# Evaluation of the Energy Value and Nutrient Digestibility of Distillers Grains That Have Undergone a Fiber Separation Process in Finishing Diets

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## Summary with Implications

*A digestion study was conducted to determine the effects of feeding a new, high protein distillers grains and corn bran plus solubles on nutrient digestibility. Treatments included a corn-based control, high protein distillers at both 20% and 40%, corn bran plus solubles, traditional wet distillers grains and traditional dry distillers grains all at 40% of diet DM. Feeding high protein distillers grains or corn bran plus solubles resulted in decreased digestibility compared to corn or traditional wet and dry distillers grains, but increased energy intake. Traditional wet and dry distillers grains also resulted in decreased digestibilities while energy intake was increased. Volatile fatty acid profiles and pH parameters were not different across treatments. Overall, nutrient digestibility for high protein distillers grains and corn bran plus solubles is similar to traditional wet or dry distillers grains.*

## Introduction

Recent technological advancements have allowed ethanol plants to fractionate products during the ethanol production process. Corn fiber (also referred to as corn bran) removal further concentrates other components of distillers grains—most notably the protein. This isolation process allows for greater ethanol production, but creates a distillers product with differing composition than what is currently produced. Furthermore, some of the isolated bran can be combined with condensed distillers solubles (CDS) to create another new byproduct. While the protein component of DGS had a similar feeding value to DGS when included at 40% (*2016 Nebraska Beef Cattle Report*, pp. 132–134), an understanding of how the new ethanol byproducts impact nutrient digestibility has not been established (*2019 Nebraska Beef Cattle Report*, pp. 88–90). Therefore, the objective of this study was to evaluate the effect of feeding high protein distillers grains, as well as corn bran plus solubles, on nutrient digestibility in finishing cattle.



## Procedure

A 126-d metabolism study was conducted utilizing six ruminally fistulated crossbred yearling steers (BW = 1165 lb ± 69 lb). The experiment was arranged in a 6 x 6 Latin square with six steers and six periods. Steers were assigned randomly to one of six treatments with each steer assigned to each treatment once throughout the study. Treatments included a corn-based control, 20% high protein distillers grains (HIPRO 20), 20% high protein distillers grains (HIPRO 40), 40% corn bran plus solubles (BRAN+SOL), traditional wet distillers grains plus solubles (WDGS), and 40% traditional dry distillers grains plus solubles (DDGS). All diets contained 15% corn silage and supplement. Byproducts replaced a 50:50 blend of high-moisture and dry-rolled corn. The supplement was formulated to provide 90 mg/steer/day of Tylan-90® (Elanco Animal Health, Greenfield, IN) and 30 g/ton of Rumensin-90® (Elanco Animal Health, Greenfield, IN; Table 1).

Steers were housed in individual concrete slatted pens and allowed *ad libitum* access to feed and water. They were fed once daily at 800 and feed refusals were removed and weighed prior to feeding. Ingredient samples were taken on days 17 and 19 of each period. Samples were composited by period, lyophilized, ground through a 1-mm screen on a Willey Mill, and analyzed for dry matter (DM), organic matter (OM), neutral detergent fiber (NDF), fat, crude protein (CP), and gross energy. Energy was calculated using bomb calorimetry and used to calculate nutrient composition of each dietary treatment (Table 1).

Each period was 21 days, and consisted of a 16 day adaptation phase with 5 days of collection. Titanium dioxide, an indigestible marker, was dosed intraruminally twice daily at 800 and 1600 h each day of the experiment to provide a total of 10 g/d for use as an estimate of total fecal output. Fecal grab samples were collected four times daily at 700, 1100, 1500, and 1900 h on days 17–20. Fecal samples were composited by day, then by period. Samples were lyophilized, ground through a 1-mm screen on a Wiley Mill, and analyzed for DM, OM, NDF, and energy for calculation of digestible energy and titanium dioxide.

Submersible wireless pH probes were inserted in the rumen on day 14, and ruminal pH was analyzed from d 17–20. Ruminal pH measurements included average pH, minimum and maximum pH, and magnitude of pH change.

Rumen in situ bags were used to estimate NDF digestibility at 16 and 24 hours of incubation using 1.25 g of dry corn bran. Following incubation, samples were washed and immediately frozen. Bags were analyzed for NDF using the ANKOM system. After being run through the NDF procedure, bags were dried in a 140$^0$F forced-air oven for 16 hours. Weights from the dried bags were used to calculate NDF digestibility. Upon removal of the in situ bags, rumen contents of each steer were mixed and a portion was removed and immediately frozen. This sample was then utilized to determine dry matter of whole rumen contents.

Samples of rumen fluid were collected on day 20 at 700, 1100 and 1400 h and immediately frozen. These samples were later analyzed for volatile fatty acid (VFA) concentration changes over time following feeding.

Digestibility and intake were analyzed using the MIXED procedure of SAS (SAS

**Table 1. Composition of dry-rolled and high-moisture corn finishing diets with high protein distillers grains (HIPRO20 & HIPRO40), corn bran plus solubles (BRAN+SOL), traditional dry distillers grains (DDGS), and traditional wet distillers grains (WDGS)**

| | Treatment[1] | | | | | |
|---|---|---|---|---|---|---|
| | CON* | HIPRO20 | HIPRO40 | BRAN+SOL | DDGS | WDGS |
| *Ingredient* | | | | | | |
| DRC | 39.3 | 30.5 | 20.5 | 20.5 | 20.5 | 20.5 |
| HMC | 39.3 | 30.5 | 20.5 | 20.5 | 20.5 | 20.5 |
| Corn Silage | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |
| HiPro DDGS | - | 20.0 | 40.0 | - | - | - |
| Bran + Solubles | - | - | - | 40.0 | - | - |
| DDGS | - | - | - | - | 40.0 | - |
| WDGS | - | - | - | - | - | 40.0 |
| *Supplement* | | | | | | |
| FGC | - | 1.8875 | 1.8875 | 1.8875 | 1.8875 | 1.8875 |
| Limestone | 1.66 | 1.62 | 1.62 | 1.62 | 1.62 | 1.62 |
| Tallow | 0.1625 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Urea | 1.29 | - | - | - | - | - |
| SBM | 3.00 | - | - | - | - | - |
| Salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Beef Trace Min. | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Vit. ADE | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 |
| Rumensin-90 | 0.0165 | 0.0165 | 0.0165 | 0.0165 | 0.0165 | 0.0165 |
| Tylan-40 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 |
| *Nutrient Composition, % DM* | | | | | | |
| DM | 63.7 | 66.0 | 68.8 | 50.0 | 68.7 | 44.7 |
| NDF | 13.9 | 18.4 | 22.9 | 23.0 | 22.7 | 22.2 |
| CP | 13.4 | 14.2 | 19.6 | 18.6 | 17.3 | 18.2 |
| Fat | 3.9 | 5.0 | 6.1 | 6.2 | 4.8 | 7.0 |

*Soypass was phase fed to meet MP requirements

[1]Treatments included CON-control; HIPRO20–20% high protein distillers grains; HIPRO40–40% high protein distillers grains; BRAN+SOL-40% corn bran plus solubles; DDGS-40% traditional dry distillers grains; WDGS-40% traditional wet distillers grains

Institute, Inc. Cary, NC). Treatment and period were treated as fixed effects while steer within period was a random effect. Ruminal pH data were summarized by hour and analyzed using the GLIMMIX procedure of SAS (SAS Institute, Inc. Cary, NC). *P*-values ≤ 0.10 were considered significant. If significant, treatments were separated and compared using a t-test.

## Results

No treatment differences were observed for dry matter intake (P = 0.55; Table 2). However, total tract dry matter digestibility (TTDMD) was decreased (P < 0.10) with inclusion of byproduct, regardless of type. When high protein distillers grains were included at 20% diet (DM) TTDMD was intermediate, but not different (P > 0.16) than CON and all other byproduct treatments except for HIPRO40. Results for total tract organic matter digestibility (TTOMD) followed the same trend as TTDMD.

Treatment affected NDF intake (*P* < 0.01) with steers fed BRAN+SOL and WDGS having the greatest intake and CON having the least (*P* < 0.01). Steers fed DDGS were intermediate, but not different from (*P* > 0.13) BRAN+SOL, WDGS, or HIPRO20. Total tract NDF digestibility (TTNDFD) was numerically greatest for BRAN+SOL at 61.57%, but was not statistically different (*P* > 0.14) from all other treatments excluding DDGS (*P* < 0.01). The lowest TTNDFD was observed for the DDGS treatment. In situ NDFD was not affected by treatment (*P* = 0.89). Acid detergent fiber intake and digestibility were also impacted by treatment. Intake was greatest for HIPRO40, BRAN+SOL and WDGS. The control treatment resulted in the lowest ADF intake (*P* < 0.01), and HIPRO20 and DDGS were intermediate to all treatments, but not different (*P* = 0.32) from one another. Total tract ADF digestibility (TTADFD) was numerically greatest with the BRAN+SOL treatment; however, inclusion of all byproduct treatments except DDGS (*P* = 0.69) resulted in greater TTADFD than CON (*P* < 0.03).

Digestible energy (DE) intake, expressed as Mcal/d, was not affected by treatment (*P* = 0.13), but tended to be greater for the treatments with 40% byproduct. When expressed as Mcal/lb, dietary treatment was significant (P < 0,01). Greatest DE intakes were observed in the HIPRO40, BRAN+SOL, DDGS, and WDGS treatments. Lesser inclusion of high protein distillers (HIPRO20) resulted in the lowest DE intake (*P* < 0.09) while CON was intermediate.

No treatment effects were observed for average pH, maximum pH, or pH magnitude of change (*P* > 0.73; Table 3). Minimum ruminal pH was lowest for the HIPRO20 treatment at 4.85, although this was not significantly different (*P* > 0.18) from CON, BRAN+SOL, DDGS or WDGS. Feeding HIPRO40 resulted in a minimum pH of 5.15; numerically greatest of all treatments.

Treatment did not affect total VFA concentration (*P* = 0.75), proportion of any of the measured VFAs (*P* > 0.44), or Acetate:-Propionate ratio.

## Conclusion

Feeding high protein distillers grains and corn bran plus solubles resulted in decreased dry matter and organic matter digestibility. However, energy intake was greater when byproducts were included at 40% of diet (DM). These results agree with previous research on traditional distillers grains products. Though digestibility is lower, the increased energy supply contributes to the increase in performance observed in other experiments where these byproducts were fed. This indicates that digestibility of components not measured (i.e. nitrogen and fate) might be greater for the byproduct

**Table 2. Effect of feeding high protein distillers grains or corn bran plus solubles on dry matter, organic matter, NDF and ADF digestibility, energy intake, and in situ NDF digestibility**

| | Treatment[1] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CON | HIPRO20 | HIPRO40 | BRAN+SOL | DDGS | WDGS | SEM | *P*-Value |
| DM | | | | | | | | |
| Intake, lb/d | 26.0 | 26.6 | 24.19 | 25.7 | 24.1 | 25.1 | 1.43 | 0.55 |
| Digestibility,% | 79.1[a] | 76.1[ab] | 72.0[c] | 74.5[bc] | 73.1[bc] | 74.0[bc] | 1.55 | 0.04 |
| OM | | | | | | | | |
| Intake, lb/d | 25.1 | 25.6 | 23.1 | 24.5 | 22.9 | 23.8 | 1.36 | 0.42 |
| Digestibility,% | 81.0[a] | 78.0[ab] | 74.6[b] | 77.4[b] | 76.0[b] | 76.8[b] | 1.49 | 0.06 |
| NDF | | | | | | | | |
| Intake, lb/d | 3.6[d] | 4.9[c] | 5.5[ab] | 5.9[a] | 5.5[abc] | 5.6[a] | 0.31 | <0.01 |
| Digestibility,% | 57.6[a] | 54.0[ab] | 54.0[ab] | 61.6[a] | 45.5[b] | 59.0[a] | 3.58 | 0.07 |
| ADF | | | | | | | | |
| Intake, lb/d | 1.7[c] | 2.8[b] | 3.5[a] | 3.6[a] | 2.6[b] | 3.4[a] | 0.18 | <0.01 |
| Digestibility,% | 42.0[b] | 58.4[a] | 62.4[a] | 66.9[a] | 44.8[b] | 63.2[a] | 6.86 | <0.01 |
| Digestible enegy intake | | | | | | | | |
| Mcal/d | 36.81 | 35.99 | 39.30 | 43.23 | 40.04 | 42.13 | 2.360 | 0.13 |
| Mcal/lb[2] | 1.42[b] | 1.36[c] | 1.64[a] | 1.67[a] | 1.68[a] | 1.67[a] | 0.028 | <0.01 |
| In situ NDFD, % | 49.4 | 49.5 | 49.2 | 49.0 | 47.5 | 49.0 | 0.14 | 0.89 |

[a-d]Values within rows with differing superscripts are different ($P < 0.10$)

[1]Treatments included CON-control; HIPRO20–20% high protein distillers grains; HIPRO40–40% high protein distillers grains; BRAN+SOL-40% corn bran plus solubles; DDGS-40% traditional dry distillers grains; WDGS-40% traditional wet distillers grains

[2]Mcal of Digestible Energy per lb of dry feed consumed

**Table 3. Effect of feeding high protein distillers grains or corn bran plus solubles on ruminal pH and VFA production**

| | Treatment[1] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CON | HIPRO20 | HIPRO40 | BRAN+SOL | DDGS | WDGS | SEM | *P*-Value |
| *pH* | | | | | | | | |
| Average pH | 5.40 | 5.36 | 5.75 | 5.47 | 5.53 | 5.45 | 0.501 | 0.73 |
| Maximum pH | 6.08 | 6.35 | 6.51 | 6.21 | 6.23 | 6.31 | 0.298 | 0.90 |
| Minimum pH | 4.89[b] | 4.85[b] | 5.15[a] | 4.99[ab] | 5.04[ab] | 4.91[b] | 0.087 | 0.08 |
| pH Magnitude | 1.18 | 1.49 | 1.36 | 1.22 | 1.19 | 1.40 | 0.243 | 0.83 |
| *VFA Proportion, %*[2] | | | | | | | | |
| Acetate, %[3] | 51.5 | 48.3 | 53.1 | 51.7 | 49.7 | 54.2 | 3.98 | 0.72 |
| Propionate, % | 34.4 | 37.9 | 29.4 | 30.0 | 34.1 | 29.1 | 5.41 | 0.46 |
| Butyrate, % | 10.8 | 9.1 | 12.1 | 14.0 | 10.9 | 11.8 | 2.14 | 0.60 |
| Total VFA, mM | 120.6 | 112.1 | 106.9 | 112.7 | 109.9 | 101.2 | 8.95 | 0.75 |
| A:P ratio[4] | 1.91 | 1.97 | 2.22 | 1.88 | 1.82 | 2.04 | 0.328 | 0.96 |

[a-b]Values within rows with differing superscripts are different ($P < 0.10$)

[1]Treatments included CON-control; HIPRO20–20% high protein distillers grains; HIPRO40–40% high protein distillers grains; BRAN+SOL-40% corn bran plus solubles; DDGS-40% traditional dry distillers grains; WDGS-40% traditional wet distillers grains

[2]Average concentration over three time points (700 h, 1100h, 1500 h)

[3]Percent of total VFA

[4]Acetate:Propionate ratio

treatments. In the present experiment, dry distillers is not as digestible as wet distillers, particularly fiber digestion.

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