Corn Fermented Protein an alternative, fermented, functional, high concentration vegetable protein for pets

Professor Peter E.V. Williams
Senior Nutritionist, Green Plains
Corn Fermented Protein an alternative, fermented, functional, high concentration vegetable protein for pets

Proff. Peter Williams Senior Nutritionist
Green Plains and the Biorefinery Concept

Strategic Opportunities Across Multiple Products

• **Sustainable Ultra-High Protein** - sustainable ingredients for high-value global markets in aquaculture, pet, dairy and poultry industries

• **Renewable Corn Oil** - low carbon feedstock for high-growth renewable diesel industry

• **Specialty Alcohol** – high purity alcohol for use in cleaners, sanitizers, disinfectants and beverage industries

• **Clean Sugar Technology** – glucose and dextrose for a variety of biochem, synthetic biology, and food industries

• **Carbon Capture & Sequestration** – building one of the largest carbon capture and storage (CCS) platforms in the world through the recently announced relationship with Summit Carbon Solutions (SCS)
Running Order

1. Alternative proteins

2. Corn Fermented Protein (mechanically separated)
   • Term describing products arising from processing advances in the ethanol biorefinery

3. Corn Fermented Protein; a feed product for companion animals
Alternative Proteins

Agronomic practices impact the feed industry

Low protein in corn leads Hormel to reformulate feed

Chief financial officer says company’s need to reformulate will result in higher feed costs

“We anticipate higher feed costs for the remainder of the year, driven by lower levels of protein in the corn crop relative to prior years,” Sheehan said on February 20. “This is requiring us to reformulate our feed with higher-cost ingredients.”

Industry data show soybean protein content is declining

Protein content of soybeans has declined almost 4% in last half-decade, nutritionist says

Since 2013, soybeans have lost almost 4% of their protein content, according to the soybean checkoff-funded High Yield PLUS Quality program. Though traditionally thought to consist of 48-48.5% crude protein, soybean meal this year is measuring 46-46.5% protein, Borg said. Soybeans have also lost critical amino acid content.

Sustainability important for feed materials
Drivers in a €2.27 bill world market
Europe > €496 mill per annum; CAGR 7.1%

Alternative proteins: protein-rich ingredients used as alternatives to animal-based protein sources.

Protein-rich ingredients sourced from plants
Soy Protein: Isolates, Concentrates, Fermented Soy Fungi,
Insect-protein,
Duckweed Protein,
Single Cell Protein.
Dry Grind Bioethanol and MSC Technology

Production of Corn Fermented Protein

Mechanical separation and fractionation
No exogenous processing aid
CFP highly consistent 6%CV from plant to plant
25% spent yeast in DM

<table>
<thead>
<tr>
<th>Nutritional composition (as received)</th>
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<tbody>
<tr>
<td>Moisture</td>
</tr>
<tr>
<td>Dry Matter</td>
</tr>
<tr>
<td>Crude Protein</td>
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<tr>
<td>Crude fat</td>
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<tr>
<td>Crude fiber</td>
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<td>Neutral detergent fiber</td>
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<tr>
<td>Ash</td>
</tr>
<tr>
<td>Starch</td>
</tr>
<tr>
<td>TDN</td>
</tr>
<tr>
<td>Digestible energy (Mcal/lb)</td>
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<tr>
<td>Metabolizable energy (Mcal/lb)</td>
</tr>
<tr>
<td>Net energy (lactation) (Mcal/lb)</td>
</tr>
<tr>
<td>Net energy (maint) (Mcal/lb)</td>
</tr>
<tr>
<td>Net energy (gain) (Mcal/lb)</td>
</tr>
<tr>
<td>Bulk Density</td>
</tr>
</tbody>
</table>

Nutritional composition of CFP
The distinction between DDGS and Corn Fermented Protein

- DDGS happened!
- DDGS was never a designed product
- Convenient approach to use co-product
- Plant operation affects product consistency
  - Reputation of an inconsistent product

- Good market acceptance
  - Discounted price compared with nutrient value

Corn Fermented Protein is a designed product
Bioethanol Fermentation: Important Producer of Yeast

- 7 MMtons yeast/yr approx. 44% protein
- 3 million metric tons of high-quality protein:
  - Ethanol yeast; *Saccharomyces cerevisiae*

- Yeast contributes approx. 20% to DDGS protein
- Yeast contributes approx. 6 -10% to DDGS dry matter
Yeast for Pets

**CFP contains approximately 24% spent yeast in DM**

**Yeast a palatability and appetite enhancer**

Glutamine - appetite enhancer – gut stimulator

Whole yeast - Modulation of gut microbiota, improved immunity (well documented scientific literature)

Yeast β-glucan - Improved immunity, improved disease resistance

Yeast can exert positive effects on animal health and well being

(Shurson G.C. 2018: Upadhaya et al. 2019)
CFP a Fermented Feed Products

Fermented Feeds and the Benefits of Fermentation
- Improved protein digestibility
- Increased the number of small peptides
- Increased energy digestibility
- Reduced fiber levels

Lactic acid fermentation
- Lower feed pH
- Meta analysis \textit{(Bocheng et al 2020)}
  - Improved weight gain
  - Improved FCR
  - Improved nutritional value and bio-availability
Drying, a key factor in product quality

- Dryer operating temperature
- Wet feed conditioning
- Dryer configuration

- Excessive heating reduces protein availability

Gentle drying optimizes product quality
Benign drying maintains product quality

**CFP – Available lysine after drying >97%**

<table>
<thead>
<tr>
<th></th>
<th>Carpenter (available ) Lysine</th>
<th>Av</th>
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<tbody>
<tr>
<td><strong>Lysine Total (%DM)</strong></td>
<td>1.93 1.95 1.83 2.22 2.04 2.10 2.15 1.72 2.17</td>
<td>2.01</td>
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<tr>
<td><strong>Available Lysine (%DM)</strong></td>
<td>2.08 1.99 1.79 2.28 1.84 1.96 1.91 1.65 2.04</td>
<td>1.95</td>
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<tr>
<td><strong>Available lysine (% of total)</strong></td>
<td>1.08 1.02 0.98 1.03 0.90 0.94 0.89 0.96 0.94</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Characteristic golden color

*absence of Maillard browning*
30+ feed trials with leading research collaborators
Quality of Protein Retained Through Processing

CFP - Precision fed caecetomized rooster protein ID 89.1%

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>7</th>
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<td>LYS</td>
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<td>83.2</td>
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<td>80.0</td>
<td>77.3</td>
<td>84.9</td>
<td>87.6</td>
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<td>MET</td>
<td>91.3</td>
<td>90.9</td>
<td>92.4</td>
<td>91.5</td>
<td>93.3</td>
<td>92.3</td>
<td>92.0</td>
<td>91.2</td>
<td>94.4</td>
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</tr>
<tr>
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<td>89.1</td>
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<td>90.3</td>
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<tr>
<td>THR</td>
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<td>83.9</td>
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<td>86.1</td>
<td>87.0</td>
<td>85.7</td>
<td>83.5</td>
<td>80.9</td>
<td>87.8</td>
<td>86.2</td>
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<tr>
<td>Av 16aa</td>
<td><strong>87.5</strong></td>
<td><strong>86.9</strong></td>
<td><strong>89.4</strong></td>
<td><strong>89.9</strong></td>
<td><strong>90.6</strong></td>
<td><strong>89.4</strong></td>
<td><strong>88.5</strong></td>
<td><strong>86.7</strong></td>
<td><strong>91.6</strong></td>
<td><strong>90.9</strong></td>
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Ileal Diestibility (%)
UHP Target Species

**Pet food formulations**
An alternative functional vegetable protein supplement

**Replace fishmeal and soy isolates in aquaculture**
An ideal protein replacement/supplement for aquaculture
Trials in carp, tilapia, trout, shrimp, Atlantic salmon

**Replace soy isolates in diets for turkey pouls**
Partial replacement of SBM meal improved N and energy retention and performance

**Replacement of soybean meal in feed for broilers**
Partial replacement of SBM improves performance

**Protein supplement for starter pigs**
An ideal protein supplement for starter pigs

**Rumen protected protein for dairy**
A RUP supplement with characteristics equivalent to SoyPass
CFP in Companion animal Nutrition

*Dried Yeast Protein was significantly more palatable than brewer’s yeast and pea protein.*

“LinkOne is proud to be working hand in hand with our partners at Green Plains to develop and market superior fermented corn protein products, not only as a standalone ingredient, but as a trusted superior ingredient in our AminoMarine products. LinkOne works directly with Green Plains to design proprietary processes in manufacturing fermented and hydrolyzed plant and animal based proteins.”
Use of CFP in diets for Atlantic salmon

Commercial North American control diet

- AA: 28%
- PBM: 25%
- Corn PC Empyreal: 18%
- Wheat Flour: 12%
- SPC: 15%
- FM Herring: 11%

Test diet formulations with CFP

- AA: 9%
- PBM: 25%
- Corn PC Empyreal: 11%
- SPC: 18%
- CFP: 25%
- FM Herring: 11%
Use of CFP in diets for Atlantic salmon

84-day growth study with post smolt Atlantic salmon

Replacement of alternative high value protein concentrates with CFP

With 10% inclusion of CFP performance was as good and numerically better than controls
42 Day Turkey Poult Trial

Turkey poult trial

**Breed**
250 male day-old BUT6 poults

**Starter**
0-21 days seived crumbs

**Grower**
22-42 days pellets

Commercial lighting and heating regime
5 birds per pen: 10 replicates per treatment

**Treatments**
High specification control diet
Inclusion of CFP at 4% and 8%
High fiber soya
Premium formulation with soy concentrate

![Graph showing d0-42 BWG (g/bird), Day 42 N retention g/kg diet, and Day 42 AMEn MJ/kg diet]
# 35 Day Broiler Trial

Diets formulated according to ROSS standards – As hatched broiler to target 2.40kg

<table>
<thead>
<tr>
<th>ROSS Broiler Nutrition Specifications</th>
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<tbody>
<tr>
<td></td>
<td>Starter 0-10</td>
<td>Grower 25-mkt</td>
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<tr>
<td>Crude protein %</td>
<td>23</td>
<td>19.5</td>
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<tr>
<td>Energy kcal</td>
<td>3000</td>
<td>3200</td>
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<tr>
<td>Lysine %</td>
<td>1.28</td>
<td>1.03</td>
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<tr>
<td>Methionine %</td>
<td>0.51</td>
<td>0.43</td>
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<table>
<thead>
<tr>
<th>Rations</th>
<th>STARTER</th>
<th>FINISHER</th>
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<tbody>
<tr>
<td></td>
<td>CONTROL 5% 0-21 5% 22+ 10% 0-21 10% 22+ CONTROL 5% 22+ 10% 22+</td>
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<tr>
<td>10.5 Wheat</td>
<td>60.28</td>
<td>61.41</td>
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<tr>
<td>48 Soya</td>
<td>34.24</td>
<td>28.55</td>
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<tr>
<td>Corn Ferm Prot</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Soya oil</td>
<td>1.95</td>
<td>1.36</td>
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<tr>
<td>Limestone</td>
<td>1.11</td>
<td>1.17</td>
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<tr>
<td>MCP</td>
<td>0.94</td>
<td>0.90</td>
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<tr>
<td>Salt</td>
<td>0.25</td>
<td>0.19</td>
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<tr>
<td>Sodium Bicarbonate</td>
<td>0.15</td>
<td>0.22</td>
</tr>
<tr>
<td>Lysine HCl</td>
<td>0.25</td>
<td>0.35</td>
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<tr>
<td>DL Methionine</td>
<td>0.29</td>
<td>0.28</td>
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<tr>
<td>L Threonine</td>
<td>0.12</td>
<td>0.13</td>
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<tr>
<td>L Arginine</td>
<td>0.02</td>
<td>0.04</td>
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<tr>
<td>Q B+ Econase</td>
<td>0.02</td>
<td>0.02</td>
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<tr>
<td>Premix</td>
<td>0.40</td>
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<tr>
<td>Total</td>
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Animal and husbandry related factors

<table>
<thead>
<tr>
<th>Birds</th>
<th>Ross 308 broiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Treatments 10 birds per pen 12 reps</td>
<td>480 birds</td>
</tr>
<tr>
<td>Age at start of trial (days)</td>
<td>Day of hatch (d0)</td>
</tr>
<tr>
<td>Age at end of trial (days)</td>
<td>35 days</td>
</tr>
<tr>
<td>Stocking density (animals/m²)</td>
<td>5 birds/m²</td>
</tr>
<tr>
<td>Temp and lighting regimen</td>
<td>Commercial</td>
</tr>
<tr>
<td>Pen type/manufacturer</td>
<td>Shavings on solid floor wire mesh partitions</td>
</tr>
</tbody>
</table>

**Ross Broiler Nutrition Specifications**

- **Starter Grower**
  - **Crude protein %**
  - **Energy kcal**
  - **Lysine %**
  - **Methionine %**

**Ross 308 Broiler**

- **Birds**: 4 Treatments 10 birds per pen 12 reps, 480 birds
- **Age at start of trial (days)**: Day of hatch (d0)
- **Age at end of trial (days)**: 35 days
- **Stocking density (animals/m²)**: 5 birds/m²
- **Temp and lighting regimen**: Commercial
- **Pen type/manufacturer**: Shavings on solid floor wire mesh partitions
35 Day Broiler Trial

30% replacement of SBM with UHP; performance NS

<table>
<thead>
<tr>
<th></th>
<th>Day 35</th>
<th>Actual</th>
<th>2.5kg Corrected</th>
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</thead>
<tbody>
<tr>
<td>Control</td>
<td>2583</td>
<td>1.62</td>
<td>1.60</td>
</tr>
<tr>
<td>5% SP50</td>
<td>2680</td>
<td>1.61</td>
<td>1.57</td>
</tr>
<tr>
<td>10% SP50</td>
<td>2697</td>
<td>1.68</td>
<td>1.64</td>
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<tr>
<td>10% SP50 22+</td>
<td>2651</td>
<td>1.65</td>
<td>1.62</td>
</tr>
</tbody>
</table>

FCR corrected to 2.5kg lwt

Cumulative body weight (kg) dys 21, 28, 35
Commercial Evaluation of Ultra High Protein

- 1,000 chicks
- Diets: starter 1 to 14 days; finisher 15 to 25 days, withdrawal 26 to 33 days
- USA commercial formulation

Birds consuming diets formulated with 3, 6, or 9 percent Ultra High Protein had live performance that was not significantly different from birds consuming Control feed from 1 to 33 days of age.
Supply Chain and Product Availability

• **A highly consistent product**
  • <6% CV in ileal digestibility between batches and different production facilities

• **500K tons per annum**
  • From 6 plants in production increasing to one million tons by end of 2023

• **Global role out of technology**
  • Investigations in progress with European plants to produce a non-GM product
Key Attributes Support Biorefinery Protein

- Economically viable
- Efficacy and regulatory compliant
- Consistency in the product
- Critical economic quantities
- Resilience and redundancy in supply chain
- Feed/food sovereignty
A paradigm shift in nutrition strategy for feed and food

More complex diets more profitable
Increased cost of production requires economies of scale
Requirement for high nutrient density

Whole grains-based feed

Functional designer feeds

Grain an imperfect RM for ration formulation

Bio-refine to create pure high density RM’s
The Future for Corn Fermented Protein

Continuous Product Development and Partnership Advantages with exclusive partner Novozymes

• Increased protein content >60%
• Improved product characteristics through yeast enhancement
• Ongoing targeted removal of anti-nutritional factors
• Direct application into specialty feeds and premixes through innovative aquafeed solutions
• Direct CO₂ sequestration from plants to allow CFP to be carbon neutral
Thank You

Email

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Walter Cronin <Walter.Cronin@gpreinc.com>