DOCDEL DELIVERY NOTE

BioChemtek
Miss, Sonia Rech
Building : 20

DDS No. : 5159
Client No. : 241620
Order No. : VWE5P0004400044NP
Document Type : ELECTRONIC IF AVAILABLE
Date : 03-DEC-04

DDS No	Document Type	Total
5159	ELECTRONIC IF AVAILABLE	0.00

Book/Report Title :

Author : MUNRO, EM

Journal Reference : CEREAL FOODS WORLD

Article/Paper Title : CORN REFINING

Year: 1994 Volume: 39 Pages: 552-555

*** PAYMENT WILL BE EFFECTED THROUGH PMS ***

Corn Refining: A Classic Value-Added Success Story

E. M. MUNRO
Corn Refiners Association, Inc.
Washington, DC

If the value-added story had to be told through one industry alone, corn refining could be one of the best examples to choose. Corn refining became one of the first modern processing industries to grow out of the industrial and scientific revolutions of the 19th century. Traditional grain processing added value by changing the physical form of grain (e.g., grinding wheat into flour). Corn wet milling, however, used a complex mix of chemistry, grinding, and separation to split grain into its major components--starch, gluten (protein), fiber, and oil (Fig. 1). Out of the process came products the world had never seen before.

Corn wet milling has emphasized science and new product creation ever since. Corn refining's growth—in the amount of corn processed, the number of products offered, and the applications for those products—reflects generations of technological progress. Corn wet millers do more than add value to their raw material-- they build multiple layers of value in a continuum that continues to reach out to new generations of products from corn. The industry plays a distinctive value-added role in another respect: Value-added corn products make it possible for food and industrial users to add further value to their own products.

A Value-Added Continuum

Comparing the relative value of a bushel of corn to its processed value demonstrates the layers of value added by each new generation of refined corn products. Originally, corn refiners produced only starch or glucose syrup, failing to recover coproducts such as oil and animal feed. Even that minimal level of recovery, however, represents added value. Translated to current terms, a bushel of corn that sold for $2.25–$2.50 would produce about $3.50 worth of corn starch (1). (Comparative values in this and the following paragraphs are estimated based on recent years' annual average prices for corn and corn-derived products and do not take into account industry expenditures for plants, other raw materials, energy, or labor.) By the early decades of this century, refiners began reclaiming the fiber, gluten, and oil and selling it as corn gluten feed, corn gluten meal, and corn oil. Adding these coproduct credits would increase the value of a milled bushel of corn to around $4.75.

Improvements in process control, the development of enzyme conversions, and new technology such as ion exchange purification have meant major improvements in corn syrup since the 19th century. Today, a bushel of corn milled into coproducts and corn syrup (glucose) would bring in about $6.50.

Dextrose and high fructose corn syrups (HFCS) represent additional layers of added value in corn refining. Translating a bushel into HFCS containing 55% fructose or dextrose would bring its value, with coproducts, to over $9.00, almost four times the value of the raw ingredient.

In these and other products-- modified

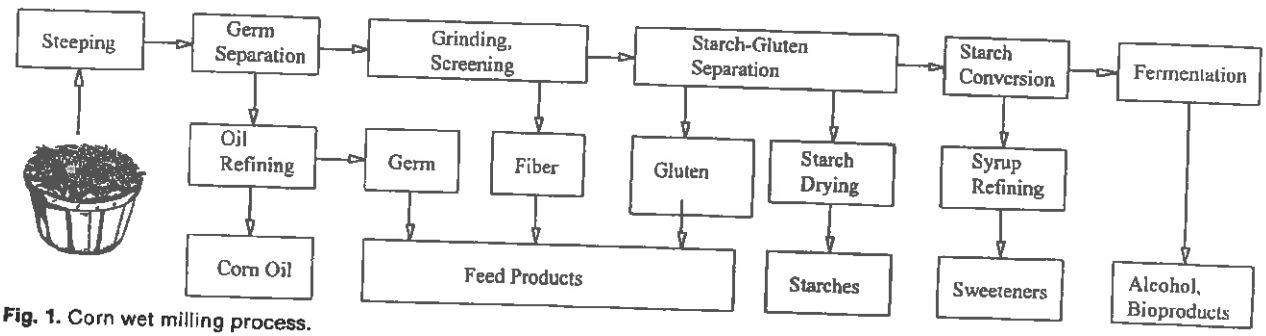

Fig. 1. Corn wet milling process.

starches, ethanol, the emerging world of bioproducts- corn refiners have invested capital, labor, and new technology to achieve generation after generation of new higher value corn products. During this process, the industry has grown in size, in the number of products it offers, and in the end markets for those products (Fig. 2).

In 1934, corn wet millers shipped less than four billion pounds of products and used an estimated 65 million bushels of corn (industry and government estimates). Last year, the industry purchased nearly 1.2 billion bushels of corn worth $2.7 billion (2). It shipped 46.6 billion pounds of products, plus over 700 million gallons of ethanol, adding $4.5 billion in value through the refining process. (Estimates are based on USDA corn usage statistics and industry sources. Added-value estimate calculated based on USDA statistics on annual average prices for corn and corn products. Wet milling share of use for fuel ethanol estimated from industry sources.)

Helping Other Industries Add Value

A survey of supermarket label listings commissioned by the Corn Refiners Association in 1989 produced a remarkable snapshot of the extent of corn product use in modern food processing. Even without the nonfood applications and the uses in packaging, the survey found nearly 4,000 discrete uses of refined corn products.

Only a few applications represent direct consumer use of refined corn products –corn oil, corn syrup, and corn starch. Most represent functional contributions essential to the complex formulations in modern food processing. Thus, a label that lists corn syrup solids, dextrose, glucose syrup, or corn starch reflects an added value product built on the various functional contributions these ingredients provide.

Starch applications demonstrate the refining industry's importance to value-added retail products particularly well. Corn refiners' ongoing efforts to tailor their products to users' needs has meant

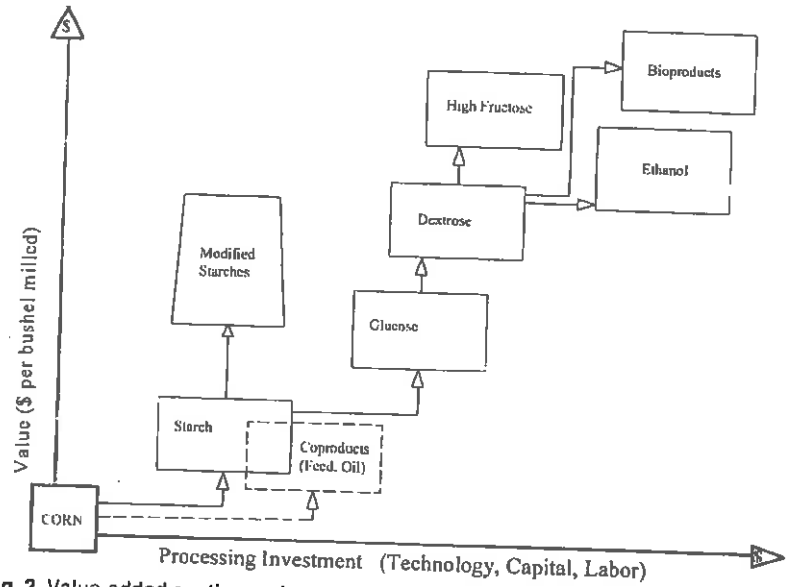

Fig. 2. Value-added continuum in corn wet milling.

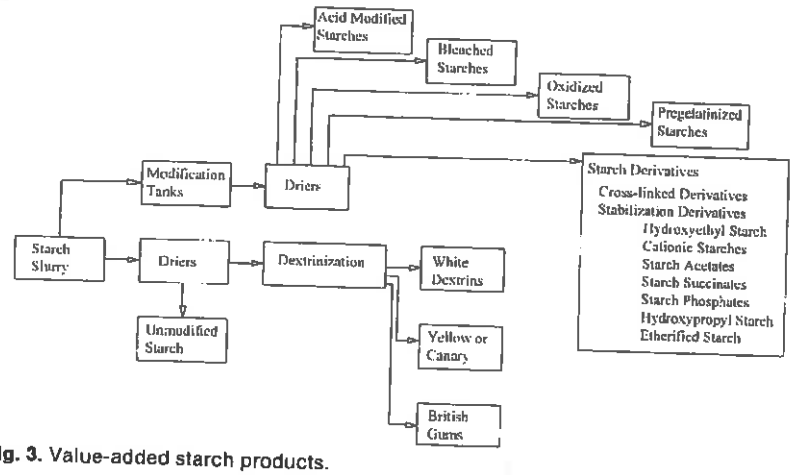

Fig. 3. Value-added starch products.

a proliferation in the types and extent of starch modification, a development especially important to food processors. According to a chapter in *Starch Chemistry and Technology*, frozen, instant, dehydrated, encapsulated, heat-and-serve foods, and cold-water swelling products would not be economically competitive without the special rheological properties obtained by chemical modification (3).

In practice, what do modified corn *starches do for food* processors? Figure 3 depicts the answer to that question.

Dextrins. Dextrins provide protective coatings such as pan coatings in confections and can replace gum arabic in the encapsulation of flavor oils.

Acid-Modified Starches. These allow starch use at higher concentrations and are important in the manufacture of gum candies.

Oxidized Starches. These starches lower viscosity and reduce amylose's tendency to retrograde. They also have the unique property of helping starch batters adhere to fish and meat and therefore find wide use in breaded foods.

Pregelatinized Starches. This type of starch has been modified to swell in cold water. Chemistry, processing techniques, and their physical form can control the texture of the finished paste they produce and the rate at which they rehydrate. As a result, they have become key ingredients in instant starch-based puddings.

Cross-Linked Starch Derivatives. These represent one of the most important modifications for food applications, providing stable, high-viscosity starch pastes. They can thicken salad dressings without viscosity breakdown and increase storage stability. In sterilizing canned foods, their low initial viscosity means high heat transfer and rapid temperature increase for quick sterilization. Subsequently, the starch thickens to provide suspension and textural properties. They are used extensively in canned soups, gravies, sauces, baby foods, cream style corn, fruit pie fillings, puddings, and batter mixes for deep-fried foods.

Stabilization Starch Derivatives. These are especially important for foods stored under refrigeration or freezing conditions, where stabilization lowers their gelatinization temperature and are also useful when cooking temperatures must be kept low.

Within this large family, frozen baked foods such as pot pies and tarts use starch acetates to give "weeping" resistance. Starch acetates also extend the shelf life of baby foods and canned fruit and pie fillings, whereas pregelatinized acetates are used in dried foods such as instant gravies. Starch phosphates make good emulsifiers for vegetable oil in water. Hydroxypropyl starch, usually cross-linked, provides freeze-thaw stability, reduces cloudiness, and holds water better under low temperature storage. At the opposite end of the spectrum from pregelatinized starches, corn starch can be modified to a hydrophobic form that is completely unwettable for use in dusting applications.

Beyond these direct contributions, value-added modified corn starches play increasingly important roles in paper, cardboard, coatings, and adhesives that come into play in food packaging. Overall, corn refiners' shipments of modified starch and dextrins now almost equal shipments of common corn starch, reflecting higher growth in the demand for higher value-added ingredients.

As with starches, corn sweeteners provide an array of ingredients the functional characteristics of which help users add more than sweetness to their products (Fig. 4).

Solubility. Not only are all corn sweeteners readily soluble in water, but dextrose has a negative heat of solution, which is useful in controlling fermentation rates in baking.

Hygroscopicity. Corn sweeteners attract and hold moisture, with sweeter varieties offering better hydration. As such, they function in foods as moisture conditioners, plasticizers, and stabilizers. Their moisture-holding capacity contributes to the non-drip character of end products such as lollipops.

Textural Characteristics. Higher saccharides give corn syrups their cohesive and adhesive properties, contributing to the body and fullness of products. They can give a chewy textural quality to some confections and gum. Because they can control the crystallization of other sugars and increase their solubility, they play a useful role in ice cream, frozen desserts, jams, jellies, and preserves. In cover syrups for canned fruits, corn sweeteners impart a glossy appearance while providing syrup drainage control.

Molecular Properties. Dextrose and fructose have a relatively high osmotic pressure, which makes them very effective in inhibiting microbial spoilage. Depending on their molecular weight, corn sweeteners can also depress freezing points, a quality important to ice cream manufacturers.

Viscosity. Viscosity, or resistance to flow, is important for any ingredient used in a liquid food system. Corn sweeteners, which vary in viscosity based on their composition, offer manufacturers great flexibility in adding sweetness to products while controlling the flow rate and mouthfeel of processed foods and beverages.

Fermentability. Fermentability is especially important for both users of corn products and the newest generation of value-added products within the refining industry. Lower molecular weight corn sweeteners are readily fermentable by yeast. Dextrose, in particular, is widely used in fermentation processes such as baking and brewing or as a fermentation feedstock.

Reducing Characteristics. Through their reducing molecular groups, dextrose and fructose have the ability to combine with various nitrogen compounds at higher temperatures to produce desirable "browning" reaction products with characteristic food flavors

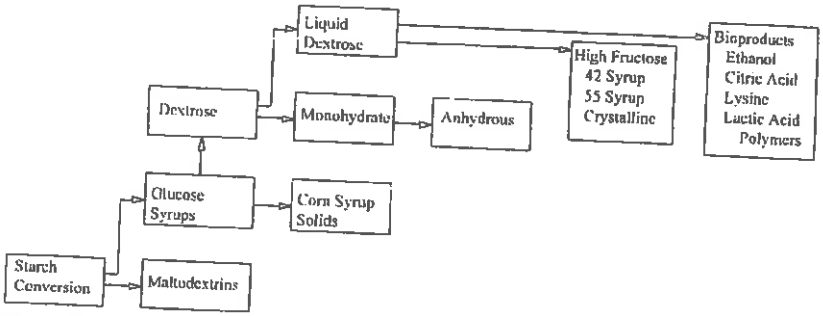

Fig. 4. Value-added sweetener and bioproducts.

E. M. Munro

Edith M. Munro is director of communications for the Corn Refiners Association, Inc., where she supervises much of the association's public affairs and information function, including development and publication of the Corn Annual and other association educational materials.

A graduate of Earlham College (B.A.) and George Washington University (M.A.), she moved from her native Indiana to Washington to serve on the staff of former Rep. Floyd Fithian. She joined the CRA in 1983, shortly after leaving Capitol Hill. Munro is a member of the communications division of the American Society of Association Executives and has won four ASAE awards, including one Gold Circle award, for CRA informational materials.

(Maillard reaction). This makes corn sweeteners especially useful in manufacturing caramel color, producing crust color in baked goods, and producing caramel flavor and color for other food products. Reducing properties in corn sweeteners also help inhibit oxidative degradation in foods, helping to maintain the bright red color of catsup, for example.

Sweetness. The obvious aspect of corn sweeteners, sweetness offers a particularly complex range of options. Some low conversion products such as maltodextrins provide other functional characteristics without tasting sweet at all, whereas others, such as crystalline fructose, are sweeter than sucrose. An added factor that gives users even more flexibility is the way some corn sweeteners, when used in combination with sucrose, can produce higher levels of sweetness than expected.

Refined corn sweeteners have proved so important to the food industry that since 1985, Americans have used more corn products than sucrose for their nutritive sweetener needs (1). Over half of the maltodextrins and glucose syrups that the industry ships go into confections, beverages, dairy products, and miscellaneous foods, with an additional quarter of its shipments used for baking, canning, condiments, jams, and jellies.

Over half of the dextrose finds application in confections, baking, alcohol beverages, chemicals, and drugs, whereas HFCS use is concentrated in beverage applications. Baking, canning, and condiments represent other significant HFCS markets (based on industry estimates).

The Future

Corn wet millers' value-added contributions do not stop with these achievements. The industry today maintains its emphasis on science and new product creation. Recent years have seen the introduction of a wide range of value-added food ingredients that are still being elaborated—fat replacers from starch, cyclodextrins for encapsulation, crystalline fructose, and new modified starches for microwave applications.

Interestingly, corn refiners also contribute indirectly to added value in meat and poultry production. Feed products from the industry, especially corn gluten meal, which provides the xanthophylls that give yolks and chickens their yellow color, have always played a role.

Now, however, corn refiners are helping to remove a major roadblock in efficient livestock production. Until recently, the high cost of lysine, tryptophan, methionine, and other essential amino acids has prevented livestock producers from including them at the optimum levels in feed rations.

Using high-dextrose feedstocks and fermentation processes, corn wet millers have begun producing essential amino acids such as lysine in volumes and at prices that will allow livestock and poultry producers to feed their animals better and produce value-added meat and poultry products more efficiently.

Wet millers have also recently moved into other fermentation processes, including citric acid production, that will have great significance for adding value in the food industry. We expect fermentation-based biotechnology to open the door to another generation of new products that will add more value to our raw material, corn, and provide more opportunities for the industries that rely on our ingredients.

References

1. Gray, F., Buzzanell, P., and Moore, W. U.S. Corn Sweetener Statistical Compendium, USDA Statistical Bulletin #868, and Feed Situation and Outlook Report, USDA FDS-328, 1993.
2. Feed Situation and Outlook Report, USDA FDS-328, November, 1993.
3. Whistler, R. L., BeMiller, J. N., and Paschall, E. F. *Starch Chemistry and Technology*. Academic Press, Orlando, FL, p. 581, 1984.