claims <u>NONE</u>	NO

2. Citations and explanations:

Please See Continuation Sheet

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

48
International application No.
PCT/US06/14335

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

V. 2. Citations and Explanations:

Claims 1-8, 21, 22, 23, 29, 30 lack an inventive step under PCT Article 33(3) as being obvious over Rubio et al. (6,322,836).

Rubio et al. disclose a method of treating corn to make various corn fractions by treating as in claims 1 and 23 (abstract and col. 6, lines 10-33). Claim 1 differs from the reference in that the fine grind is suitable for dairy-based foods and claim 23 differs from the reference in the step of separating using an air separator. However, the reference discloses the use of a cyclone separator (col. 4, lines 5-10). No patentable distinction is seen in the use of an air separator in a method claim, as a different apparatus may be used in a method claim, which performs the same function absent anything unexpected using an air separator. As the process of making the corn flour has been shown, nothing is seen that the product made would not have been suitable for use with dairy based foods. Therefore, it would have been obvious to treat the corn to make corn flour as shown by Rubio.

Claim 2 further requires the use of a particular amount of sulfite. The reference discloses the use of 0.16% sulfite additive. No difference is seen in the use of 0.15% and 0.16% absent a showing of unexpected results using the lower amount.

Further limitations of separating as in claim 3, and remilling as in claim 4 and remilling as in claim 5, to yield particular amounts of flours as in claim 6 are disclosed by the reference in col. 3, lines 25-70, col. 4, lines 1-29.

The limitations of claim 7 are found in col. 6, lines 27-30.

Claim 8 further requires particular amounts of the light corn bran fraction. The reference discloses a minimum of from 3-5%, which is within the claimed amounts (col. 6, lines 33-36).

Claims 21, 22, 29 and 30 further require the use of a centrifugal air separator. No difference is seen in the use of cyclones as in the reference to Rubio et al. and in the use of centrifugal air separators absent a showing of unexpected results using air separators. Therefore, it would have been obvious to use cyclones in place of air separators in the process of Rubio absent unexpected results.

Claim 30 further requires that the air separator use more gravity than drag forces. However, this is a function of the type of apparatus, and nothing is seen that the cyclone of Rubio et al. does not do the same thing. Therefore, it would have been obvious to use a type of apparatus that which affects gravity in treating corn flour.

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US06/14335

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Claims 9, 24, 25 lack an inventive step under PCT Article 33(3) as being obvious over the prior art as applied in the immediately preceding paragraph and further in view of Duvall (4,350,714) and Delrue et al. (6,068,873).

Claim 24 further requires regrinding the light corn bran fraction to under 45 mesh.

Duvall discloses that it is known to use mesh sizes of 40 in a corn bran product (abstract and col. 2, lines 10-15, 49-50); Delrue et al. disclose using a blend of corn flour and bran with a mesh size of 60 and 80 and on up. However, the reference discloses that the size of the milled product depends on the type of application of the masa flour (col. 4, lines 30-50, col. 6, lines 4-9). Therefore, it would have been obvious to use a known mesh size for bran in the process of Rubio et al.

Duval discloses using corn flour with bran flour as in claims 9 and 25 (col. 2, lines 65-68, col. 3, lines 1-10). Duval uses different amounts of ingredients, but it is seen that it would have been within the skill of the ordinary worker to use particular amounts of bran with corn flour, depending on the type of product required. Therefore, it would have been obvious to use particular amounts of ingredients according to the type of product required.

Claims 10, 11 and 26 lack an inventive step under PCT Article 33(3) as being obvious over the prior art as applied in the immediately preceding paragraph and further in view of Vanderveer et al.

Vanderveer et al. disclose a process of making a high bran flour containing whole-wheat flour and corn bran as in claims 10, 11 and 26. The bran can be used at within the claimed amounts (col. 21, lines 64-68, col. 22, lines 10-13). Claims 10, 11 and 26 differ from the reference in that no sulfite has been used in the process. However, as it is known to add corn bran to whole-wheat flour, no difference is seen at this time, in whether the bran is sulfite treated or not absent unexpected results using the sulfite treated bran. Claims 11 and 26 further require that the mixture has a decreased calorie content. This is seen as being obvious since bran has less calories than flour. Therefore, it would have been obvious to use known types of bran in the claimed process and to make a product with less calories due to the bran replacing part of the flour.

Claims 1-11, 21-26, 29, 30 meet the requirements for industrial applicability as defined by PCT Article 33(4) by providing a method for making a pregelatinized corn flour.

Claims 1-11, 21-26, 29, 30 meet the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest the claimed invention in one reference.

PATENT COOPERATION TREATY

VOD

From the INTERNATIONAL SEARCHING AUTHORITY

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

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL SEARCH REPORT AND
THE WRITTEN OPINION OF THE INTERNATIONAL
SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 9002-1054WO	Date of mailing (day/month/year) 10 APR 2007
International application No. PCT/US06/14335	International filing date (day/month/year) 17 April 2006 (17.04.2006)
Applicant RUBIO, FELIPE A.	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

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

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

Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes
1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 338.82.70.

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

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

4. **Reminders**

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

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

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

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

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

Name and mailing address of the ISA/ US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Authorized officer Helen F. Pratt Telephone No. 571-272-1201
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Form PCT/ISA/220 (January 2004)

(See notes on accompanying sheet)

CORRECTED VERSION

From the INTERNATIONAL BUREAU

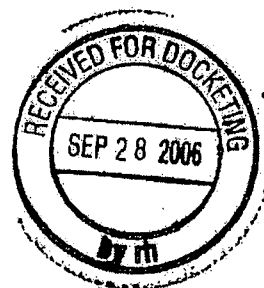
PCT

NOTIFICATION OF RECEIPT OF
RECORD COPY

(PCT Rule 24.2(a))

To:

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



Date of mailing (day/month/year) 18 September 2006 (18.09.2006)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 9002-1054WO	International application No. PCT/US2006/014335

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

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

RUBIO, Felipe, A. et al (for US)
INVESTIGACION DE TECNOLOGIA AVANZADA, S.A. DE C.V. (for all designated States except US)

International filing date: 17 April 2006 (17.04.2006)

Priority date(s) claimed: 05 May 2005 (05.05.2005)

Date of receipt of the record copy by the International Bureau: 16 June 2006 (16.06.2006)

List of designated Offices:

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

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

EP: AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR

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

National: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW

ATTENTION: The applicant should carefully check the data appearing in this notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau. In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

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

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

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Campin Helene Facsimile No. +41 22 338 89 65 Telephone No. +41 22 338 97 16
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Facsimile No. +41 22 338 82 70

Form PCT/IB/301 (October 2005)

1/CZMKT7V0

INFORMATION ON ENTERING THE NATIONAL PHASE

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

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

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

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

REQUIREMENTS REGARDING PRIORITY DOCUMENTS

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

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

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

If the priority document concerned is not submitted to the International Bureau and if the request to the receiving Office to prepare and transmit the priority document has not been made (and the corresponding fee, if any, paid) within the applicable time limit indicated under the preceding paragraphs, any designated State may disregard the priority claim, provided that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances (Rule 17.1(c)).

Where several priorities are claimed, the priority date to be considered for the purposes of computing the 16-month time limit (and all other PCT time limits) is the filing date of the earliest application whose priority is claimed (Article 2(xi)(b)).

PCT

NOTIFICATION CONCERNING THE
FILING OF AMENDMENTS OF THE CLAIMS

(PCT Administrative Instructions, Section 417)

From the INTERNATIONAL BUREAU

To:

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

✓

Date of mailing (day/month/year) 18 June 2007 (18.06.2007)	
Applicant's or agent's file reference 9002-1054WO	IMPORTANT NOTIFICATION
International application No. PCT/US2006/014335	International filing date (day/month/year) 17 April 2006 (17.04.2006)
Applicant RUBIO, Felipe, A. et al	

1. The applicant is hereby notified that amendments to the claims under Article 19 were received by the International Bureau on:
11 June 2007 (11.06.2007) .

2. This date is

☒ within the time limit under Rule 46.1.

Consequently, the international publication of the international application will contain the amended claims according to Rule 48.2(f), (h) and (i).

☐ after the expiration of the time limit under Rule 46.1.

Consequently, the amendments will not be published and will not be considered for the international procedure.

3. The applicant is reminded that the international application (description, claims and drawings) may be amended during the international preliminary examination under Chapter II, according to Article 34, and in any case, before each of the designated Offices, according to Article 28 and Rule 52, or before each of the elected Offices, according to Article 41 and Rule 78.

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

Authorized officer

Smahi Abderrezak

Facsimile No. +41 22 338 89 65

e-mail pt02.pct@wipo.int

Telephone No. +41 22 338 74 02

Form PCT/IB/346 (July 1992; reprint January 2004)

1/DAG182XB0

CORRECTED VERSION

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

Date of mailing (day/month/year) 18 September 2006 (18.09.2006)	To: JENSEN, Eric c/o Young & Thompson 745 South 23rd. Street Arlington, VA 22202 ETATS-UNIS D'AMERIQUE
Applicant's or agent's file reference 9002-1054WO	IMPORTANT NOTIFICATION
International application No. PCT/US2006/014335	International filing date (day/month/year) 17 April 2006 (17.04.2006)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 05 May 2005 (05.05.2005)
Applicant RUBIO, Felipe, A. et al	

1. By means of this Form, which replaces any previously issued notification concerning submission or transmittal of priority documents, the applicant is hereby notified of the date of receipt by the International Bureau of the priority document(s) relating to all earlier application(s) whose priority is claimed. Unless otherwise indicated by the letters "NR", in the right-hand column or by an asterisk appearing next to a date of receipt, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
2. (If applicable) The letters "NR" appearing in the right-hand column denote a priority document which, on the date of mailing of this Form, had not yet been received by the International Bureau under Rule 17.1(a) or (b). Where, under Rule 17.1(a), the priority document must be submitted by the applicant to the receiving Office or the International Bureau, but the applicant fails to submit the priority document within the applicable time limit under that Rule, 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.
3. (If applicable) 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) (the priority document was received after the time limit prescribed in Rule 17.1(a) or the request to prepare and transmit the priority document was submitted to the receiving Office after the applicable time limit under Rule 17.1(b)). Even though the priority document was not furnished in compliance with Rule 17.1(a) or (b), the International Bureau will nevertheless transmit a copy of the document to the designated Offices, for their consideration. In case such a copy is not accepted by the designated Office as the priority document, Rule 17.1(c) 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
05 May 2005 (05.05.2005)	11/122,106	US	15 June 2006 (15.06.2006)

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

Authorized officer

Campin Helene

Facsimile No. +41 22 338 82 70

Facsimile No. +41 22 338 89 65

Telephone No. +41 22 338 97 16

From the INTERNATIONAL BUREAU

PCT

SECOND AND SUPPLEMENTARY NOTICE
INFORMING THE APPLICANT OF THE
COMMUNICATION OF THE INTERNATIONAL
APPLICATION (TO DESIGNATED OFFICES
WHICH APPLY THE 30 MONTH TIME
LIMIT UNDER ARTICLE 22(1))

(PCT Rule 47.1(c))

To:

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

Date of mailing (day/month/year) 07 September 2007 (07.09.2007)		IMPORTANT NOTICE	
Applicant's or agent's file reference 9002-1054WO			
International application No. PCT/US2006/014335	International filing date (day/month/year) 17 April 2006 (17.04.2006)	Priority date (day/month/year) 05 May 2005 (05.05.2005)	
Applicant RUBIO, Felipe, A. et al			

1. **ATTENTION:** For any designated Office(s), for which the time limit under Article 22(1), as in force from 1 April 2002 (30 months from the priority date), **does not apply**, please see Form PCT/IB/308(First Notice) issued previously.

2. Notice is hereby given that the following designated Office(s), for which the time limit under Article 22(1), as in force from 1 April 2002, **does apply**, has/have requested that the communication of the international application, as provided for in Article 20, be effected under Rule 93bis.1. The International Bureau has effected that communication on the date indicated below:
09 November 2006 (09.11.2006)

AU, AZ, BY, CN, CO, DZ, EP, HU, KG, KP, KR, MD, MK, MZ, NA, NG, PG, RU, SY, TM, US

In accordance with Rule 47.1(c-bis)(i), 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).

3. The following designated Offices, for which the time limit under Article 22(1), as in force from 1 April 2002, **does apply**, have not requested, as at the time of mailing of the present notice, that the communication of the international application be effected under Rule 93bis.1:

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

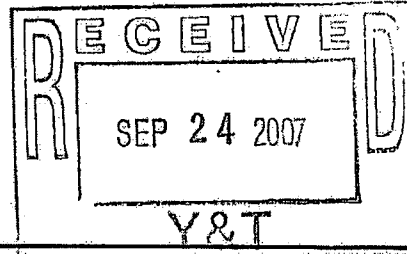
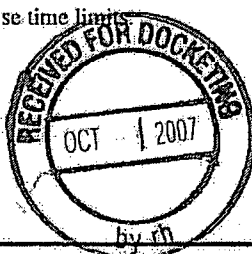
In accordance with Rule 47.1(c-bis)(ii), those Offices accept the present notice as conclusive evidence that the Contracting State for which that Office acts as a designated Office does not require the furnishing, under Article 22, by the applicant of a copy of the international application.

4. **TIME LIMITS** for entry into the national phase

For the designated or elected Office(s) listed above, 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.

In practice, time limits other than the 30-month time limit will continue to apply, for various periods of time, in respect of certain of the designated or elected Office(s) listed above. For regular updates on the applicable time limits (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>.

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



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

Authorized officer

Nora Lindner

PCT REQUEST

Original (for SUBMISSION)

0	For receiving Office use only	PCT/US 06/14335
0-1	International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	
0-4	Form PCT/RO/101 PCT Request	
0-4-1	Prepared Using	PCT-SAFE [EASY model] Version 3.50 (Build 0002.163)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	United States Patent and Trademark Office (USPTO) (RO/US)
0-7	Applicant's or agent's file reference	9002-1054WO
I	Title of invention	CONTINUOUS PRODUCTION OF PREGELATINIZED CORN FLOURS FOR DAIRY-BASED AND CEREAL-BASED FOODS
II	Applicant	
II-1	This person is	applicant and inventor
II-2	Applicant for	US only
II-4	Name (LAST, First)	RUBIO, Felipe A.
II-5	Address	1319 Ivy Lane Edinburg, Texas 78539 United States of America
II-6	State of nationality	US
II-7	State of residence	US
III-1	Applicant and/or inventor	
III-1-1	This person is	applicant and inventor
III-1-2	Applicant for	US only
III-1-4	Name (LAST, First)	RUBIO, Manuel J.
III-1-5	Address	1621 Collins Avenue Miami Beach, Florida 33139 United States of America
III-1-6	State of nationality	US
III-1-7	State of residence	US

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PCT REQUEST

Original (for SUBMISSION)

III-2	Applicant and/or inventor	
III-2-1	This person is	applicant and inventor
III-2-2	Applicant for	US only
III-2-4	Name (LAST, First)	ARROYO, Francisco
III-2-5	Address	501 W. Chapin Edinburg, Texas 78539 United States of America
III-2-6	State of nationality	US
III-2-7	State of residence	US
III-3	Applicant and/or inventor	
III-3-1	This person is	applicant and inventor
III-3-2	Applicant for	US only
III-3-4	Name (LAST, First)	NORTON, Rick
III-3-5	Address	1159 Cottonwood Lane Irving, Texas 75038 United States of America
III-3-6	State of nationality	US
III-3-7	State of residence	US
III-4	Applicant and/or inventor	
III-4-1	This person is	applicant and inventor
III-4-2	Applicant for	US only
III-4-4	Name (LAST, First)	CONTRERAS, Roberto
III-4-5	Address	R. Cortines 2002 Ote 67110 Guadalupe, N.L. Mexico
III-4-6	State of nationality	MX
III-4-7	State of residence	MX
III-5	Applicant and/or inventor	
III-5-1	This person is	applicant and inventor
III-5-2	Applicant for	US only
III-5-4	Name (LAST, First)	ARCE, Miguel
III-5-5	Address	R. Cortines 2002 Ote 67110 Guadalupe, N.L. Mexico
III-5-6	State of nationality	MX
III-5-7	State of residence	MX

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PCT REQUEST

Original (for SUBMISSION)

III-6	Applicant and/or inventor	
III-6-1	This person is	applicant and inventor
III-6-2	Applicant for	US only
III-6-4	Name (LAST, First)	RAMIREZ, J. Fernando
III-6-5	Address	R. Cortines 2002 Ote 67110 Guadalupe, N.L. Mexico
III-6-6	State of nationality	MX
III-6-7	State of residence	MX
III-7	Applicant and/or inventor	
III-7-1	This person is	applicant only
III-7-2	Applicant for	all designated States except US
III-7-4	Name	INVESTIGACION DE TECNOLOGIA AVANZADA, S.A. DE C.V.
III-7-5	Address	Ave Ruiz Cortines S/N frente a colonia la Purisima Entre Gral. Bonifacio Salinas y Carretera Miguel Aleman 67110 Guadalupe, N.L. Mexico
III-7-6	State of nationality	MX
III-7-7	State of residence	MX
IV-1	Agent or common representative; or address for correspondence	
	The person identified below is hereby/ has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name (LAST, First)	JENSEN, Eric
IV-1-2	Address	C/O Young & Thompson 745 South 23rd. Street Arlington, Virginia 22202 United States of America
IV-1-3	Telephone No.	703-521-2297
IV-1-4	Facsimile No.	703-685-0573
IV-1-5	e-mail	embon@young-thompson.com
IV-1-6	Agent's registration No.	37,855
IV-2	Additional agent(s)	
		additional agent(s) with same address as first named agent
IV-2-1	Name(s)	CASTEL, Benoît (35,041); PERKINS, Thomas W. (33,027)

PCT REQUEST

Original (for SUBMISSION)

V	DESIGNATIONS		
V-1	The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the International filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.		
VI-1	Priority claim of earlier national application		
VI-1-1	Filing date	05 May 2005 (05.05.2005)	
VI-1-2	Number	11/122,106	
VI-1-3	Country	US	
VI-2	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	International Searching Authority Chosen	United States Patent and Trademark Office (USPTO) (ISA/US)	
VIII	Declarations	Number of declarations	
VIII-1	Declaration as to the identity of the inventor	-	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	-	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	-	
IX	Check list	number of sheets	electronic file(s) attached
IX-1	Request (including declaration sheets)	5	✓
IX-2	Description	24	-
IX-3	Claims	6	-
IX-4	Abstract	1	✓
IX-5	Drawings	1	-
IX-7	TOTAL	37	

PCT REQUEST

Original (for SUBMISSION)

	Accompanying Items	paper document(s) attached	electronic file(s) attached
IX-8	Fee calculation sheet	✓	-
IX-17	PCT-SAFE physical media	-	✓
IX-19	Figure of the drawings which should accompany the abstract	1	
IX-20	Language of filing of the international application	English	
X-1	Signature of applicant, agent or common representative		
X-1-1	Name (LAST, First)	JENSEN, Eric	
X-1-2	Name of signatory		
X-1-3	Capacity		

FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	IAP7 Rec'd PCT/PTO 17 APR 2006
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/US
10-6	Transmittal of search copy delayed until search fee is paid	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	
------	--	--

The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ US

PCT

CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:

The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty.

For International Preliminary Examining Authority use only	
Identification of IPEA	Date of receipt of DEMAND
Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION	
Applicant's or agent's file reference 9002-1054 WO	
International application No. PCT/US2006/014335	International filing date (day/month/year) 17 April 2006
(Earliest) Priority date (day/month/year) 05 May 2005	
Title of invention CONTINUOUS PRODUCTION OF PREGELATINIZED CORN FLOURS FOR DAIRY-BASED AND CEREAL-BASED FOODS	
Box No. II APPLICANT(S)	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) RUBIO, Felipe A. 1319 Ivy Lane Edinburg, Texas 78539 United States of America	Telephone No.
	Facsimile No.
	Applicant's registration No. with the Office
State (that is, country) of nationality: US	State (that is, country) of residence: US
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) RUBIO, Manuel J. 1621 Collins Avenue Miami Beach, Florida 33139 United States of America	
State (that is, country) of nationality: US	State (that is, country) of residence: US
☒ Further applicants are indicated on a continuation sheet.	

Continuation of Box No. II APPLICANT(S)

If none of the following sub-boxes is used, this sheet should not be included in the demand.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

ARROYO, Francisco
501 W. Chapin
Edinburg, Texas 78539
United States of America

State *(that is, country)* of nationality:

US

State *(that is, country)* of residence:

US

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

NORTON, Rick
1159 Cottonwood Lane
Irving, Texas 75038
United States of America

State *(that is, country)* of nationality:

US

State *(that is, country)* of residence:

US

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

CONTRERAS, Roberto
R. Cortines 2002 Ote.
67110 Guadalupe, N.L.
Mexico

State *(that is, country)* of nationality:

MX

State *(that is, country)* of residence:

MX

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

ARCE, Miguel
R. Cortines 2002 Ote.
67110 Guadalupe, N.L.
Mexico

State *(that is, country)* of nationality:

MX

State *(that is, country)* of residence:

MX



Further applicants are indicated on another continuation sheet.

Continuation of Box No. II APPLICANT(S)

If none of the following sub-boxes is used, this sheet should not be included in the demand.

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

RAMIREZ, J. Fernando
R. Cortines 2002 Ote.
67110 Guadalupe, N.L.
Mexico

State (that is, country) of nationality:
MX

State (that is, country) of residence:
MX

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

Investigación De Tecnología Avanzada, S.A. DE C.V.
Ave Ruiz Cortines S/N
frente a colonia la Purisima
Entre Gral. Bonifacio Salinas y
Carretera Migual Aleman
Guadalupe, N.L. México C.P. 67110
MÉXICO

State (that is, country) of nationality:
MX

State (that is, country) of residence:
MX

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

State (that is, country) of nationality:

State (that is, country) of residence:

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

State (that is, country) of nationality:

State (that is, country) of residence:

☐ Further applicants are indicated on another continuation sheet.

Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCEThe following person is ☒ agent ☐ common representativeand ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination.☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*JENSEN, Eric
c/o Young & Thompson
745 South 23rd Street
Arlington, Virginia 22202
United States of America

Telephone No.

703-521-2297

Facsimile No.

703-685-0573

Agent's registration No. with the Office

37,855

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.**Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION****Statement concerning amendments:***

1. The applicant wishes the international preliminary examination to start on the basis of:

☐ the international application as originally filedthe description ☒ as originally filed☐ as amended under Article 34the claims ☐ as originally filed☒ as amended under Article 19 (together with any accompanying statement)☐ as amended under Article 34the drawings ☒ as originally filed☐ as amended under Article 342. ☐ The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.3. ☒ Where the IPEA wishes to start the international preliminary examination at the same time as the international search in accordance with Rule 69.1(b), the applicant requests the IPEA to **postpone** the start of the international preliminary examination until the expiration of the applicable time limit under Rule 69.1(d).4. ☒ The applicant expressly wishes the international preliminary examination to **start earlier** than at the expiration of the applicable time limit under Rule 54bis.1(a).

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Language for the purposes of international preliminary examination:☒ which is the language in which the international application was filed.☐ which is the language of a translation furnished for the purposes of international search.☐ which is the language of publication of the international application.☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination.**Box No. V ELECTION OF STATES**

The filing of this demand constitutes the election of all Contracting States which are designated and are bound by Chapter II of the PCT.

Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

- | | | | |
|--|---|-------|--------|
| 1. translation of international application | : | _____ | sheets |
| 2. amendments under Article 34 | : | _____ | sheets |
| 3. copy (or, where required, translation) of amendments under Article 19 | : | 3 | sheets |
| 4. copy (or, where required, translation) of statement under Article 19 | : | 3 | sheets |
| 5. letter | : | 1 | sheets |
| 6. other (<i>specify</i>) | : | _____ | sheets |

For International Preliminary Examining Authority use only

received not received

☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐

The demand is also accompanied by the item(s) marked below:

- | | |
|--|---|
| 1. ☒ fee calculation sheet | 5. ☐ statement explaining lack of signature |
| 2. ☐ original separate power of attorney | 6. ☐ sequence listing in electronic form |
| 3. ☐ original general power of attorney | 7. ☐ tables in electronic form related to a sequence listing |
| 4. ☐ copy of general power of attorney; reference number, if any: | 8. ☐ other (<i>specify</i>): |

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).

_____ Eric JENSEN, Agent

For International Preliminary Examining Authority use only

1. Date of actual receipt of DEMAND:

2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):

3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply.
☐ The applicant has been informed accordingly.
4. ☐ The date of receipt of the demand is WITHIN the time limit of 19 months from the priority date as extended by virtue of Rule 80.5.
5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

6. ☐ The date of receipt of the demand is AFTER the expiration of the time limit under Rule 54bis.1(a) and item 7 or 8, below, does not apply.
7. ☐ The date of receipt of the demand is WITHIN the time limit under Rule 54bis.1(a) as extended by virtue of Rule 80.5.
8. ☐ Although the date of receipt of the demand is after the expiration of the time limit under Rule 54bis.1(a), the delay in arrival is EXCUSED pursuant to Rule 82.

For International Bureau use only

Demand received from IPEA on:

PCT

FEE CALCULATION SHEET

Annex to the Demand

International application No. PCT/US2006/014335 Applicant's or agent's file reference 9002-1054 WO Applicant Investigación De Tecnologia Avanzada, S.A. DE C.V.	For International Preliminary Examining Authority use only Date stamp of the IPEA								
CALCULATION OF PRESCRIBED FEES 1. Preliminary examination fee \$600.00 P 2. Handling fee (<i>Applicants from certain States are entitled to a reduction of 75% of the handling fee. Where the applicant is (or all applicants are) so entitled, the amount to be entered at H is 25% of the handling fee.</i>) \$155.00 H 3. Total of prescribed fees Add the amounts entered at P and H and enter total in the TOTAL box \$755.00 TOTAL									
MODE OF PAYMENT (<i>Not all modes of payment may be available at all IPEAs</i>) <table style="width: 100%;"> <tr> <td>☒ authorization to charge deposit account with the IPEA (see below)</td> <td>☐ cash</td> </tr> <tr> <td>☐ cheque</td> <td>☐ revenue stamps</td> </tr> <tr> <td>☐ postal money order</td> <td>☐ coupons</td> </tr> <tr> <td>☐ bank draft</td> <td>☐ other (<i>specify</i>):</td> </tr> </table>		☒ authorization to charge deposit account with the IPEA (see below)	☐ cash	☐ cheque	☐ revenue stamps	☐ postal money order	☐ coupons	☐ bank draft	☐ other (<i>specify</i>):
☒ authorization to charge deposit account with the IPEA (see below)	☐ cash								
☐ cheque	☐ revenue stamps								
☐ postal money order	☐ coupons								
☐ bank draft	☐ other (<i>specify</i>):								
AUTHORIZATION TO CHARGE (OR CREDIT) DEPOSIT ACCOUNT (<i>This mode of payment may not be available at all IPEAs</i>) <table style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> ☒ Authorization to charge the total fees indicated above. ☒ (<i>This check-box may be marked only if the conditions for deposit accounts of the IPEA so permit</i>) Authorization to charge any deficiency or credit any overpayment in the total fees indicated above. </td> <td style="width: 50%; vertical-align: top;"> IPEA/ <u>US</u> Deposit Account No.: <u>25-0120</u> Date: <u>July 6, 2007</u> Name: <u>Eric JENSEN</u> Signature: _____ </td> </tr> </table>		☒ Authorization to charge the total fees indicated above. ☒ (<i>This check-box may be marked only if the conditions for deposit accounts of the IPEA so permit</i>) Authorization to charge any deficiency or credit any overpayment in the total fees indicated above.	IPEA/ <u>US</u> Deposit Account No.: <u>25-0120</u> Date: <u>July 6, 2007</u> Name: <u>Eric JENSEN</u> Signature: _____						
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**REQUISITOS MINIMOS PARA ADMISION A TRAMITE
PCT**

PATENTE DE INVENCION []

MODELO DE UTILIDAD []

- ◆ Indicación de que se solicita la concesión de una patente []
- ◆ Datos de identificación del solicitante o de la persona que presenta la solicitud []
- ◆ Descripción de la invención []
- Dibujos de ser estos pertinentes []
- Comprobante de pago de las tasas establecidas []

COMPLETA []

INCOMPLETA []

DISEÑO INDUSTRIAL []

- ◆ Indicación de que se solicita el registro de Diseño Industrial []
- ◆ Datos de identificación del solicitante o de la persona que presenta la solicitud []
- ◆ Representación gráfica y fotográfica del Diseño Industrial o muestra del material que incorpora el diseño []
- ◆ Comprobante de pago de las tasas establecidas []

COMPLETA []

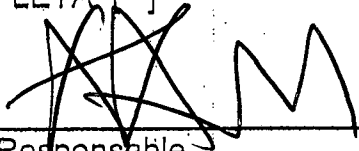
INCOMPLETA []

ESQUEMA DE TRAZADO []

- ◆ Indicación de que se 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 trazado []
- Comprobante de pago de las tasas establecidas []

COMPLETA []

INCOMPLETA []


Firma Responsable

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

Fecha



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