Anexos

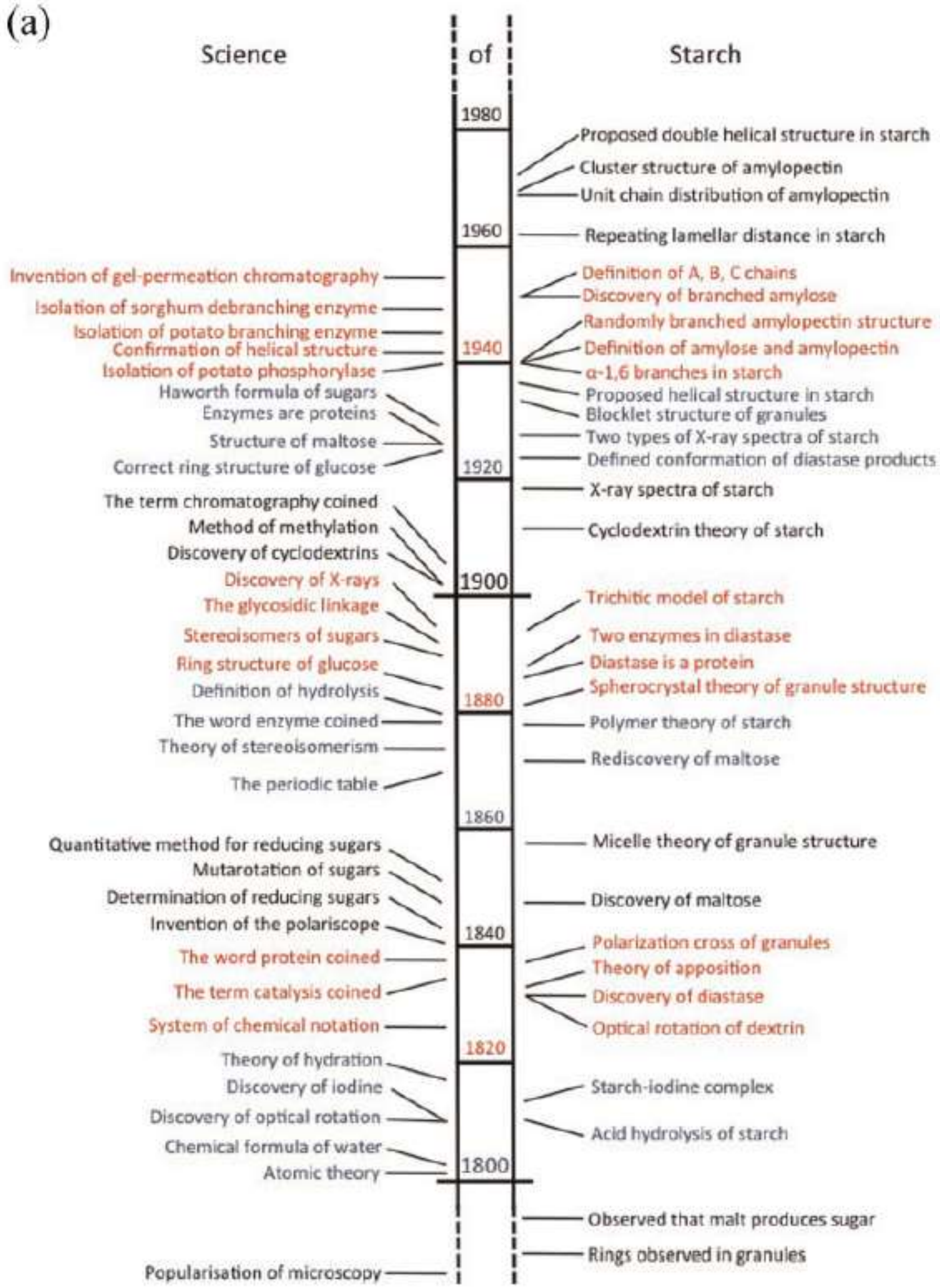
Origen del Azúcar. Web.29 de Septiembre 2015. Disponible en: http://www.conazucar.com/images/slider/Origen-del-azucar.jpg

'Sociedad para el Fomento de las Artes, & c. Adelphi ' Por Thomas Rowlandson, y por Auguste Charles Pugin, grabado por John Bluck, publicado por Rudolph Ackermann grabado y aguatinta coloreados a mano, publicado el 1 de julio de 1809 y Legado por (Frederick) Leverton Harris, 1927.

Presentación del azúcar de remolacha a Napoleón Bonaparte (Gómez, 2007)

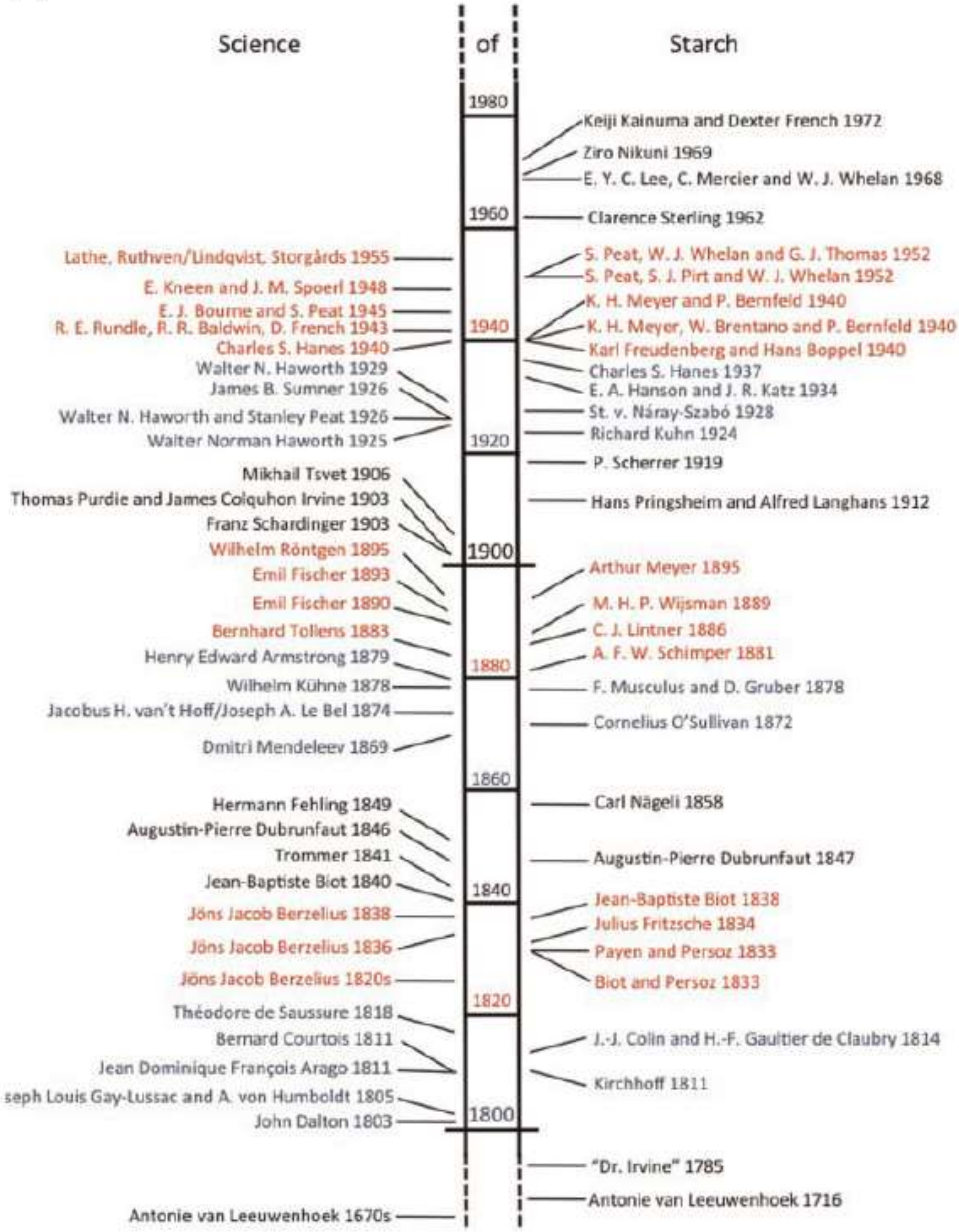
Plano de las “Vegas de las Cañas Dulces” de Almuñécar (Gómez,2007).

A la izquierda tenemos una línea cronológica acerca de los avances científicos más relevantes desde el 1980, a la derecha se encuentran los descubrimientos acerca de la historia del almidón (Seetharaman y Bertoft, 2013).



En este diagrama tenemos los autores de los descubrimientos expuestos en el esquema (a).

(b)



Datos de producción del almidón de patata (Kraak, 1992).

-Tabla 1: consumo mundial de almidón de patata en 1992.

-Tabla 2: Uso dado al almidón de patata.

Tabla 1:

World-wide starch consumption

World production of starch (x 1000 t)		Starch production by origin (x 1000 t)	
USA	10000	Maize	19900
EC	5700	Potato	2300
Japan	2300	Tapioca	1800
Rest of world	7600	Wheat	1300
		Waxy maize	300
	25600		25600

Tabla 2:

Ultimate destination of starches

Potato starch (x 1000 t)		Maize starch/waxy maize (x 1000 t)	
Non-food	1300	Non-food	3000
Food	900	Food	3000
Dextrose/syrups	100	Dextrose/syrups	14200
	2300		20200

- Tabla 3: Consumo de almidón por industrias.
- Tabla 4: Almidón usado como adhesivo.

Tabla 3

Estimated world-wide consumption of starches in main application areas (x 1000 t)

Paper	3600
Adhesive	1400
Textiles	680
Oil field	30
Miscellaneous	250
Food	3740
Dextrose/syrups	15900
	25600

Tabla 4

Starch as adhesive world-wide: 1.4 million tons

Segment	Consumption (x 1000 t)	Starch examples
Corrugated board	1200	Native starches (mainly maize)
Gumming	30	Potato starch ethers
Paper bags	40	Starches with short texture
Wallpaper	20	Crosslinked starch ethers
Formulators	100	Dextrins; various derivatives
Laminating/ winding	10	Oxidized starch ethers; dextrins

- Tabla 5: Almidón destinado a la industria alimentaria.

Starch in food world-wide: 3.7 million tons*

Segment	Consumption (x 1000 t)	Starch examples
Convenience products	900	Crosslinked cold-soluble starches
Bakery products	350	Crosslinked starch acetates
Confectionery	400	Thin-boiling/oxidized starches
Extruded products	200	Crosslinked/native starches
Infant foods	350	Malto-dextrins
Preserved foods	1100	Crosslinked hydroxypropyl starches
Dairy products	200	Crosslinked hydroxypropyl starches
Unsegmented	200	Native starches

*Dextrose/syrups: 15.9 million tons

Weight and composition of component parts of kernels from five grain sorghum varieties (Eckhoff y Watson, 2009).

		Percent dry weight of whole kernel	Composition of kernel parts (% dry basis)			
			Starch	Protein	Fat	Ash
Germ	Range	7.8–12.1	–	18.0–19.2	26.9–30.6	–
	Mean	9.8	13.4[a]	18.9	28.1	10.36[a]
Endosperm	Range	80.0–84.6	81.3–83.0	11.2–13.0	0.4–0.8	0–0.44
	Mean	82.3	82.5	12.3	0.6	0.37
Bran	Range	7.3–9.3	–	5.2–7.6	3.7–6.0[b]	–
	Mean	7.9	34.6[a]	6.7	4.9	2.02[a]
Whole kernel	Range	–	72.3–75.1	11.5–13.2	3.2–3.9[b]	1.57–1.68
	Mean	–	73.8	12.3	3.6	1.65

Contenido aproximado de almidón en granos de diferentes cereales (Fassio *et al.*, 2000).

Cereal	Almidón (%)	
	Grano entero	Endosperma
Maíz	72	88
Trigo	65	79
Arroz	81	90
Sorgo	74	83
Cebada	60	77
Avena	45	70

Adaptado de Haaland (1980).

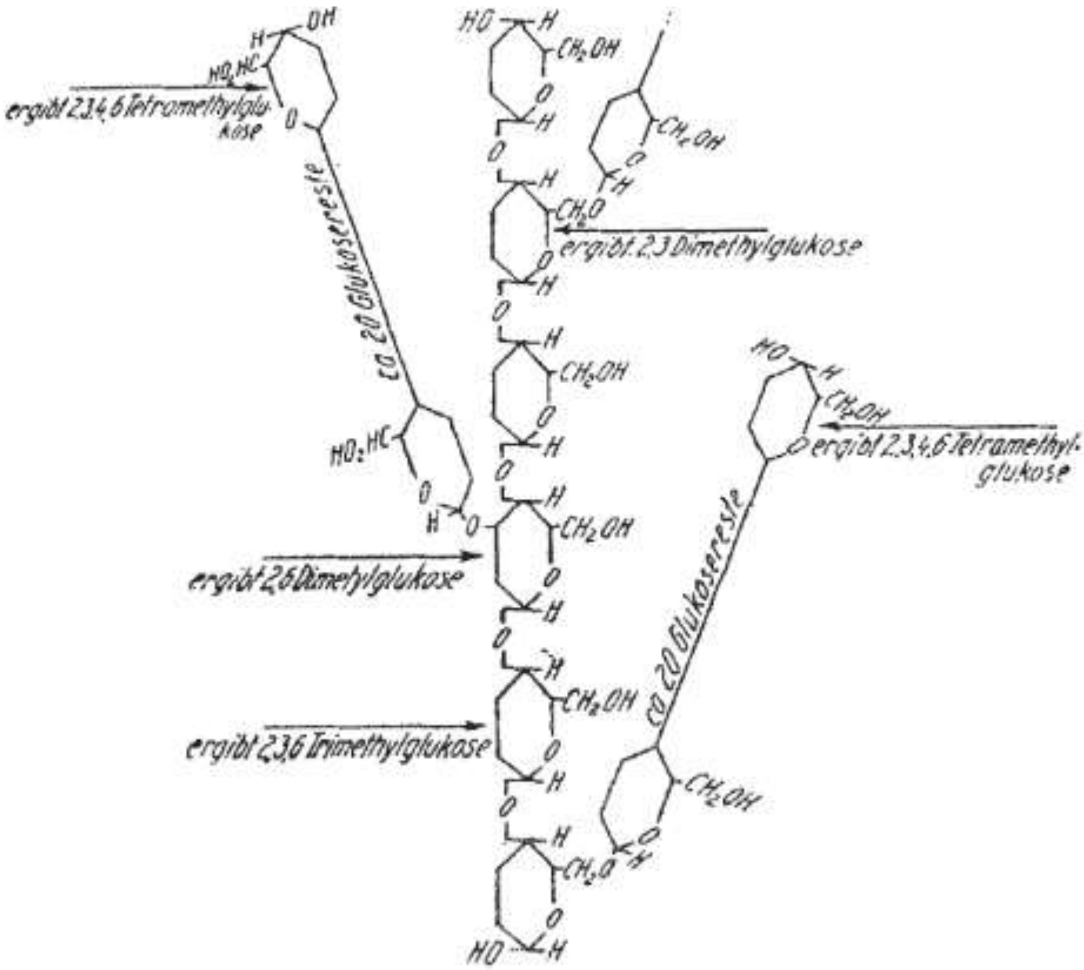
Contenido de amilosa y amilopectina de varios tipos de cereales (Fassio *et al.*, 2000).

Cereal	Amilosa (%)	Amilopectina (%)
Maíz	24	76
Maíz céreo	1	99
Maíz de alta amilosa	75	25
Trigo	25	75
Arroz	18	82
Arroz céreo	1	99
Sorgo	25	75
Sorgo céreo	1	99

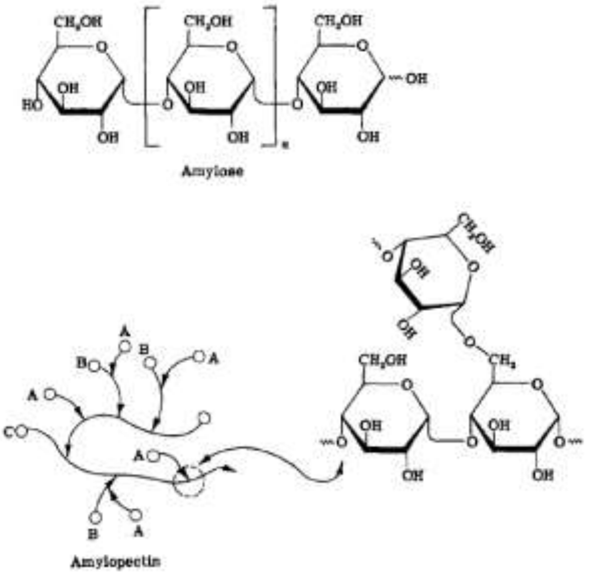
Adaptado de Haaland (1980).

ESTRUCTURA DEL ALMIDÓN.

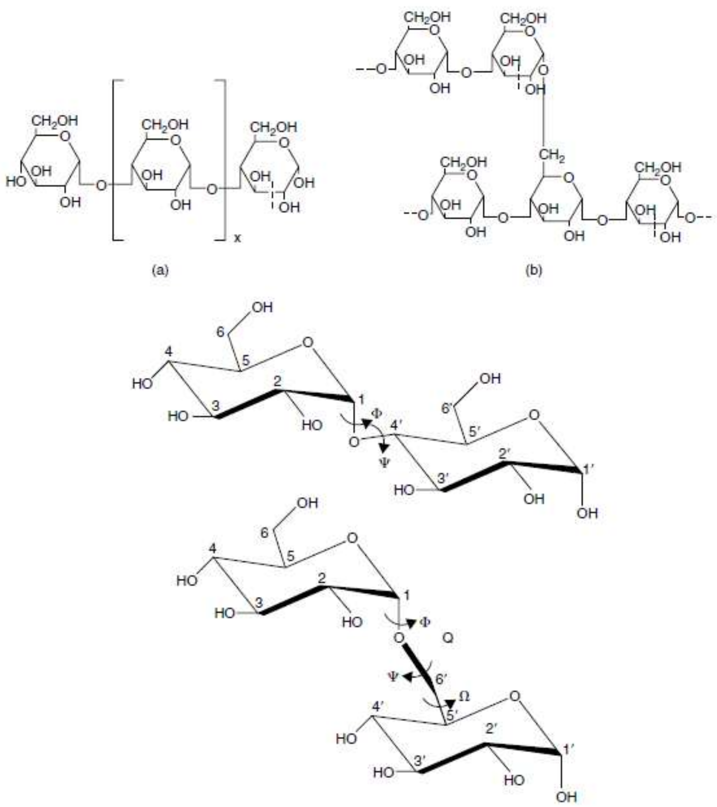
Structure depicting both a-1,3 and a-1,6 linkages also in 1937 by Staudinger and Husemann: U¨ ber hochpolymere Verbindungen. 150. Mitteilung. U¨ ber die Konstitution der Sta¨rke. Liebigs Ann. Chem. 1937, 527, 195–236. Copyright Wiley-VCH Verlag GmbH & Co. KGaA. Reproduced with permission.



Estructura de la amilosa y amilopectina (Macallister, 1979).



Schematic diagram of (a) amylose; and (b) amylopectin with a branch point at the O6 position. (c) Schematic representation of the disaccharide components of starch: maltose [αGlc-(1→4)Glc] and isomaltose [αGlc(1→6)Glc] along with the torsion angle (Pérez, Baldwin y Gallant, 2009).



Longitudinal 10-μm bisection of a steeped dent corn kernel (magnified *6, iodine stained). Note how starch has been lost from floury endosperm cells as a result of sulfur dioxide action (Eckhoff y Watson, 2009).

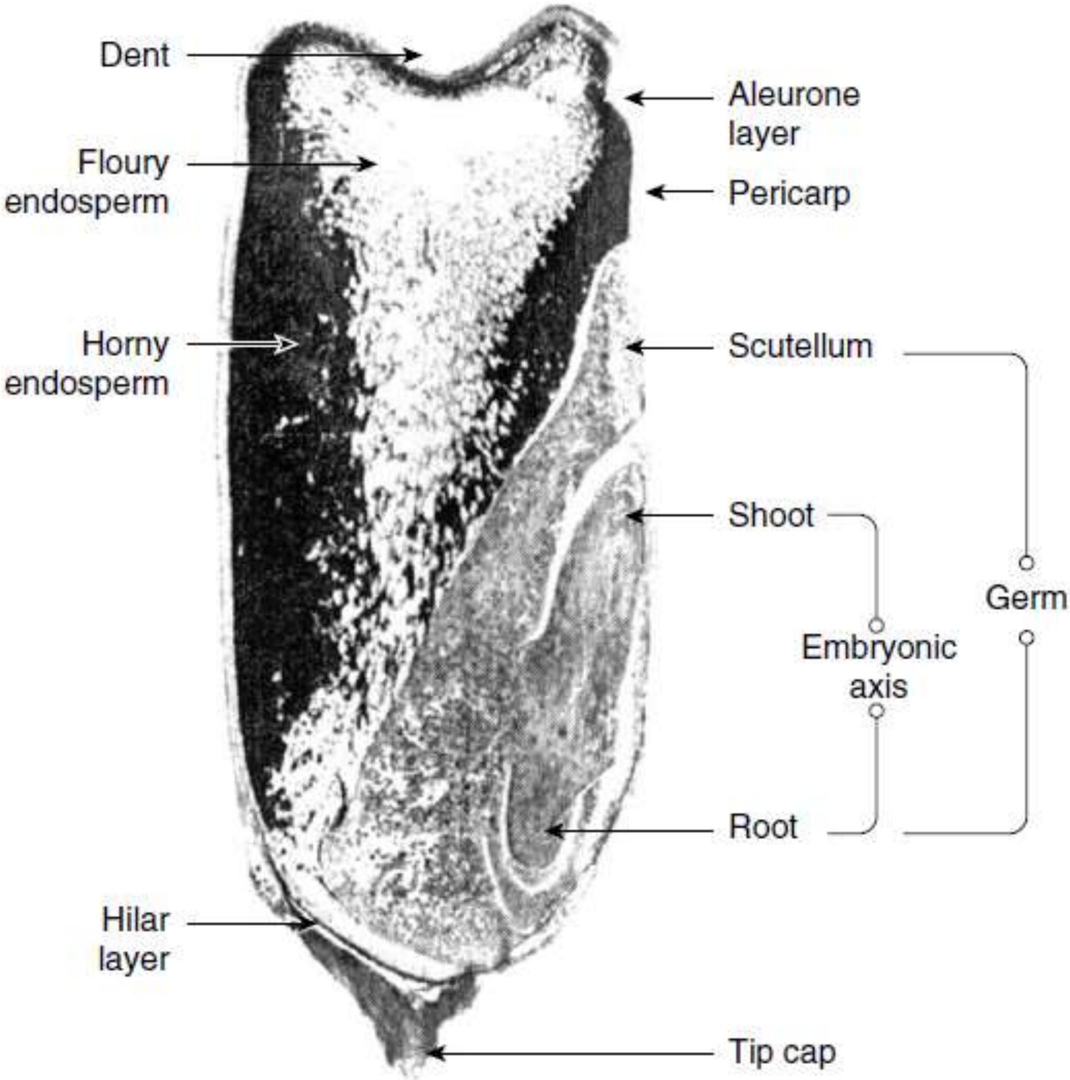
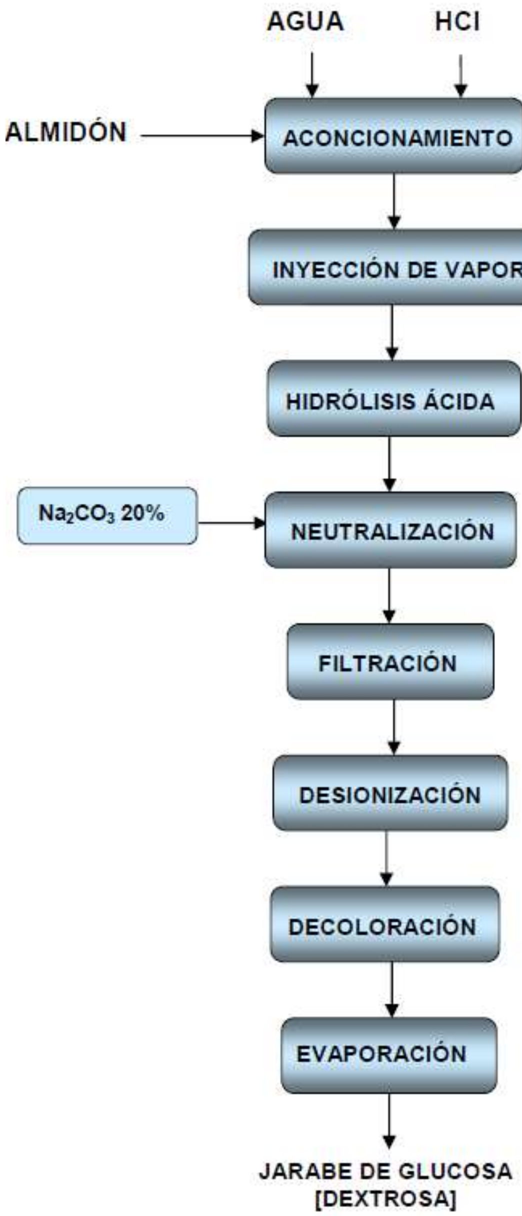


Diagrama de bloques del proceso (hidrólisis ácida). (Morales, 2004) .



Production of de-ionised acid converted 35 or 42 DE glucose syrup pp.27 Glucose Syrups Technology and Applications (Hull, 2010).

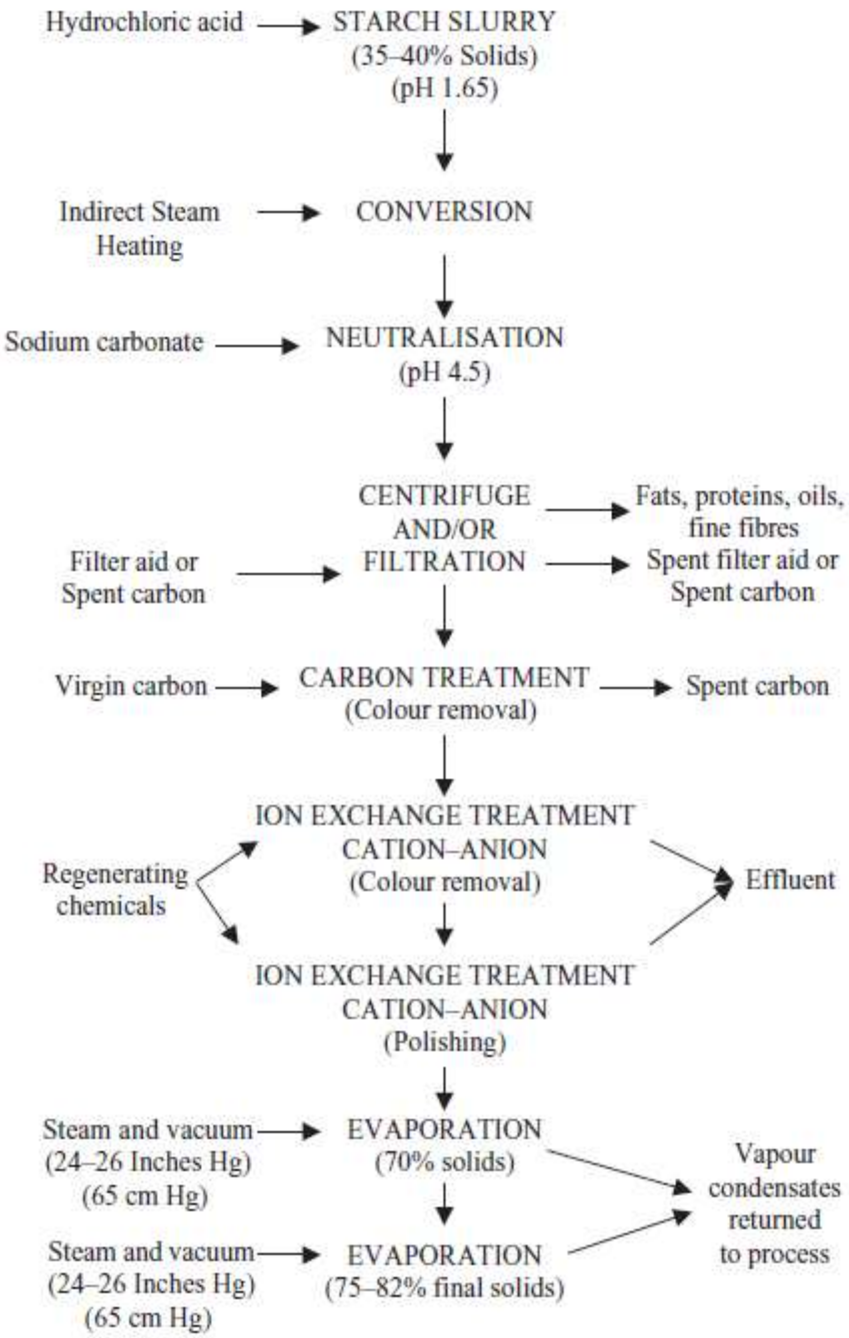
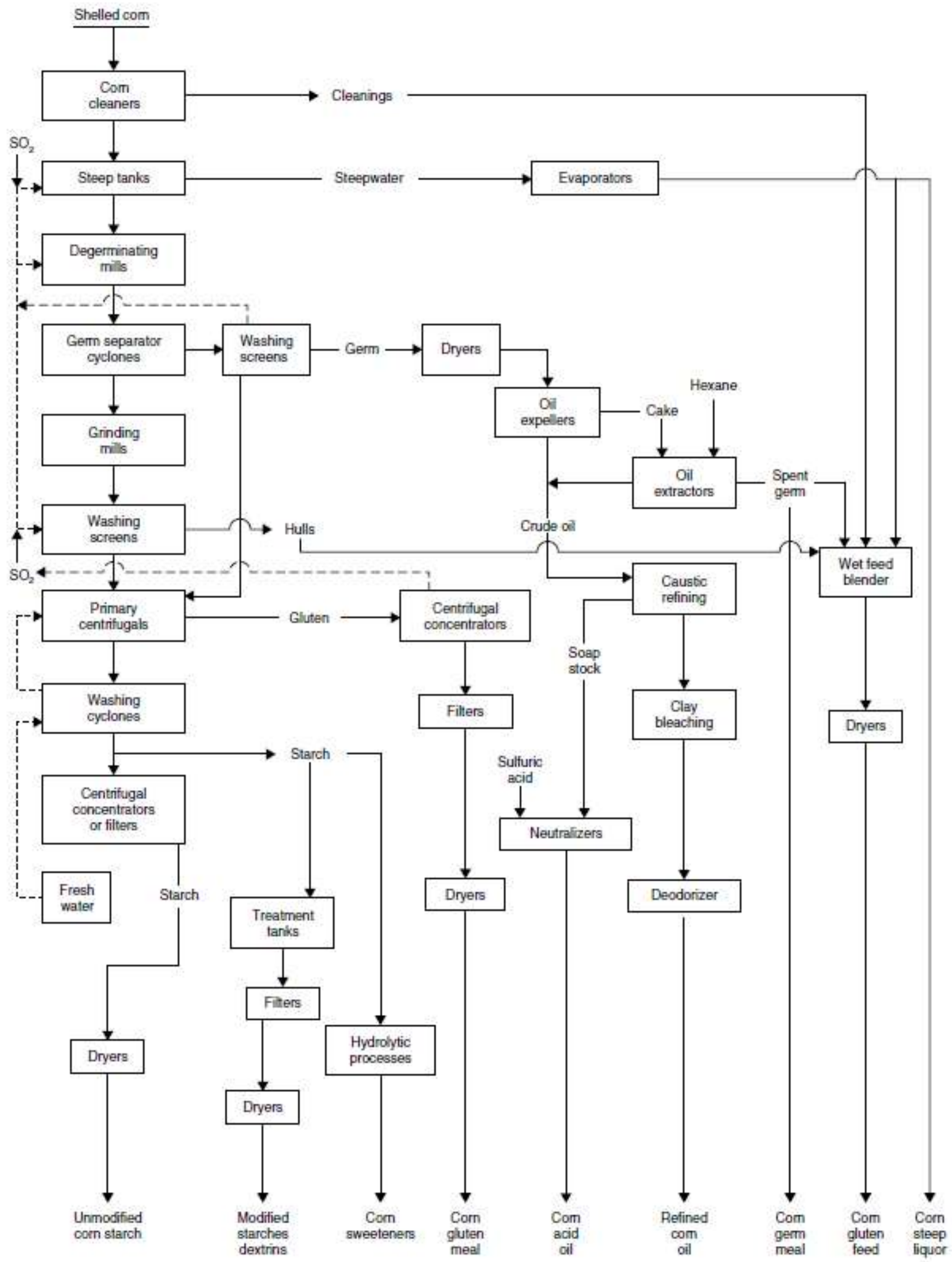


Diagrama de flujo del almidón de maíz (Eckhoff y Watson, 2009).



Detalles de la disposición, del equipo y del flujo de agua y de la corriente del proceso que emplea el sistema de centrifugación de separación en cuatro etapas de alta densidad. (Eckhoff y Watson, 2009).

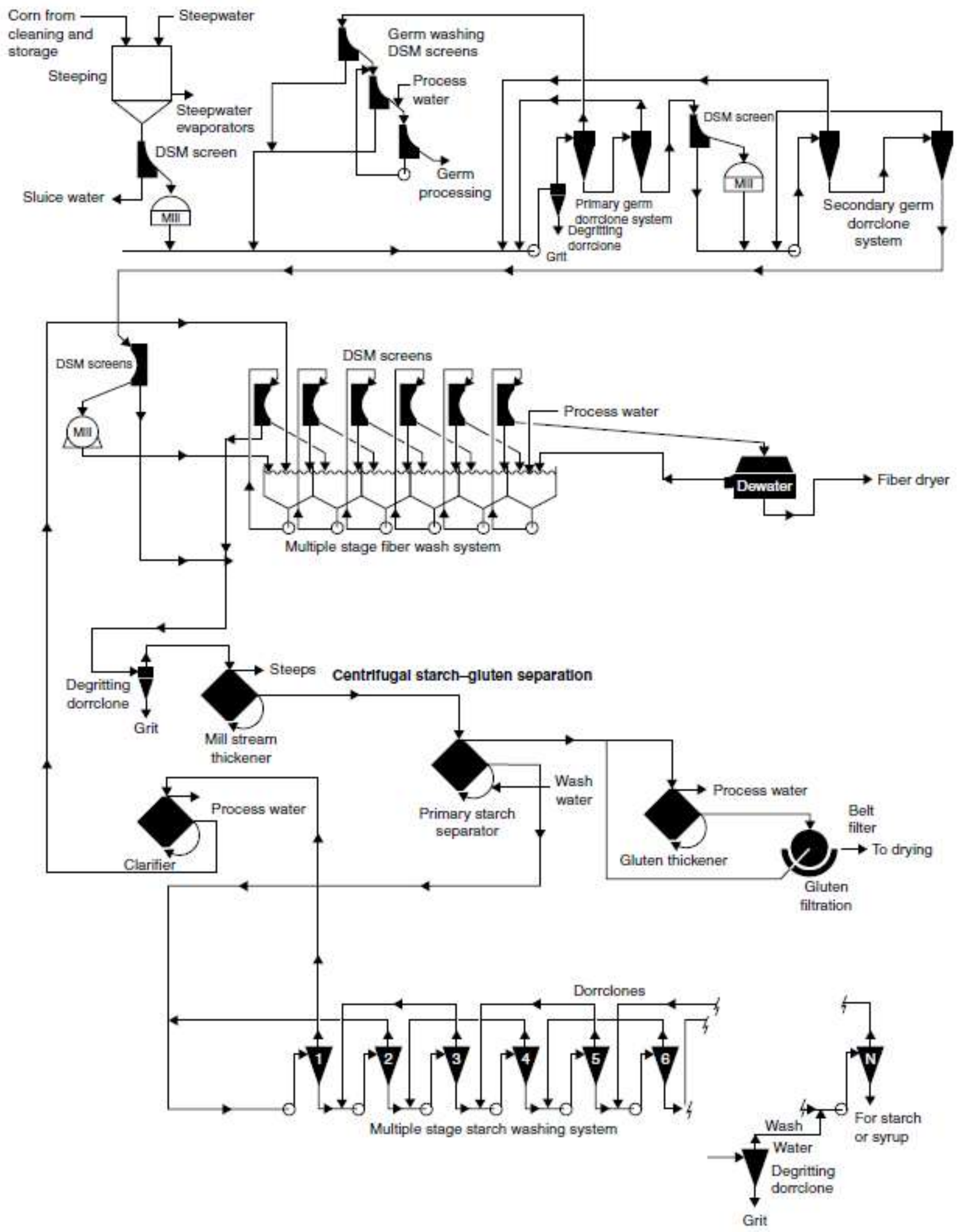
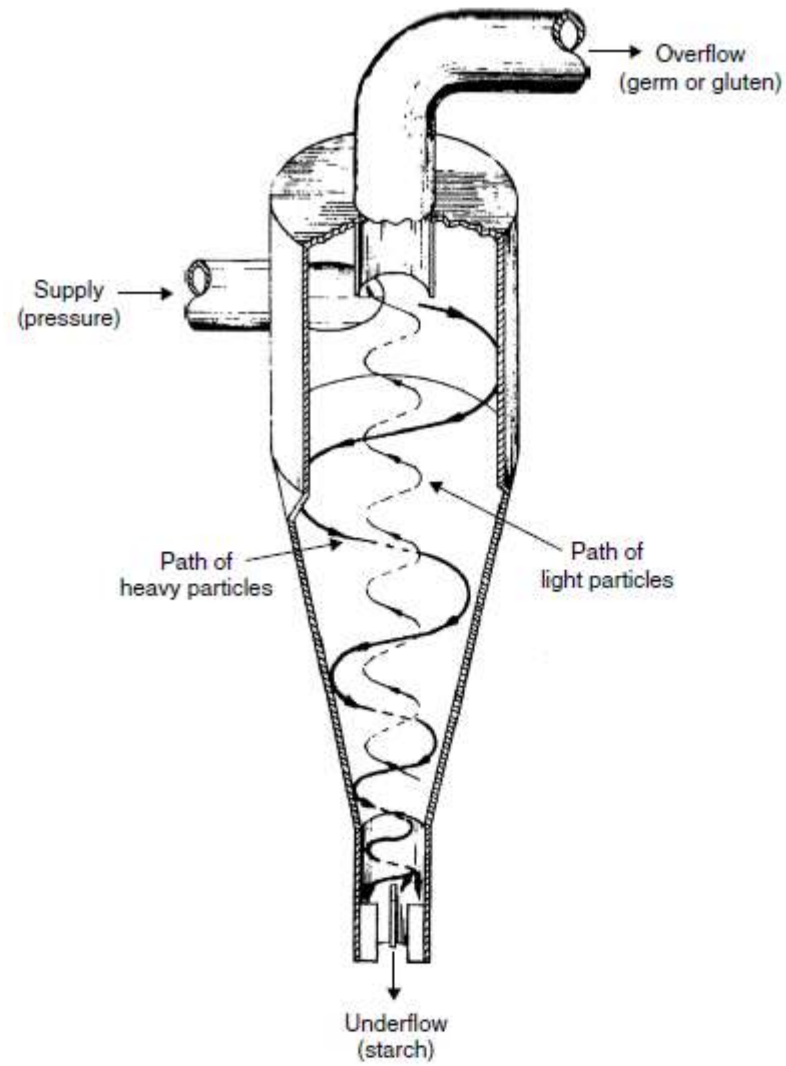
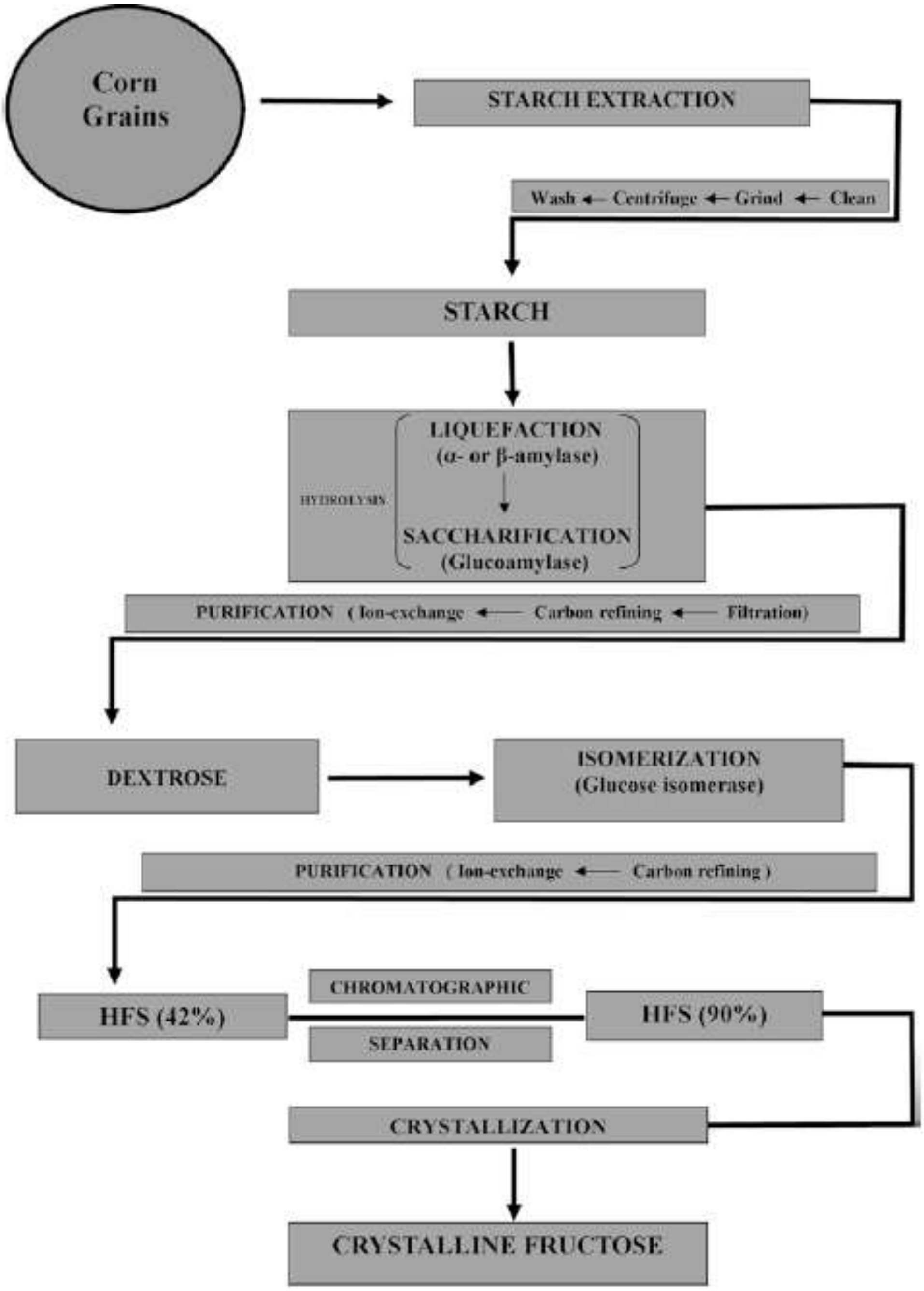
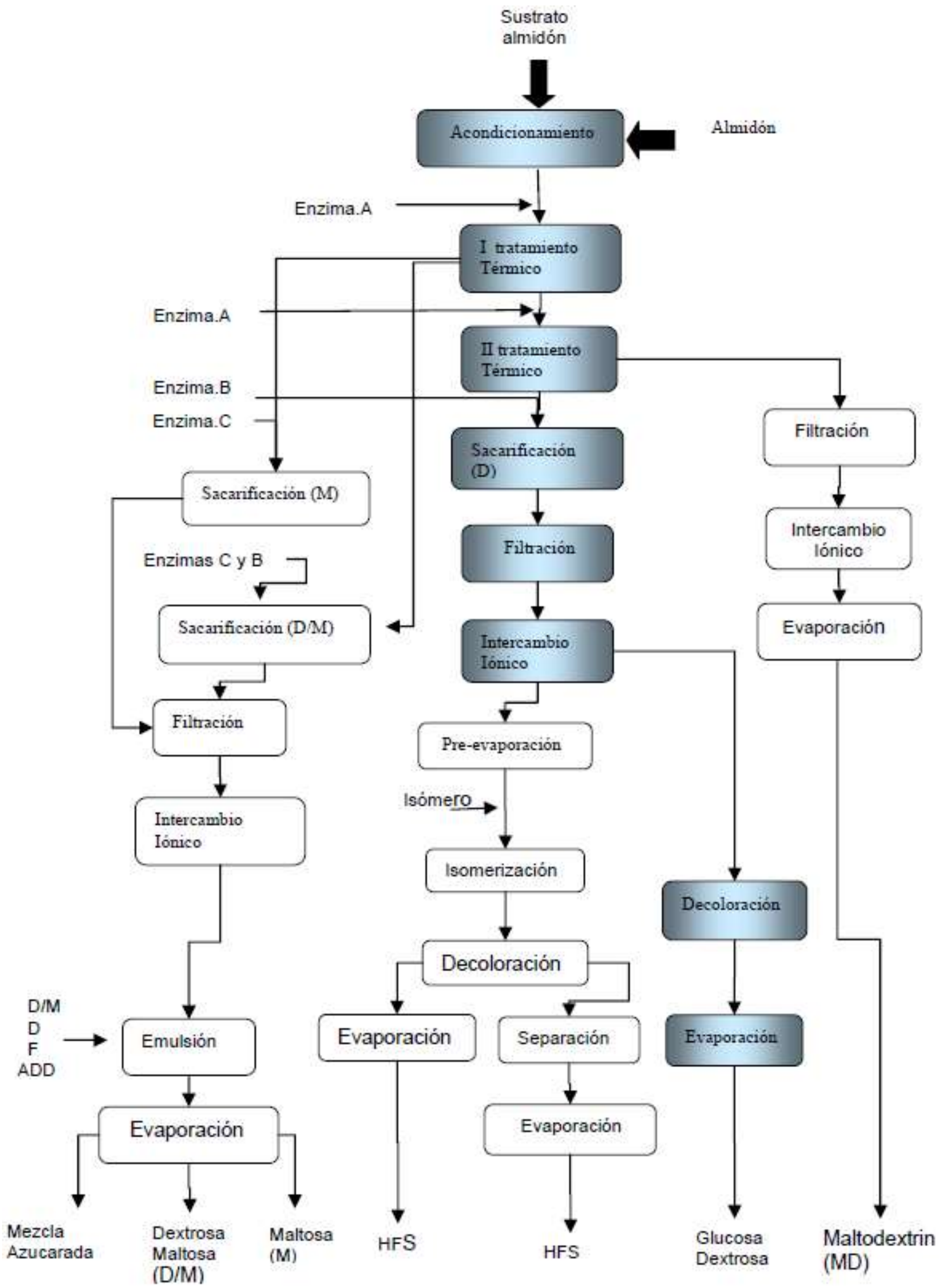


Diagrama de corte de un separador de hidrociclón (Eckhoff y Watson, 2009).

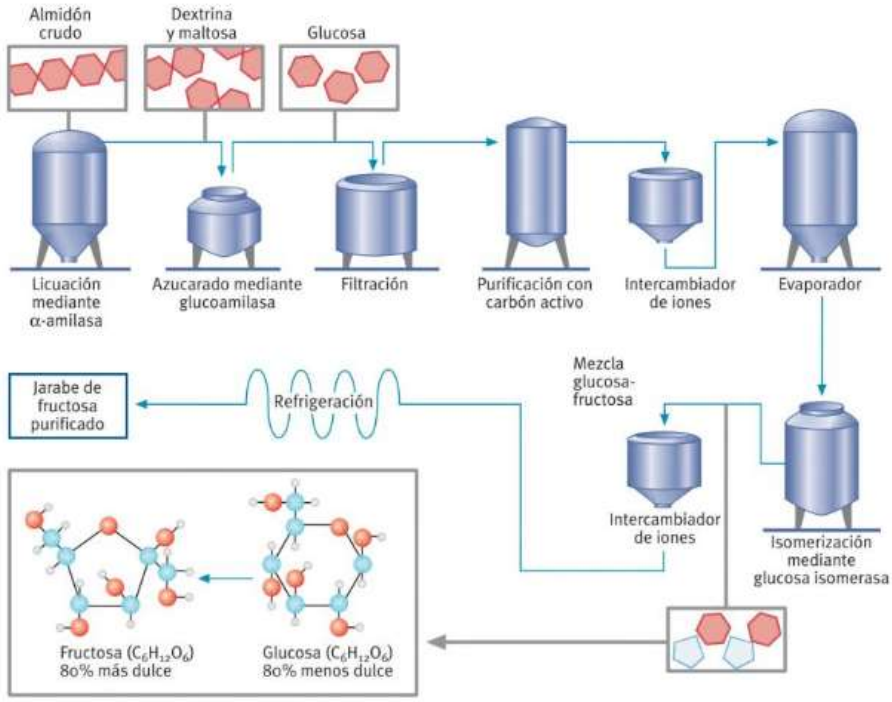



Corn Grains
STARCH EXTRACTION
Wash ← Centrifuge ← Grind ← Clean
STARCH
HYDROLYSIS
LIQUEFACTION
(α- or β-amylase)
SACCHARIFICATION
(Glucoamylase)
PURIFICATION (Ion-exchange ← Carbon refining ← Filtration)
DEXTROSE
ISOMERIZATION
(Glucose isomerase)
PURIFICATION (Ion-exchange ← Carbon refining)
HFS (42%)
CHROMATOGRAPHIC
SEPARATION
HFS (90%)
CRYSTALLIZATION
CRYSTALLINE FRUCTOSE

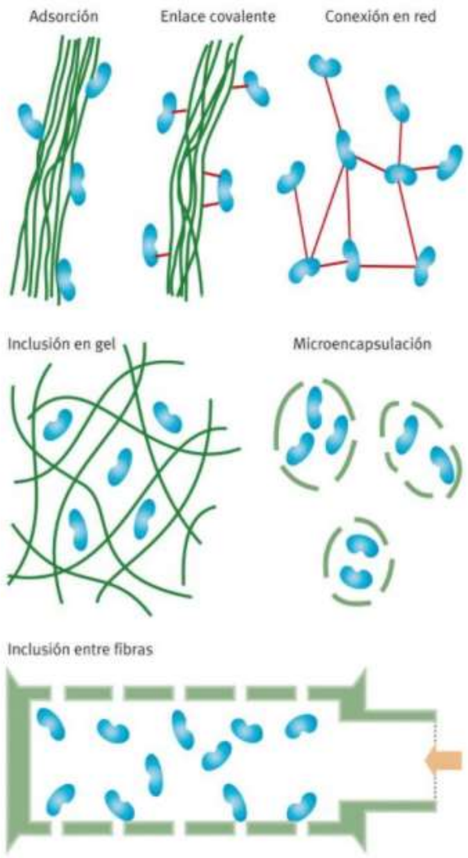
Algunos procesos del almidón. Disponible en: www.lurgi-lifescience.com/l.pdef



Obtención del jarabe de fructosa a partir del almidón. Disponible pp.43 Biotecnología para principiantes (Renneberg et al., 2012).



Esquema de enzimas inmovilizadas. Disponible pp.41 Biotecnología para principiantes (Renneberg et al., 2012).



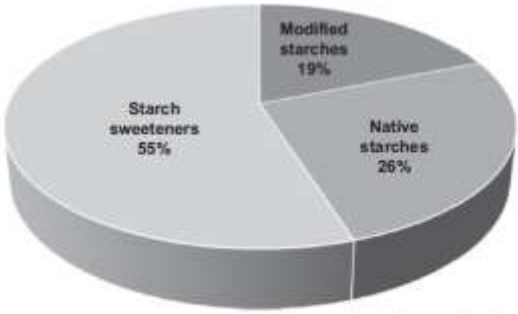


Figure 3.3 European consumption of starch and starch derivatives for 2015. *(Data from Starch Europe, n.d. Retrieved from: http://www.aaf-eu.org; https://www.starch.eu/european-starch-industry.)*

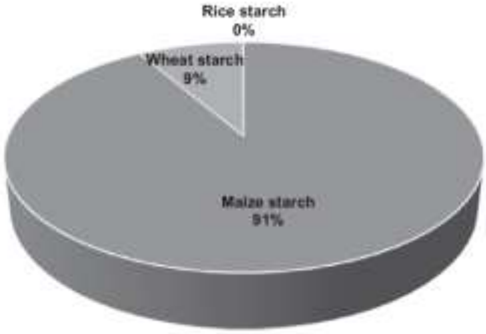


Figure 3.2 Estimated world production of cereal starches. *(Based on Waterschoot, J., Gomand, S.V., Fierens, E., Delcour, J.A., 2015. Production, structure, physicochemical and functional properties of maize, cassava, wheat, potato and rice starches. Starch Starke 67, 14–29.)*

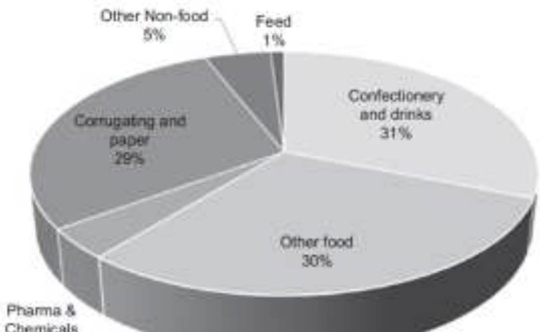


Figure 3.1 Main starch applications—2015. *(Data from Starch Europe, n.d. Retrieved from: http://www.aaf-eu.org; https://www.starch.eu/european-starch-industry.)*

Table III. Genetic and Protein Engineering Techniques and Technologies to Improve the Properties of Example Industrial Enzymes.

Property Required	*Engineering Modification Procedure*	*How the Procedure Works*	*Examples*
		Genetic Engineering	
Increased productivity/ yield	**Homologous gene transfer**	The number of gene copies coding for the enzyme are increased	**Xylanase** that is used to enhance the raising of bread dough when baked (*13*)
		ProteinEngineering	
Decreased need for calcium addition	**Site-Directed Mutagenesis**	Additions/deletions/ substitutions of specific amino-acids and/or protein folds are introduced to the enzyme encoding DNA sequence	**α-Amylase** in starch liquefaction (*14*)
Increased thermal and pH stability	**Random Mutagenesis (Directed evolution)**	Mutations at random along the entire length of a gene encoding the enzyme are introduced using error-prone PCR, DNA shuffling, chemical mutagenesis, UV irradiation techniques, etc. (*14*)	**α-Amylase** in starch liquefaction (*14*)

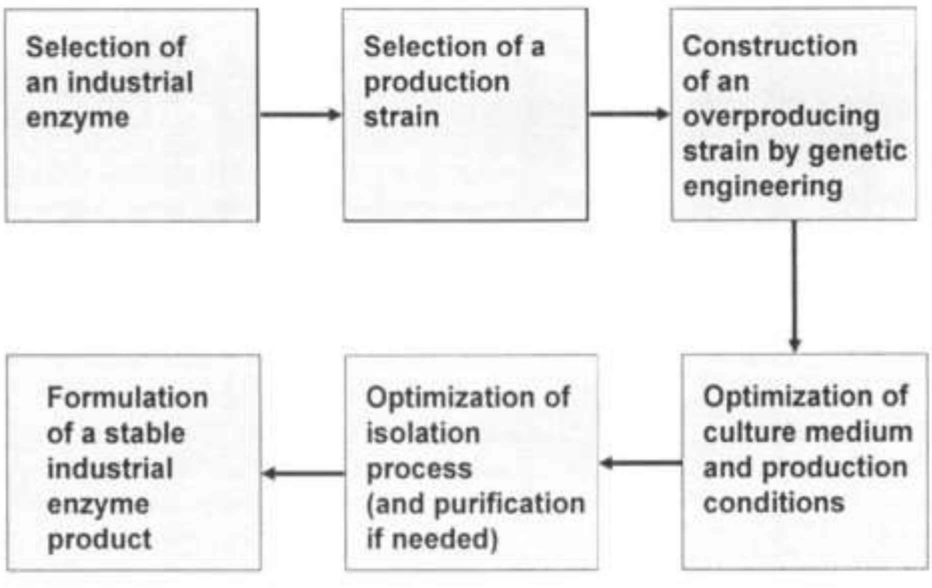
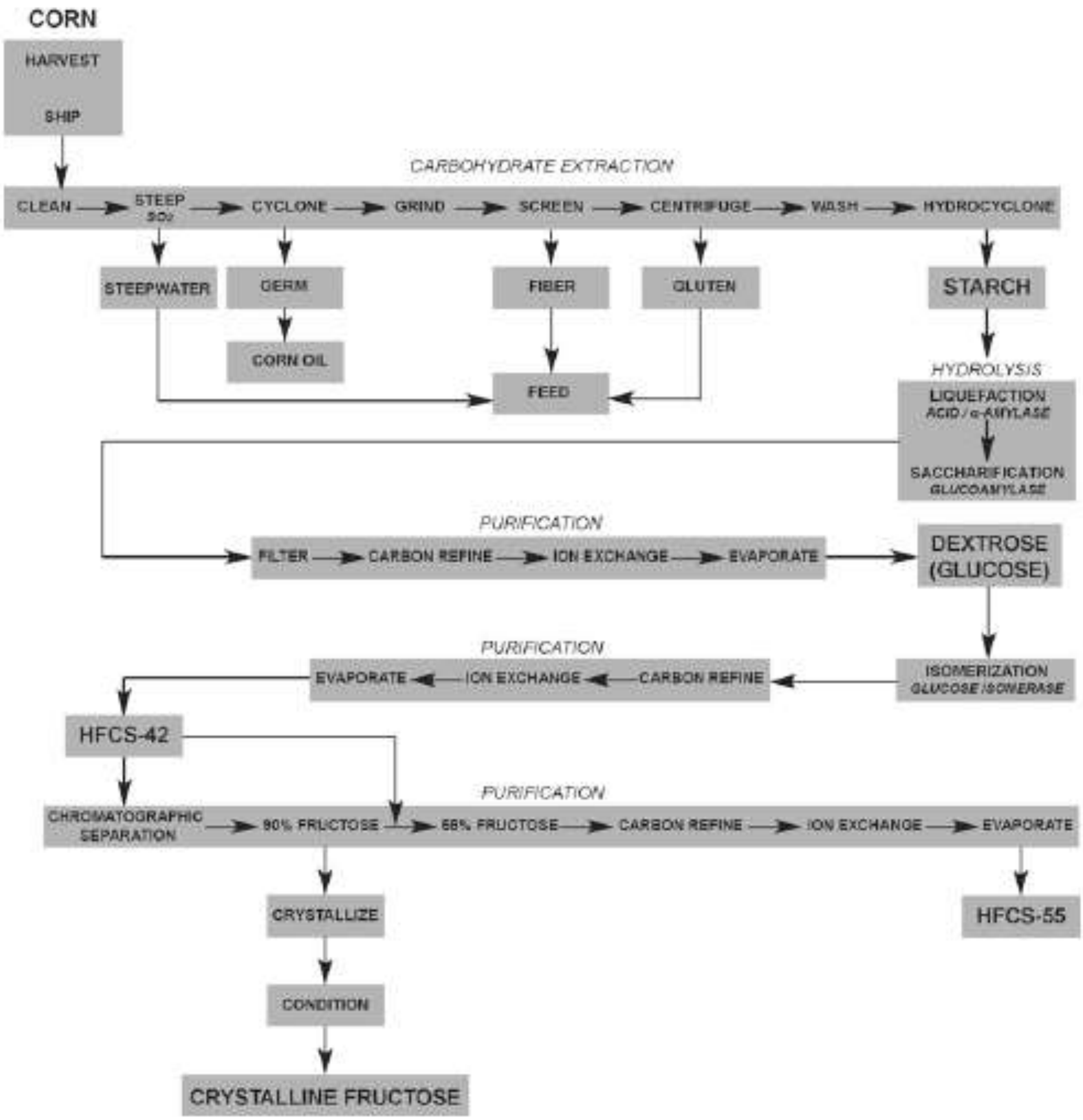
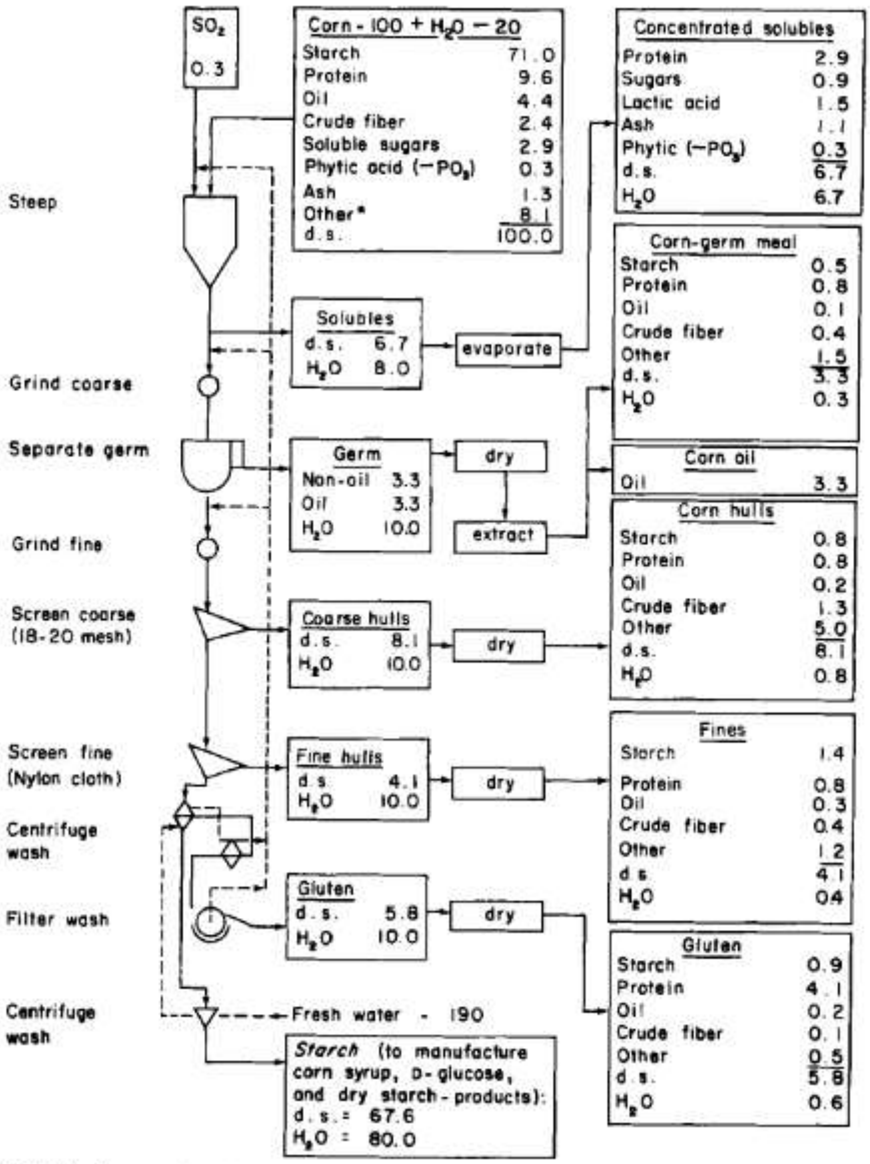


Figure 1. General scheme of process phases in industrial enzyme production.

Diagrama de flujo de HFCS, pp.20 *Fructose, High Fructose Corn Syrup, Sucrose and Health* (Rippe,2014)



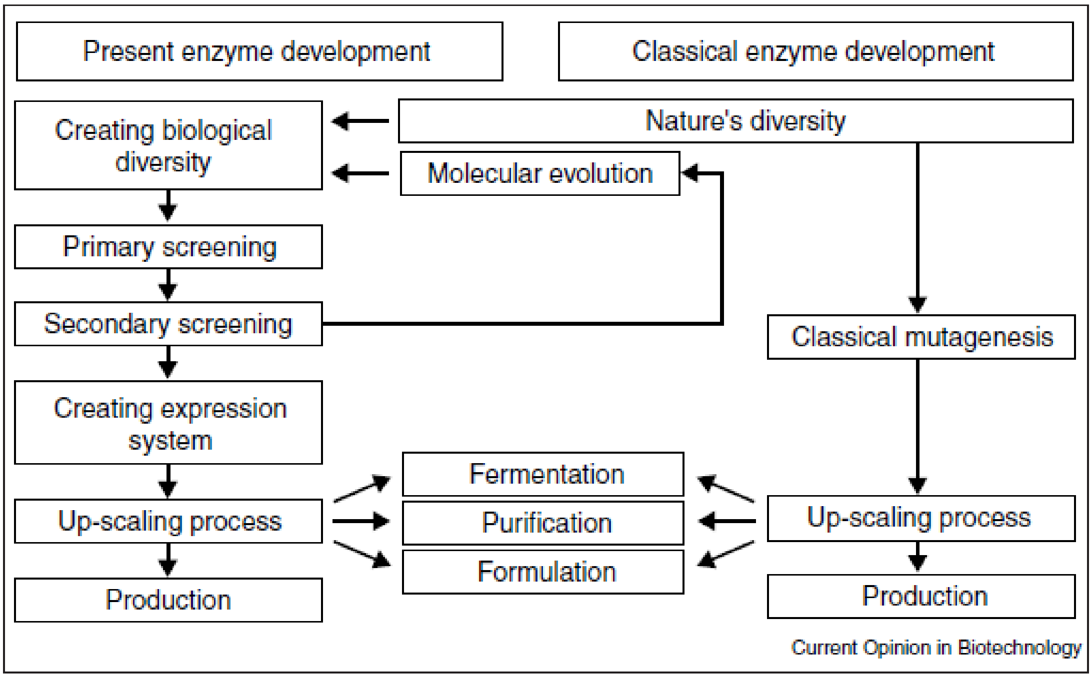
Procesos de molienda húmeda y separación de maíz. [Base: 100 partes en peso de maíz de sustancia seca] (Macallister, 1979).



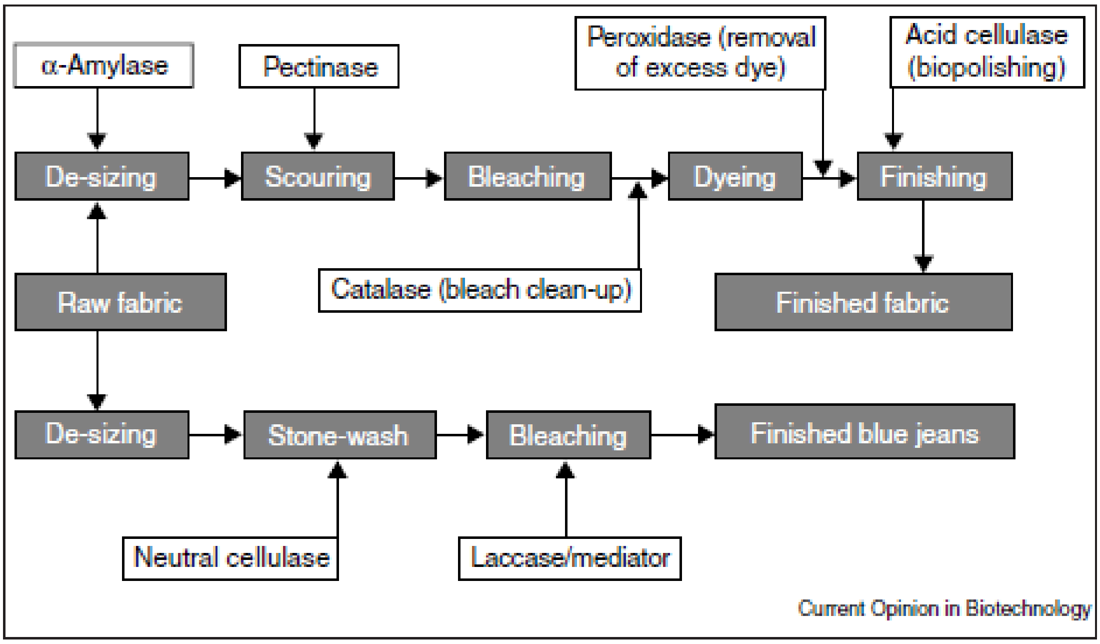
* Mainly glycans other than starch and crude fiber.

Industrial enzyme Industrial enzyme applications Ole Kirk*, Torben Vedel Borchert and Claus Crone Fuglsang (Kirk, Borchert y Fuglsang, 2002).

The steps involved in classical versus state-ofthe- art development of enzymes.



The steps involved in classical versus state-ofthe- art development of enzymes.



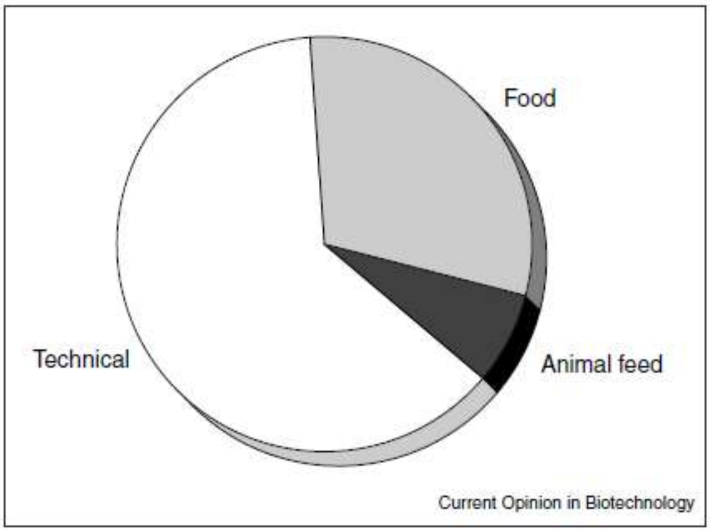
Enzymes used in various unit operations in textile wet processing and the manufacturing of Denim (Kirk, Borchert y Fuglsang, 2002).

Table 1

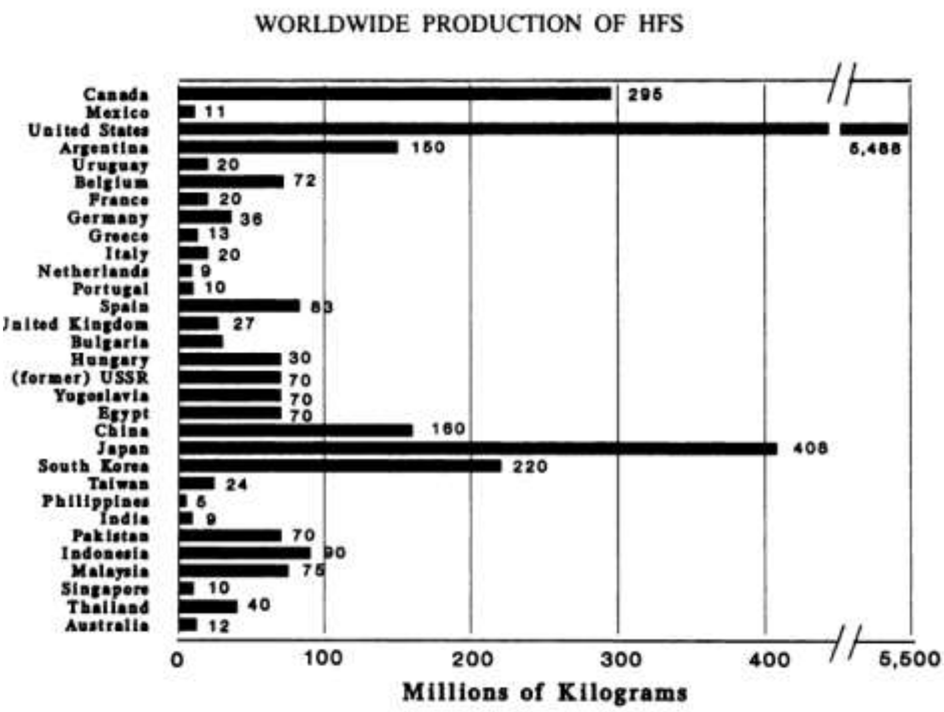
Enzymes used in various industrial segments and their applications.

Industry	Enzyme class	Application
Detergent (laundry and dish wash)	Protease	Protein stain removal
	Amylase	Starch stain removal
	Lipase	Lipid stain removal
	Cellulase	Cleaning, color clarification, anti-redeposition (cotton)
	Mannanase	Mannanan stain removal (reappearing stains)
Starch and fuel	Amylase	Starch liquefaction and saccharification
	Amyloglucosidase	Saccharification
	Pullulanase	Saccharification
	Glucose isomerase	Glucose to fructose conversion
	Cyclodextrin-glycosyltransferase	Cyclodextrin production
	Xylanase	Viscosity reduction (fuel and starch)
	Protease	Protease (yeast nutrition – fuel)
Food (including dairy)	Protease	Milk clotting, infant formulas (low allergenic), flavor
	Lipase	Cheese flavor
	Lactase	Lactose removal (milk)
	Pectin methyl esterase	Firming fruit-based products
	Pectinase	Fruit-based products
	Transglutaminase	Modify visco-elastic properties
Baking	Amylase	Bread softness and volume, flour adjustment
	Xylanase	Dough conditioning
	Lipase	Dough stability and conditioning (*in situ* emulsifier)
	Phospholipase	Dough stability and conditioning (*in situ* emulsifier)
	Glucose oxidase	Dough strengthening
	Lipoxygenase	Dough strengthening, bread whitening
	Protease	Biscuits, cookies
	Transglutaminase	Laminated dough strengths
Animal feed	Phytase	Phytate digestibility – phosphorus release
	Xylanase	Digestibility
	β-Glucanase	Digestibility
Beverage	Pectinase	De-pectinization, mashing
	Amylase	Juice treatment, low calorie beer
	β-Glucanase	Mashing
	Acetolactate decarboxylase	Maturation (beer)
	Laccase	Clarification (juice), flavor (beer), cork stopper treatment
Textile	Cellulase	Denim finishing, cotton softening
	Amylase	De-sizing
	Pectate lyase	Scouring
	Catalase	Bleach termination
	Laccase	Bleaching
	Peroxidase	Excess dye removal
Pulp and paper	Lipase	Pitch control, contaminant control
	Protease	Biofilm removal
	Amylase	Starch-coating, de-inking, drainage improvement
	Xylanase	Bleach boosting
	Cellulase	De-inking, drainage improvement, fiber modification
Fats and oils	Lipase	Transesterification
	Phospholipase	De-gumming, lyso-lecithin production
Organic synthesis	Lipase	Resolution of chiral alcohols and amides
	Acylase	Synthesis of semisynthetic penicillin
	Nitrilase	Synthesis of enantiopure carboxylic acids
Leather	Protease	Unhearing, bating
	Lipase	De-pickling
Personal care	Amyloglucosidase	Antimicrobial (combined with glucose oxidase)
	Glucose oxidase	Bleaching, antimicrobial
	Peroxidase	Antimicrobial

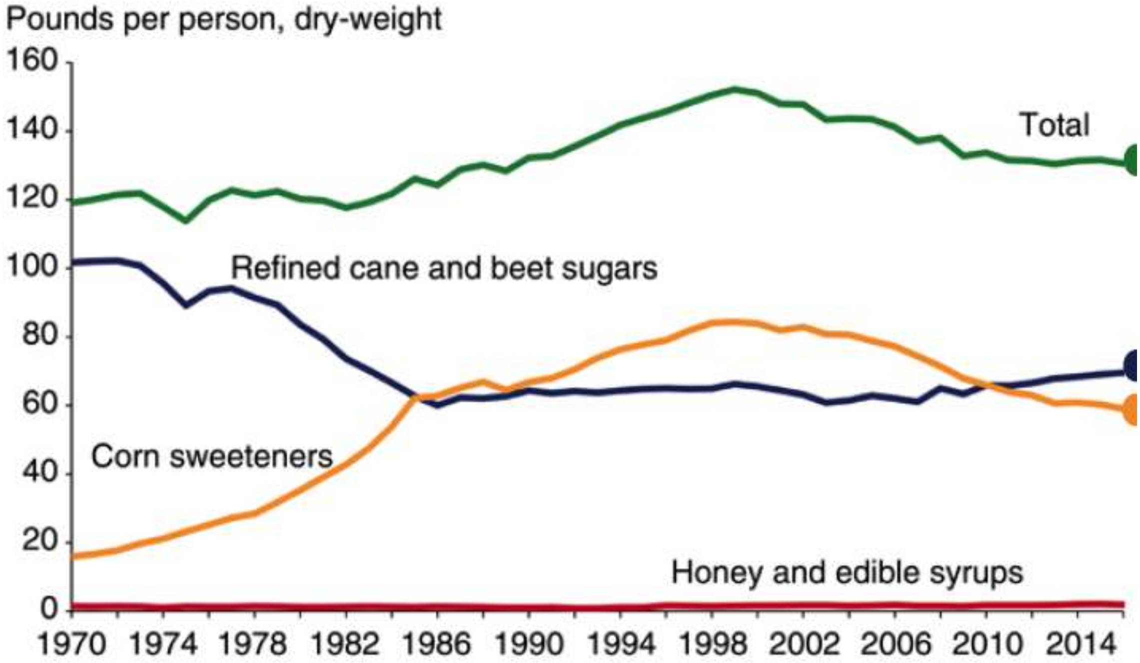
Segmentación del mercado de enzimas industriales. En el año 2000, el mercado de enzimas ascendió a $ 1.5 mil millones. El segmento “Technical” comprende la industria de detergente, almidón, textil, alcohol, combustible, cuero y pulpa e industria del papel (Kirk, Borchert y Fuglsang, 2002).



Disponibilidad estimada de jarabe con alto contenido de fructosa, por país, 1990. La disponibilidad es la cantidad de producto disponible para el consumo. Generalmente sobrestima la cantidad realmente consumida, debido a muchos factores, incluida la pérdida de producto durante el almacenamiento, transporte y composición del producto (Vuilimier, 1993) .



El azúcar total disponible aumentó aproximadamente un 20% entre 1970 y 2000, donde alcanzó un máximo de 152 libras por persona al año. Desde 2000, total El edulcorante ha disminuido ligeramente. Azúcar refinado (caña y remolacha) y maíz La disponibilidad de edulcorantes es similar a alrededor de 60 libras por persona al año.



Notes: Corn sweeteners include high-fructose corn syrup (HFCS), glucose syrup, and dextrose. Edible syrups include sorgo (sweet sorghum), maple and sugarcane syrup, edible molasses, and edible refiners' syrup.
Source: USDA, Economic Research Service, Food Availability Data.

Eckhoff, S. R. y Watson, S. A. (2009) *Corn and Sorghum Starches: Production*. Third Edit, *Starch*. Third Edit. Elsevier Inc.
DOI: 10.1016/B978-0-12-746275-2.00009-4.

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Gomez, C. (2007) *El libro blanco del azúcar*, *UOC Nutrició*. Disponible en: http://www.madrid.org/cs/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobheadername1=Content-disposition&blobheadername2=cadena&blobheadervalue1=filename%3DLibro-Blanco-del-Azucar-Indice-Interactivo.pdf&blobheadervalue2=language%3Des%26site%3DH.

Kirk, O., Borchert, T. V. y Fuglsang, C. C. (2002) «Industrial enzyme applications», *Current Opinion in Biotechnology*, 13(Abril), pp. 345-351.
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DOI: 10.1016/B978-0-12-746275-2.00005-7.

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Rippe, J. M. (2014) «Fructose, high fructose corn syrup, sucrose and health», *Fructose, High Fructose Corn Syrup, Sucrose and Health*, pp. 1-379.
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DOI: 10.1002/star.201200190.

Vuilimier, S. (1993) «Worldwide crystalline of high-fructose syrup requests», *The American Journal of Clinical Nutrition*, (February), pp. 733-736.