A new way to produce ETHANOL

by Arvin Donley

Researchers have developed the 'biorefinery' maize-to-ethanol production method that combines the wet milling and dry grind processes

With maize-based ethanol production capacity continuing to expand — it is expected to reach 6 billion gallons in the U.S. in 2007 — producers of the fuel alternative are seeking newer and more efficient processing methods to meet the growing demand for the product.

To this end, researchers at the University of Illinois are working to modify and combine the two processes that govern ethanol production — wet milling and dry grind — into a process called "biorefinery."

Vijay Singh, assistant professor of agriculture and biological engineering at the university, said that by modifying the two processes and combining them, ethanol producers can "reduce the cost of the process and recover more valuable co-products."

WET MILLING VERSUS DRY GRIND

About 40% of the ethanol produced in the U.S. comes from wet milling, a process in which the maize is soaked in water with sulfur dioxide for 24 to 36 hours so that the kernel can be separated into its four component parts: germ, protein, fiber and starch.

After the separation occurs, the starch is fermented into ethanol and the three remaining parts are sold as co-products such as maize gluten meal and maize gluten feed. These are considered to be relatively high-value co-products.

Dry grind accounts for about 70% of the ethanol production in the U.S. It starts with maize that is finely milled and cooked. The starch is fermented and converted into ethanol, and the three non-fermentable parts of the maize (protein, fiber and fat) are carried through the process and recovered at the end as a feed product called distillers dried grains with solubles (DDGS).

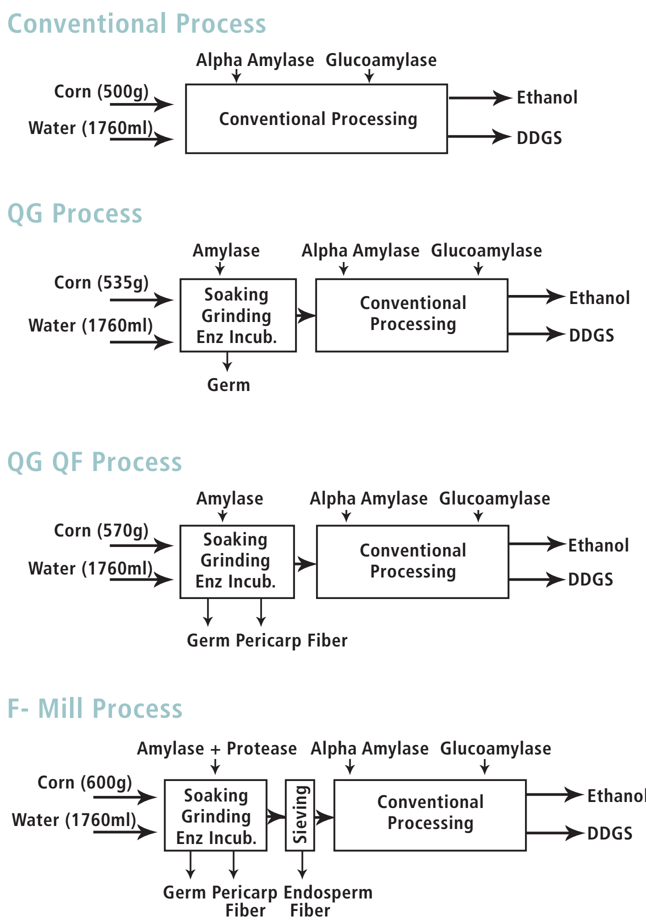
Using the conventional dry grind process, the amount of DDGS produced grows proportionately as ethanol production increases..

One bushel of maize produces about 2.65 gallons of ethanol and 15 to 17 pounds of DDGS, which is used primarily to feed dairy and beef cattle. Because of its high fiber content, however, DDGS is fed in only limited quantities to non-ruminant animals such as hogs and poultry, so the concern is that more DDGS will be produced than the market demands.

To address this concern, University of Illinois researchers along with colleagues from the U.S. Department of Agriculture's (USDA) Eastern Regional Research Center, Agricultural Research Service have developed a new maize milling process called enzymatic dry grind that increases the amount of ethanol produced per batch as well as the value of the co-products resulting from the process. The process involves soaking the maize in water for a short period of time, grinding it coarsely and incubating it with enzymes, which break down the maize kernel.

"That allows us to pull out the germ and fiber at the front end of the process, before fermentation," Singh said.

The enzymatic dry grind process reduces the volume of DDGS by 65% to 70% and improves its nutritional character-



Source: University of Illinois

istics, reducing the amount of fiber and increasing its protein content to a level that is comparable to soybean meal.

In laboratory experiments, the researchers noted that, when compared to the conventional dry-grind process, the modified dry-grind process yielded higher rates of fermentation and ethanol concentrations were 8% to 27% higher. Researchers also found that, depending on the modification, protein contents of DDGS increased from 28% to 58% and acid detergent fiber content was reduced from 11% to 2%, relative to the conventional dry-grind process.

Because of the initial hydration process, which takes up to 21% of a plant's total capital, wet milling is almost three times as expensive as dry grind, Singh said. That expense is partially recovered through the production of higher-valued coproducts and the large-scale capabilities of wet milling — the average plant process between 200,000 and 300,000 bushels of maize per day.

Dry grind costs less — according to Singh, the per-gallon cost of the dry grind process is about 24¢ less than the cost of the wet milling process — but average production runs at about 50,000 bushels per day and only one lower-value coproduct (DDGS) is produced.

The enzymatic dry grind process developed by researchers at the University of Illinois reduces the volume of DDGS (above) by 65% to 70% and improves its nutritional characteristics. Photo courtesy of Distillers Grains Technology Council.

HOW IT WORKS

Singh explains that the new biorefinery process adds technology very similar to maize wet milling at front end of the dry grind process. It also incorporates the most recent advance in wet milling technology — enzymatic milling. Several patents related to these technologies have been issued and are jointly held by the University of Illinois at USDA.

Instead of soaking maize in water with sulfur dioxide for 24 to 36 hours, researchers have developed a process that uses enzymes rather than sulfites to fractionate maize. The enzymatic technology takes only six hours, he said, and eliminates health or environmental concerns caused by the use of sulfites.

After this shortened fractionation step, the pericarp fiber (the kernel's outer coating) and germ can be removed prior to fermentation. This differs significantly from the dry grind process, which is designed to ferment as much of the maize kernel as possible.

Germ recovered from the biorefinery process is of good enough quality to be used for oil extraction. The pericarp recovery at this stage allows a producer to pack more fermentable material in the fermentor, thereby producing more ethanol per batch and improving cost savings.

Singh said the removal of germ and pericarp fiber also reduces and refines the DDGS that is recovered at the back end of the modified dry grind process.

"The U.S. market for DDGS is saturated," Singh said. "By pulling the germ and pericarp fiber out, you reduce the volume of DDGS by 45%. You also diversify the market for DDGS because the DDGS that you're getting now is potentially higher-protein feed that can be fed to poultry and swine." WG

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