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Mark E. Corrigan
University of Nebraska-Lincoln

Galen E. Erickson
University of Nebraska-Lincoln, gerickson4@unl.edu

Terry J. Klopfenstein
University of Nebraska-Lincoln, tklopfenstein1@unl.edu

Nathan F. Meyer
University of Nebraska-Lincoln, nmeyer2@unl.edu

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Terry J. Klopfenstein
Nathan F. Meyer[1]

Summary

Seven ruminally cannulated steers were used in a metabolism experiment to determine the effects of distillers grains level (0% or 40% of diet DM) on diet digestibility and rumen metabolism in diets consisting of dry-rolled, high-moisture, or steam-flaked corn. Intakes were greater while digestibility was reduced for DM and organic matter in steers fed 40% compared to 0% distillers grains. Average and maximum pH were less for steers fed 40% distillers grains, but pH change and variance were also less for 40% compared to 0% WDGS. Feeding WDGS does not increase rumen pH, but does decrease variance. Starch intakes were equal whether 0 or 40% WDGS were fed because cattle fed 40% WDGS had greater DMI, which may influence rumen pH.

Introduction

In a previously reported study (*2007 Nebraska Beef Report*, pp. 33-35), diets based on dry-rolled corn (DRC), high-moisture corn (HMC), or steam-flaked corn (SFC) were fed. Corn was replaced with increasing amounts of wet distillers grains with soluble (WDGS; 0%, 15%, 27.5%, or 40% of diet DM). No effect of WDGS level on feed efficiency was observed in SFC based diets, and ADG was reduced when 27.5% or 40% WDGS were fed. In DRC and HMC based diets however, feed efficiency improved linearly with increasing WDGS level, and ADG increased. The current study was conducted to determine the effects of corn processing method and WDGS level on nutrient digestion and ruminal fermentation characteristics in an attempt to elucidate the reasons for the interaction observed in the finishing trial.

Procedure

Seven ruminally cannulated steers were used in a six-period cross-over study. A 3 × 2 factorial treatment structure was used. The first factor was corn processing method (DRC, HMC, or SFC), and the second factor was WDGS inclusion level (0% or 40% of diet DM; Table 1). Steers were assigned randomly to one of two groups. Group 1 steers were assigned to diets containing 0% WDGS during the first three periods and diets containing 40% WDGS during the final three periods, while group 2 steers were assigned to diets containing 40% WDGS during the first three periods and diets containing 0% WDGS during the final three periods A two-week transition period was included between periods three and four during which group 2 steers were fed decreasing levels of WGDS as follows: day 1 to 4: 30%, day 5 to 10: 20%, and day 11 to 14: 10% WDGS, DM. During that transition, group 1 steers were switched immediately to diets containing 40% WDGS and all diets were based on an equal mixture of DRC, HMC, and SFC.

Period duration was 20 days and consisted of a 15-day adaptation period followed by a 5 day fecal sample and pH data collection period. Chromic oxide (7.5g/dose) was dosed intraruminally at 0800 and 2000 daily beginning on day 11 in each period. Fecal samples were collected daily at 0800, 1400, and 2000, composited by period, and analyzed for chromium content to determine nutrient digestibility. Steers were fed once daily at 0730 and, if present, feed refusals were also collected at this time. Continuous ruminal pH measurements were taken using pH probes that were suspended in the rumen fluid via the rumen cannula. Data were collected using a computer and software (Labtech, Wilmington, Mass.) that collected readings every 6 seconds and averaged those for each minute for the 5 days collection within each period.

Table 1. Diets fed to steers in the digestibility experiment evaluating wet distillers grains plus solubles (WDGS) when fed with different corn processing methods[a] (% of diet DM).

Ingredient	0% WDGS	40% WDGS
DRC, HMC, or SFC	82.5	47.5
WDGS	0.0	40.0
Alfalfa hay	7.5	7.5
Molasses	5.0	0.0
Supplement	5.0	5.0

[a]DRC = dry-rolled corn, HMC = high-moisture corn, and SFC = steam-flaked corn.

Data were analyzed as a six- period crossover design using the MIXED procedure of SAS (SAS Inst. Inc.). Period was included in the model as a fixed effect and the random effect was steer. No corn processing method × WDGS inclusion level interactions were observed ($P > 0.20$) for any variables, so only the main effects of corn processing method and WDGS inclusion level are presented. As a result, main effects were analyzed and statistics presented with the interaction term removed from the model.

Results

Data for nutrient intake and digestibility are presented in Table 2. No corn processing method × WDGS inclusion level interactions for nutrient intake or digestibility were observed ($P > 0.43$), so main effects will be discussed. Corn processing method did not affect intake or digestibility of DM or organic matter (OM). Digestibility of neutral detergent fiber (NDF) was similar between corn processing methods; however, cattle fed HMC consumed slightly less NDF ($P < 0.05$). Starch intake was not impacted by corn processing method, but starch digestibility was greater

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($P < 0.06$) for SFC compared to both DRC and HMC. Feeding WDGS increased intake of DM and OM but decreased the digestibility percentage of both. While NDF digestibility was not impacted by feeding WDGS, cattle fed 40% WDGS consumed more NDF ($P < 0.01$) because WDGS contain more NDF than corn. Starch is removed during the production of WDGS. Despite lower dietary starch percentage in the 40% WDGS diets, feeding WDGS did not reduce total starch intake ($P = 0.90$) and did not impact starch digestibility.

Rumen pH data are presented in Table 3. No corn processing method × WDGS inclusion level interactions for rumen pH data were observed ($P > 0.27$), so only the main effects are discussed. An effect of corn processing method on maximum pH ($P = 0.04$), the magnitude of pH change ($P = 0.05$), and the variance of the ruminal pH ($P < 0.02$) was observed. Steers fed DRC had lower maximum rumen pH values compared to steers fed HMC and SFC ($P < 0.10$). Interestingly, average and minimum rumen pH values were not different between the three corn processing methods. This led to both magnitude of pH change and variance of pH being numerically lowest in steers fed DRC. Although not significant, steers fed HMC had a numerically greater pH change and variance than steers fed DRC. Steers fed SFC experienced a pH change and variance that was greater ($P < 0.10$) than steers fed DRC or HMC. Inclusion level of WDGS also affected rumen pH. Interestingly, steers fed 0% WDGS tended to have greater average pH ($P < 0.12$), maximum pH ($P = 0.07$), pH change ($P = 0.08$), and pH variance ($P = 0.09$) compared to steers fed 40% WDGS. As was the case with corn processing method, minimum pH was not different between 0% and 40% WDGS. Area under the curve for pH of 5.6 and 5.3 followed similar trends as maximum pH. Steers fed SFC had a rumen pH below 5.6 and 5.3 for more minutes compared to steers fed DRC, with HMC fed steers being intermediate. Interestingly, feeding 40% WDGS resulted in greater time spent below a rumen pH of 5.6 or 5.3 compared to cattle fed 0% WDGS. These data agree with previous research evaluating rumen metabolism with and without WDGS (*2007 Nebraska Beef Report*, pp. 39-42).

The lack of an interaction between corn processing method and WDGS inclusion level in this trial does not explain the interaction observed in previous finishing trials. However, DMI was markedly reduced when WDGS were fed at 40% of the diet in SFC-based diets in the previous finishing study. A similar intake response was not observed in this metabolism experiment as DMI was 18.9 lb/day for 0% WDGS and 22.4 lb/day for 40% WDGS in SFC diets. Despite no interaction between corn processing method and WDGS inclusion, starch digestibility was consistent between WDGS levels in HMC and SFC diets, with less than 0.3 percentage unit change between 0 and 40% WDGS within each corn processing method. However, steers fed 0% WDGS with DRC had a starch digestibility of 93.9% which was numerically lower than the 40% WDGS with DRC treatment (97.0%).

Table 2. Effect of corn processing method and wet distillers grains plus solubles (WDGS) level on nutrient intake and digestibility.

	Corn processing method[a]			WDGS level		P-value[b]		
Item	DRC	HMC	SFC	0%	40%	Process	WDGS	Inter
DM								
Intake, lb/day	20.8	19.5	20.7	18.4	22.3	0.25	0.01	0.93
Digestibility, %	78.7	78.8	81.4	81.8	77.5	0.31	0.08	0.96
OM								
Intake, lb/day	20.1	19.0	19.9	18.0	21.4	0.34	0.02	0.94
Digestibility, %	80.7	80.9	83.3	84.0	79.3	0.32	0.05	0.94
NDF								
Intake, lb/day	3.94[c]	3.35[d]	3.74[c]	2.39	4.97	0.02	0.01	0.64
Digestibility, %	49.4	47.2	50.9	47.8	50.5	0.80	0.72	0.73
Starch								
Intake, lb/day	12.0	11.2	11.7	11.6	11.7	0.65	0.90	0.77
Digestibility, %	95.5[c]	96.5[c]	99.1[d]	96.6	97.5	0.04	0.57	0.43

[a]DRC = dry-rolled corn, HMC = high-moisture corn, and SFC = steam-flaked corn.
[b]P-value where Process = corn processing method; WDGS = wet distillers grains plus solubles level; Inter = interaction between corn processing method and WDGS level.
[c,d]Means with different superscripts differ ($P < 0.06$).

Table 3. Effect of corn processing method and wet distillers grains plus solubles (WDGS) level on rumen pH.

	Corn processing method[a]			WDGS level		P-value[b]		
Item	DRC	HMC	SFC	0%	40%	Process	WDGS	Inter
Average pH	5.53	5.56	5.44	5.61	5.41	0.27	0.12	0.51
Maximum pH	6.22[c]	6.41[d]	6.50[d]	6.50	6.26	0.04	0.07	0.49
Minimum pH	5.00	5.06	4.93	5.01	4.98	0.63	0.80	0.82
pH change	1.21[c]	1.34[c]	1.56[d]	1.50	1.25	0.05	0.08	0.27
pH variance	0.070[c]	0.109[c]	0.161[d]	0.140	0.087	0.02	0.09	0.56
Area under curve (magnitude of pH < 5.6 or 5.3 by minute)								
< 5.6	260[c]	307[cd]	398[d]	245	399	0.10	0.07	0.62
< 5.3	67[c]	113[cd]	149[d]	76	144	0.06	0.08	0.97

[a]DRC = dry-rolled corn, HMC = high-moisture corn, and SFC = steam-flaked corn.
[b]P-value where Process = corn processing method; WDGS = wet distillers grains plus solubles level; Inter = interaction between corn processing method and WDGS level.
[c,d]Means with different superscripts differ ($P < 0.10$).

[1]Mark E. Corrigan, graduate student; Galen E. Erickson, associate professor; Terry J. Klopfenstein, professor; Nathan F. Meyer, research technician; Department of Animal Science, Lincoln.