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Summary

Seventy-two commercially available corn hybrids were used to quantify the existing range in kernel characteristics shown to correlate with improved feeding value to cattle. Twelve hybrids were steam flaked at two different bulk densities. Hybrids were tested for kernel size, hardness, in situ digestibility, and starch use. For dry rolled corn, a 27% difference in dry matter disappearance was found across hybrids. For flaking, a 6% to 29% improvement over dry rolled corn was observed. An 8% to 36% advantage for flaking in starch digestibility was also found. The results of this trial suggest there can be an interaction between hybrid value and whether fed as dry-rolled or steam-flaked corn.

Introduction

Recent research has begun to explore corn hybrid testing as an important way to improve cattle performance in the feedlot. Previous hybrid testing data showed how corn hybrid interacts with processing methods. A previous study comparing dry rolled corn with high moisture corn (*2003 Nebraska Beef Report,* pp. 32-34) illustrated that a harder (flinty) endosperm had improved performance when processed as high moisture corn compared with dry rolled corn. Another study using HMC (*2006 Nebraska Beef Report,* pp. 40-42) indicates that processing corn hybrids can increase the feeding performance of harder kernels. Evaluating hybrids when processed differently is critical because some poorer performing hybrids fed as dry rolled corn, may be greatly improved when fed as steam flaked corn. Our objective for the first trial was to identify kernel traits that indicate feeding value and how these traits are influenced by hybrid as dry rolled corn. Our objective for the second trial was to identify how hybrid kernel characteristics affect the flaking process and feeding value of the resulting flakes.

Procedure

Dry Corn Trial

Whole grain samples of 72 commercially available corn hybrids were used for Stenvert Hardness tests and *in situ* analysis. A duplicate analysis was run for the Stenvert Hardness test (procedure detailed in *2006 Nebraska Beef Report*, pp. 43-44) since only one sample of each hybrid was present. After the Stenvert analysis, 24 hybrids were selected for *in situ* analysis to include a wide range of kernel characteristics. A sample of each hybrid was ground through the Wiley Mill to simulate a masticate grind for the *in situ* analysis. This grind produces a particle size equivalent to a masticated, rolled corn. A 10 g sample of ground corn was weighed and placed in an *in situ* bag for incubation. Each hybrid was replicated six times in two ruminally cannulated steers using an incubation period of 24 hours. After the incubation period each sample was removed, machine washed using five three minute cycles, and placed in a 60ºC oven to dry for 48 hours after which it was weighed and dry matter disappearance (DMD) was calculated. Feed value was measured for each hybrid using an *in situ* procedure; disappearance was correlated with measured kernel traits. Correlation results were compared to previous investigations comparing kernel characteristics with feed efficiency using *in situ* disappearance and a feedlot pen study.

Steam Flaked Corn Trial

Twelve hybrids, which were used in the dry corn *in situ* trial, were sent to the Department of Grain Science and Industry's Feed Processing Center at Kansas State University (KSU), Manhattan, Kan., to determine the hybrid effect on flaking characteristics. Characteristics measured included: bulk density at two levels (light and heavy, 27 lb/bu and 32 lb/bu, respectively); electrical consumption of the steam flaking motor to determine kilowatt hours/ton (kWh/ton); and production rates. Corn hybrids were steam flaked on a Roskamp flaker equipped with a 25 HP motor and 16"x 12"(diameter x width) rolls at 16 grooves/in. A 12"x15"x72" stainless steel steam chamber was used to steam condition all corn before entering the flaking rolls. The feeder was set at a constant rate to allow for any electrical differences to be measured. For the drive motor, voltage and amperage across each electrical phase was measured using a recording volt-amp meter (Model DM-II Pro, Amprobe, Miami, FL). Electrical consumption was determined by relative (gross) and specific (net) energy. Gross energy was defined as the total amount of energy required while the machine was used under a load. Net energy was defined as the energy required to operate the machine under a load, minus the energy required to operate the machine empty. Retention time of the corn in the steam chest before flaking was eight minutes with a steam conditioning temperature of 98.8°C (210°F) for all corn hybrids.

After the flaking was conducted at KSU, approximately 30 lb of each hybrid and flake density (n=24) were returned for *in situ* analysis. The samples were placed in feed bags to cool and dry to prevent spoilage before being shipped. A sub sample

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of the 24 samples was ground in the Wiley Mill without a screen. For the *in situ* procedure each hybrid was tested as ground dry corn, whole flaked corn, and ground flaked corn. Each flake density for each hybrid was analyzed to compare the densities; as well as flaking versus dry corn. A 5 g sample was placed in an *in situ* bag for incubation. Each sample was replicated in each of two animals per day over two days (eight total bags), with an incubation period of 24 hours. Starch analysis was conducted on the original unincubated samples, and the *in situ* residue samples which were composited across animals within days.

Results

Dry Corn Trial

A wide range was observed within each kernel trait across hybrid (Table 1). Production related traits of 1,000 kernel weight and test weight were correlated (P < 0.05) to each other and to a few of the Stenvert observations. Kernel weight was negatively correlated (P < 0.01) to test weight, indicating that a higher volume weight does not necessarily indicate heavier kernels. Test weight was positively correlated to the Stenvert grind time (P < 0.01), which indicates that a higher volume weight causes the sample to grind slower. Dry matter digestibility is believed to be the best measure of value to the hybrid for finishing cattle. Therefore, kernel traits that relate to DMD are of primary interest. Test weight was the only kernel trait correlated to DMD (P = 0.07) and the relationship was not strong (r = 0.4). Previous research showed that softer kernels were more digestible based on Stenvert soft height percentage. The relationship (r = 0.27) between DMD and the percentage soft particles in the kernel was weak and not significant (P = 0.27). We can contrast some findings from this study with the feedlot trial from 2004. In that trial the relationship (r = 0.85) between gain:feed and soft height percentage was strong and would directly relate to feedlot performance. We did not use these hybrids in a feedlot trial, but did use DMD as an equivalent measure for this analysis. It is also important to note that our *in situ* process is designed to mimic what would occur in a feedlot; however, we are only testing a small amount of feed, and for a short period, so though helpful, it cannot be evaluated on the same scale as a feedlot trial.

Table 1. Kernel characteristics of 72 single replicate Golden Harvest hybrids.

Trait	Mean	Standard Dev.	Range	r[b]
Test Wt., lb/bu	58.7	1.71	55.2-62.5	- 0.38
Dry Kernel Wt., g	341	27.4	259-407	0.23
RPM	2470	98.0	2240-2720	< 0.01
Soft Height %	80.2	2.11	67.9-84.2	- 0.27
Grind Time, s	6.27	0.67	5.00-8.00	- 0.11
Hard %	82.4	2.81	72.9-89.3	- 0.27
24 Hr DMD[a]	53.8	5.98	44.7-71.0	

[a]24 Hr DMD = Percentage dry matter disappearance over 24 hours of incubation.
[b]Correlation coefficient to DMD; no significance at P < 0.05, but test weight was at P < 0.1.

Table 2. Flaking characteristics of 12 Golden Harvest hybrids.

	Bulk density(lb/bu)		Amperage			kWh/ton	
Hybrid	Light	Heavy	Light	Heavy	Prod. Rate [a]	Light	Heavy
9430	26.0	30.6	17.8	16.7	2200	2.71	2.11
9485	26.1	30.3	17.9	17.2	2020	3.02	2.58
9494	26.8	30.6	17.7	16.6	2120	2.79	2.12
8803	26.1	30.5	18.0	17.0	1940	3.19	2.57
8906	25.8	30.3	18.3	17.2	2200	3.04	2.39
8700	27.4	30.1	17.2	16.6	2340	2.24	1.94
9507	26.8	31.3	17.5	16.7	1760	3.21	2.62
8562	27.8	31.5	17.6	17.1	1890	3.04	2.69
9164	26.9	32.2	18.1	16.9	1940	3.26	2.53
9248	26.5	31.9	18.1	17.1	2090	3.07	2.45
9209	27.3	30.3	17.3	16.8	2160	2.49	2.22
9360	27.2	30.3	17.4	16.7	2480	2.23	1.86

[a]Production Rate in lb/hour.

Steam Flaking Characteristics

Flaked corn production rates fluctuated by corn hybrid (Table 2). Although there were differences in the production rates, an adjustment was made when calculating kWh/ton to accurately assess the effect of hybrid on kWh/ton. As expected, there was a difference in kWh/ton between light and heavy flakes. The steam flaker consumed more electricity as flaking became more rigorous in creating a lighter flake. There also appeared to be differences among hybrids within each bulk density treatment. For example, hybrid 8700 had an electrical consumption of 2.243 kWh/ton and hybrid 9164 had an electrical consumption of 3.258 kWh/ton. This is a difference of 1.1 kWh/ton. A feedlot with 4 flakers operating at 50 ton/hour each, operating 16 hours/day and six days a week, at a $0.07/kW charge has a potential savings of $1,478.40 per week in electrical costs. Replications were not conducted, so statistical differences could not be calculated.

Dry Matter Disappearance

A comparison of the mean dry matter disappearances between dry rolled corn and steam-flaked corn is shown in Table 3. Since no effect of grinding on the flakes was present, data are pooled and reported on the basis of bulk density and compared to the dry rolled corn samples for each hybrid. There was a hybrid* processing interaction (P < 0.01) for DMD. The bulk densities of flakes (P < 0.01)

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Table 3. *In situ* **DM disappearance and hybrid rank for steam flaked and dry rolled corn from 12 hybrids.[a]**

Hybrid	DRC[b]	Rank	Light Flake[c]	Rank	Heavy Flake[b]
9430	38.5	1	49.5	2	38.0
9485	42.2	2	59.7	10	45.4
9494	43.4	3	52.3	3	41.1
8803	43.4	4	54.3	5	48.0
8906	43.8	5	58.6	9	46.8
8700	43.9	6	52.5	4	41.6
9507	44.9	7	56.4	6	45.8
8562	45.1	8	47.9	1	38.4
9164	45.2	9	56.9	7	40.3
9248	45.9	10	58.6	9	41.2
9209	47.5	11	57.9	8	49.5
9360	49.4	12	56.9	7	45.9
LSD[d]	6.00		4.23		4.17

[a]Main effect of hybrid , Main effect of processing, Main effect of hybrid*processing.
[b]DRC not different from heavy flakes, except hybrid 8562.
[c]Light flakes different from both DRC and heavy flakes except hybrid 8562 was not different between DRC and light flakes.
[d]Least Significant Difference.

Table 4. *In situ* **starch digestibility and hybrid rank for steam flaked and dry rolled corn from 12 hybrids.[a]**

Hybrid	DRC	Rank	Light Flake	Rank	Heavy Flake
8700	42.2[b]	1	66.2[c]	5	55.8[d]
9485	46.4[b]	2	68.7[c]	8	59.7[d]
9430	48.2[b]	3	63.7[c]	3	54.6[d]
8562	52.4[b]	4	56.8[b]	1	52.9[b]
8803	53.3[b]	5	59.5[c]	2	58.4[bc]
9209	53.8[b]	6	69.2[c]	9	67.3[c]
8906	54.0[b]	7	68.5[c]	7	56.0[b]
9494	54.1[b]	8	68.2[c]	6	52.4[b]
9248	55.3[b]	9	69.5[c]	10	46.5[d]
9360	56.4[b]	10	65.4[c]	4	47.6[d]
9164	57.5[b]	11	73.9[c]	11	46.3[d]
9507	57.9[b]	12	68.5[c]	7	48.0[d]
LSD[e]	5.31		4.50		5.40

[a]Main effect of hybrid, Main effect of processing, Main effect of hybrid*processing.
[b,c,d]Means within a row with unlike superscripts differ (P < 0.05).
[e]Least Significant Difference.

influenced DMD, while the lighter flakes were more digestible than the heavier flakes. The lighter flakes were also more digestible than the dry rolled corn (P < 0.01), which supports performance data on comparing flaked corn with DRC. The second poorest hybrid (DMD) when fed as dry rolled corn, turned out to be the best hybrid using a light flake, with a 29% improvement in DMD. The hybrid with the least improvement for light flakes over dry rolled corn had a 5% improvement. Another interesting observation was that the two hardest hybrids based upon all of the Stenvert tests, responded the best to flaking with the lighter flakes from these hybrids having the greatest change in DMD. This observation suggests that harder kernels perform better when processed as steam flaked corn than when fed as dry-rolled corn. Clearly, hybrids responded differently to flaking. The range in DMD values for DRC is 10.9 percentage units. The range in DMD for light flakes was 11.8 percentage units. This information could be very useful in identifying hybrids for feeders with steam flakers.

Starch Digestibility

Hybrid starch digestibility for DRC, light flakes, and heavy flakes is represented in Table 4, with the means being 52.6%, 66.5%, and 63.8% respectively. A lighter flake resulted in a significantly higher (P < 0.01) digestibility. There was a significant hybrid*process interaction (P < 0.01) as was also seen with DMD. The ranking of hybrid efficiency changed somewhat, however a strong relationship (r = 0.79) between DMD and starch digestibility still exists. Hybrid 8562, which in previous studies had been a good performing hybrid, showed some interesting properties in the flaking trial. It was the only hybrid in which the starch digestibility of the DRC, light, and heavy flakes were not significantly different.

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