# COMPARISON OF THE SITE AND EXTENT OF ORGANIC MATTER DIGESTION BETWEEN CORN AND FOUR DIVERGENT SORGHUM GRAIN HYBRIDS

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## Story in Brief

Corn and four divergent sorghum grain hybrids were dry rolled before incorporation into 85% grain diets. Sorghum grain hybrids were grown during the summer of 1986 in a single location to reduce variation caused by the environment. The four sorghum hybrids represented yellow, cream, hetero-yellow and red endosperm types. Diets were fed at 2% of body weight to 5 Angus x Angus-Hereford steers (532 lb) equipped with large ruminal and L-type duodenal and ileal cannulae to determine the site and extent of organic matter (OM) digestion. Total tract OM digestibility was greater for corn (76.6%) than red (66.6%) or yellow (66.1%) but was not different from cream (73.3%) or hetero-yellow (68.5%). Feed OM digestion in the rumen was greater for corn (81.8%) than for hetero-yellow (57.8%), yellow (60.9%) and red (55.6%). Ruminal OM digestibility of cream was not different from corn or other sorghum grain hybrids. Organic matter digestibility through the ileum tend to reflect differences observed in the total tract. Corn (76.6%) OM digestibility through the ileum was greater than observed for hetero-yellow (63.8%), red (60.2%) and yellow (58.8%), but not different from cream (70.3%). Based on OM digestibility of sorghum grain hybrids in this study it appears some current sorghum grain hybrids may approach the digestibility of corn.

(Key Words: Sorghum Hybrid, Corn, Organic Matter Digestion)

## Introduction

Sorghum grain is an important energy source for feedlot diets in the High Plains region. Increasing water demands in the High Plains may decrease water available for irrigated corn production in the future. Sorghum grain is a viable alternative to corn, requiring less water to produce a crop than corn. However, sorghum grain is generally considered to have lower feeding value than corn even though the gross composition of the grain types is similar. Recent studies with sorghum hybrids having pure yellow endosperm suggest this sorghum type may approximately equal the feeding value of corn. Estimates for the value of sorghum are based on sorghum varieties not used today and are, therefore, in need of adjustment. Therefore, the objectives of this study were to determine differences in chemical composition and site and extent of organic matter digestion between corn and currently available sorghum grain hybrids.

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## Materials and Methods

Five diets were developed (Table 1) using corn and four currently available divergent sorghum grain hybrids. The four sorghum grains had either red, cream, hetero-yellow or pure yellow endosperm. All sorghum grain hybrids were grown in a single location during the summer of 1986, to reduce variation due to the environment. All grains were dry rolled before incorporation into high grain rations (85.0%) containing urea as the only supplemental nitrogen (N) source.

Diets were fed twice daily at 2% of individual body weight (DM basis) to 5 Angus x Angus-Hereford steers (532 lb) fitted with large ruminal and L-type duodenal and ileal cannulae. Diets were randomly assigned in a 5x5 Latin Square with experimental periods of 14 days. Days 1 through 11 were used for diet adaptation. Digesta and fecal samples were collected at 1200, 1800 and 2400 hours on day 12, 600, 1500 and 2100 hours on day 13 and 300 and 900 hours on day 14. The sampling schedule resulted in sample collection every 3 hours in a 24 hour period to reduce the effect of diurnal variation of chromic oxide flow. Ruminal fluid, for ammonia determination, was collected during the last 4 sampling times. Additionally, ruminal fluid, for bacterial isolation, was collected at 1400 hour on day 14 of each sampling period. Digesta and fecal samples were composited across day and time within periods. Ruminal, digesta and fecal samples were sub sampled at the end of each period and frozen. Duodenal, ileal and fecal samples were freeze dried and ground through a 1mm screen in a laboratory Wily mill prior to chemical analysis. All samples were analyzed for all or part of the following chemical components: dry matter (DM), organic matter (OM), pH and chromium. Organic matter, truly fermented in the rumen, was calculated using determined microbial OM, N and purine N values. The site and extent of OM digestion was determined using chromium ratios.

Data were analyzed using least squares procedures. Least squares means were separated using least significant difference protected by an initial F test.

## Results and Discussion

The crude protein content (Table 2) of red grain (10.4%) was greater than ($P<.05$) observed for cream (9.7%), hetero-yellow (9.6%) and yellow (9.5%) but was not different ($P>.05$) from corn (10.0%). Corn

**Table 1. Diet Composition Dry Matter Basis**

| Ingredient | % DM |
|---|---|
| Dry Rolled Grain | 85.0 |
| Cottonseed Hulls | 8.0 |
| Molasses | 3.0 |
| Urea | 1.2 |
| Supplement | |
| Dicalcium phosphate | 0.44 |
| Calcium carbonate | 0.93 |
| Potassium chloride | 0.57 |
| Sodium sulfate | 0.36 |
| Trace mineralized salt | 0.25 |
| Chromic oxide | 0.20 |
| Vitamin A (IU/Kg) | 2200 |

**Table 2. Chemical Composition of Grains and Diets.**

| Item (%) | Corn | Cream | Hetero | Red | Yellow |
|---|---|---|---|---|---|
| Grain | | | | | |
| Crude Protein | $10.0^{ab}$ | $9.7^{bc}$ | $9.6^{bc}$ | $10.4^{a}$ | $9.5^{c}$ |
| Starch | $72.2^{c}$ | $78.3^{ab}$ | $72.9^{bc}$ | $79.6^{a}$ | $78.7^{ab}$ |
| Feed | | | | | |
| Crude Protein | $12.1^{c}$ | $12.5^{b}$ | $12.6^{b}$ | $13.5^{a}$ | $12.6^{b}$ |
| Starch | 64.7 | 62.6 | 65.4 | 65.2 | 65.1 |

$^{abc}$ Means in the same row with different superscripts differ (P<.05)

contained more crude protein (P<.05) than yellow but was not different from cream or hetero-yellow. Red (79.6%), yellow (78.7%) and cream (78.3%) grains were not different (P>.05) in starch content, but contained more (P<.05) starch than corn (72.2%). Hetero-yellow (72.9%) contained less (P<.05) starch than red but was not different from cream or yellow. The crude protein content of hetero-yellow (12.6%), yellow (12.6%) and cream (12.5%) feeds were not different (P>.05) but were greater than (P<.05) observed for corn (12.1%) and less than (P<.05) observed for red (13.5%). Diets were not different in starch content and averaged 64.6%.

Organic matter intake (Table 3) was not different (P>.05) between corn (4629 g/d), cream (4625 g/d), hetero-yellow (4608 g/d) and yellow (4601 g/d). Red OM intake (4582 g/d) was less than (P<.05) that for corn and cream, but did not differ (P>.05) from hetero-yellow or yellow.

Total tract OM digestibjlity was greater (P<.05) for corn (76.6%) than hetero-yellow (68.5%), red (66.6%) and yellow (66.1%), but was not different (P>.05) from cream (73.3%). Cream was also not different (P>.05) from hetero-yellow, red or yellow. A large proportion of total OM digestion should be starch; therefore, particle size, protein solubility and digestibility differences between grain sources may be the cause of differences in total tract OM digestibility.

Ruminal OM digestion corrected for microbial OM was greatest for corn (81.8%) and lowest for red (55.6%). Corn had greater (P<.05) ruminal OM digestibility than hetero-yellow (57.8%), red (55.6%) and yellow (60.9%), but was not different (P>.05) from cream (67.7%). Within sorghum hybrids, hetero-yellow, red and yellow were not different (P>.05) from cream.

Organic matter disappearance in the small intestine was not different between grain sources and averaged 33.9% of OM entering the small intestine. The small intestine digested an average of 18.6% of OM intake. The small intestine appeared to compensate for lower ruminal OM digestion with cream (19.2%), hetero-yellow (23.0%) and red (21.3%) compared to yellow (15.1%).

Ileal OM appearance (g/d) for corn (1081) was less than (P<.05) for hetero-yellow (1646), red (1811) and yellow (1892). The amount of corn OM passing the ileum was not different (P>.05) from passage of cream OM (1362 g/d). Cream OM appearance at the ileum was less than (P<.05) observed with yellow (1892 g/d), but not different (P>.05) from observed with hetero-yellow or red. Organic matter appearance at the ileum was not different (P>.05) between hetero-yellow, red and yellow. Digestibility of OM through the ileum was greater (P<.05) for corn (76.6%) and cream (70.3%) than for yellow (58.8%). Corn OM

**Table 3. Comparison of corn and sorghum grain hybrid organic matter digestion.**

| Item | Corn | Cream | Hetero | Red | Yellow |
|---|---|---|---|---|---|
| OM Intake (g/d) | 4629[a] | 4625[a] | 4608[ab] | 4582[b] | 4601[ab] |
| Total Tract OM Digestibility | 76.6[a] | 73.3[ab] | 68.5[b] | 66.6[b] | 66.1[b] |
| Ruminal Environment | | | | | |
| pH | 5.97 | 5.83 | 5.94 | 5.92 | 5.86 |
| Ammonia N (mg/dl) | 7.60 | 7.81 | 8.36 | 9.45 | 10.02 |
| Duodenal Appearance | | | | | |
| Feed OM (g/d) | 840[a] | 1504[ab] | 1939[b] | 2042[b] | 1800[b] |
| Corrected Ruminal OM Digestion | | | | | |
| % Intake | 81.8[a] | 67.7[ab] | 57.8[b] | 55.6[b] | 60.9[b] |
| Disappearance in the Small Intestine | | | | | |
| OM g/d | 656 | 912 | 1076 | 993 | 706 |
| % OM Entry | 37.8 | 36.5 | 38.7 | 34.8 | 21.6 |
| % OM Intake | 14.2 | 19.2 | 23.0 | 21.3 | 15.1 |
| Ileal Appearance | | | | | |
| OM g/d | 1081[a] | 1362[ab] | 1646[bc] | 1811[bc] | 1892[c] |
| Digestion Through the Ileum | | | | | |
| % OM Intake | 76.2[a] | 70.3[ab] | 63.8[bc] | 60.2[bc] | 58.8[c] |
| % Total OM | 100.1 | 95.6 | 93.0 | 89.8 | 89.5 |
| Disappearance in the Large Intestine | | | | | |
| OM g/d | -1.7 | 139.6 | 207.9 | 287.0 | 337.8 |
| % OM Entry | -0.8 | 9.9 | 12.2 | 15.4 | 18.1 |
| % OM Intake | -0.1 | 3.1 | 6.4 | 4.7 | 7.3 |

[abc] Means with different superscripts in the same row differ ($P<.05$).

digestibility through the ileum was also greater than ($P<.05$) observed for hetero-yellow (63.8%) and red (60.2%). Ileal OM digestibility for hetero-yellow and red was not different ($P>.05$) from cream or yellow. Ileal OM digestibility expressed as a percent of total tract digestion was not different between grain sources and averaged 93.6%. However, corn (100.1%) and cream (95.6%) appeared to have a greater percentage of total OM digestion occurring before the ileum than red (89.8%) or yellow (89.5%). Organic matter digested before the ileum may be of greater benefit in supporting efficient gain than digestion in the large intestine.

Organic matter disappearance from the large intestine was not different between treatments and averaged 11.1% of OM entry. Disappearance of OM from the large intestine expressed as a percent of OM entry appeared to be greatest for yellow (18.1%) and red (15.4%), intermediate for hetero-yellow (12.2%) and cream (9.9%) and lowest for

corn (-0.8%). Negative OM digestibility in the large intestine may be the result of starch fermentation and subsequent excretion of microbial OM.

Corn and cream OM were more completely digested through the ileum and total tract than other sorghum grain hybrids. However, through the ileum and in the total tract corn was numerically greater than all sorghum grain hybrids tested. Based on OM digestibility it appears that some currently available sorghum grain hybrids may have greater feeding value relative to corn than older, more traditional hybrids like red. The pure yellow hybrid included in this study does not support previous research suggesting pure yellow sorghum hybrids to be of greater nutritional value than other sorghum hybrids.