Production of Furfural from Dried Distillers’ Grains
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Introduction
Finding additional utilization for Dried Distillers’ Grains (DDG), a byproduct of corn ethanol production sold mainly as animal feed, has the potential to increase the value of DDG and thus can further decrease the cost for corn ethanol. Hemimellulosans are abundant in DDG but are underutilized since they are not the major source for animal feed. The pentose of hemimellulosans have the potential of being converted into furfural. In this study, however, by economic analysis, merely producing furfural would not make DDG more profitable. Therefore, as a two-step process, dilute acid extraction followed by dehydration of hydrolysate, is proposed to convert DDG into furfural, and the animal feed value of the remaining part of DDG needs to be considered.

Objectives
Extract more profits from corn ethanol byproducts
- Optimize the condition of extraction of pentose
- Optimize the condition of converting pentose into furfural
- Retain byproducts animal feed value
- Economic estimation

Project Scenario

Experimental Methods

Pentose extraction

Furfural conversion

Small Scale Equipment: Circulating Digester  
Large Scale Equipment: Rotating Digester

2.5 full factorial design with central point

Find best condition

2.5 full factorial experiment

Yield of Glucose %

Results – Pentosan Extraction

Yield %

Total pentosan and glucose yield - 1st screening experiment

Total Pentosan Extracted %  
Yield of Glucose %

Result – Furfural and Feed

Furfural yield from different conditions

Dry basis %

Compositional compare of raw DDG and acid hydrolysate residue

Ash  
Crude fat  
Crude protein  
Starch  
Cellulose  
Arananin  
Galanin  
Alyn  
Marin Componets

Economic Analysis

<table>
<thead>
<tr>
<th>Animal feed only</th>
<th>Batch Furfural</th>
<th>BRD Furfural</th>
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<tbody>
<tr>
<td>Raw (kg/day)</td>
<td>10000</td>
<td>5000</td>
</tr>
<tr>
<td>Protein Content</td>
<td>16.3%</td>
<td>16.3%</td>
</tr>
<tr>
<td>Feed Yield</td>
<td>55.0%</td>
<td>65.0%</td>
</tr>
<tr>
<td>Feed (kg/Day)</td>
<td>30000</td>
<td>32500</td>
</tr>
<tr>
<td>Protein (% w/w)</td>
<td>12.3</td>
<td>10.5</td>
</tr>
<tr>
<td>Refined Corn (kg)</td>
<td>825</td>
<td>835</td>
</tr>
<tr>
<td>Surfage yield</td>
<td>0.2%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Furfural produc. (kg/Day)</td>
<td>1.20</td>
<td>3.00</td>
</tr>
<tr>
<td>Acid recovered (kg)</td>
<td>1.76</td>
<td>2.35</td>
</tr>
<tr>
<td>Total revenue (k$/Day)</td>
<td>1250</td>
<td>1300</td>
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Conclusions
- Pentose in DDG can be extracted in a yield of 75%
- DDG dilute acid hydrolysate can be converted into furfural by batch method in a yield of 42%
- DDG dilute acid hydrolysate can be converted into furfural by BRD method in a yield of 62%
- DDG residue still has high digestibility and high protein value after hydrolysis
- Converting DDG hydrolysate by BRD method and selling the DDG residue as animal feed can theoretically make profits

Future work
The system needs to be further optimized to provide more economic incentive
- Improve the pentose yield of dilute acid pretreatment on DDG
- Improve the furfural yield of BRD method

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