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Impact of Corn Silage Moisture and/or Kernel Processing at Harvest on Finishing Steer Growth Performance, Efficiency of Dietary Net Energy Utilization and Carcass Traits

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Objective

The objective of this experiment is to investigate the impact of corn silage moisture content and kernel processing at harvest on growth performance, efficiency of dietary net energy utilization, and carcass traits in finishing steers when fed at 20% DM inclusion in finishing diets containing modified distillers grains plus solubles.

Study Description

Red Angus steers (n = 192; initial shrunk BW = 983 ± 62.3 lbs) were used in the 112 d finishing experiment at the Southeast Research Farm (SERF) of the South Dakota Agricultural Experiment Station in Beresford. Steers were from a single source and obtained from a local SD auction facility. Steers were received 2 weeks prior to trial initiation. Steers were offered a common diet containing 60% concentrate upon arrival. Steers were transitioned to a 90% concentrate diet over the course of 14 d. Steers were consuming the finishing diet (Table 1) at the initiation of the experiment. Fresh feed was manufactured once daily for each treatment in a single batch using a stationary mixer and bunks were managed for ad libitum access to feed. Actual diet formulation and composition is based upon weekly DM analyses, tabular nutrient values, and corresponding feed batching records. Diets presented in Table 1 are actual DM diet composition, tabular nutrient concentrations, and tabular energy values (Preston, 2016).

Take Home Points

- Harvest time and kernel processing of corn silage have minimal effects on animal growth performance and only moderately affect carcass traits in finishing steers.
- Kernel processing does not enhance the apparent feeding value of corn silage when corn silage is fed as the sole roughage component of a feedlot finishing diet (i.e. 20% inclusion DM basis).

Introduction

Corn silage is a cornerstone feed ingredient in the Northern Plains. Based upon recent USDA data (2019) corn silage was grown on 340,000 acres in SD with an average yield (as-is basis) of 17.5 tons per acre resulting in 5.95 million tons of corn silage produced. Corn silage is typically harvested in early fall once whole plant DM is near 35 to 40% which coincides with one half to two thirds milk line. Timing of harvest dictates total DM tonnage produced. It is recommended that corn silage be harvested when whole plant moisture is around 65%. Unfortunately, whole plant moisture content for an entire field is difficult to determine and as such milk line checks across a field are used to gauge field plant moisture content. In addition to this, meteorological challenges and other workload demands at harvest can very easily result in corn silage being harvested at a greater DM content than deemed ideal (i.e. after black layer). Harvesting corn silage at a greater DM content can cause issues related to inability to properly pack the harvested feed that in turn can result in aerobic stability issues that result in inventory losses due to spoiled feed. Kernel processing (KP) of corn silage has gained wide acceptance in the last 20 y, especially on dairy operations. Kernel processing effects on diet digestibility and growth performance have yielded inconsistent results in beef cattle. This is in part a function of differing DM content of corn silage at harvest and inclusion levels of corn silage in the diet. Kernel processing has proven beneficial in growing cattle diets (Ovinge, 2019) at a high inclusion level (greater than 50% DM inclusion), however, no improvements in growth performance or gain efficiency were noted in finishing cattle diets due to kernel processing (Ovinge, 2019). To our knowledge, no research had investigated the interaction of whole corn crop plant moisture and KP in finishing diets.

Experimental Procedures

Growth Performance

Steers were individually weighed on d -3, 1, 28, 56, 84, and 112. Cumulative growth performance was based upon initial BW (average BW from d -3 and 1 with a 4% shrink applied to account for digestive tract fill) and carcass-adjusted final BW (FBW; HCW/0.625). Average daily gain (ADG) was calculated as the difference between FBW and initial shrunk BW, divided by days on feed and feed efficiency was calculated from ADG/DMI. Observed dietary NE was calculated from daily energy gain (EG; Mcal/d): EG = $ADG^{1.097} \times 0.0557W^{0.75}$, where W is the mean equivalent BW [average initial shrunk BW and FBW × (478/AFBW), kg; (NRC, 1996)]. Maintenance energy required (EM; Mcal/d) was calculated by the following equation: EM = $0.077BW^{0.75}$ (Lofgreen and Garrett, 1968) where BW is the mean shrunk BW (average of initial shrunk BW and FBW). Using the estimates required for maintenance and gain the observed dietary NEm and NEg values (Owens and Hicks, 2019), of the diet were generated using the quadratic formula: $x = \frac{-b \pm \sqrt{b^2-4ac}}{2c}$, where x = NEm, Mcal/kg, a = -0.41EM, b = 0.877EM + 0.41DMI + EG, c = -0.877DMI, and NEg was determined from: 0.877NEm – 0.41 (Zinn and Shen, 1998; Zinn et al., 2008). The ratio of observed-to-expected NE ratio was determined from observed dietary NE for maintenance or gain/tabular NE for maintenance or gain.

Carcass Traits

Steers were harvested after 112 d on feed. Steers were shipped the afternoon following final BW determination and harvested the next day at Tyson Fresh Meats in Dakota City, NE. Steers were comingled at the time of shipping and remained this way until 0700 h the morning after shipping. Hot carcass weight (HCW) was captured immediately following the harvest procedure. Video image data were obtained from the packing plant for rib eye area, rib fat, and USDA marbling scores. A common kidney, pelvic, heart (KPH) fat percentage of 2.5% was applied to all calculations requiring a KPH%. Yield grade was calculated according to the USDA regression equation (USDA, 1997). Dressing percentage was calculated as HCW/(final BW × 0.96). Estimated empty body fat (EBF) percentage and final BW at 28% EBF (AFBW) were calculated from observed carcass traits (Guiroy et al., 2002), and proportion of closely trimmed boneless retail cuts from carcass round, loin, rib, and chuck (Retail Yield, RY; Murphey et al., 1960). Carcass data were available for all but four steers: ML/KP- (2), BL/KP- (1), BL/KP+ (1).

Statistical Analysis

Growth performance, carcass traits, and efficiency of dietary NE utilization were analyzed as a randomized complete block design using the GLIMMIX procedure of SAS 9.4 (SAS Inst. Inc., Cary, NC) with pen as the experimental unit. The model included the fixed effects harvest time, kernel processing, and their interaction; block (location) was included as a random variable. Least squares means were generated using the LSMEANS statement of SAS and treatment effects were analyzed using the pairwise comparisons PDIFF and LINES option of SAS 9.4. Distribution of USDA Yield and Quality grade data as well as carcass weight distributions were analyzed as binomial proportions in the GLIMMIX procedure of SAS 9.4 with fixed and random effects in the model as described previously. If a significant harvest time by processing interaction was detected ($P < 0.05$), simple treatment means were separated. An α of 0.05 or less determined significance and tendencies are discussed between 0.05 and 0.10.

Results and Discussion

Growth Performance

No Harvest time × KP interaction was detected ($P \geq 0.16$) for any growth performance parameters (Table 1). Initial BW was not influenced by harvest time ($P = 0.53$) or KP ($P = 0.95$). Final BW was not affected by harvest time ($P = 0.66$) or KP ($P = 0.14$). Cumulative ADG was not influenced by harvest time ($P = 0.60$) but ADG was numerically decreased by 3.6% ($P = 0.12$) for KP+ steers. Daily DMI was not influenced by harvest time ($P = 0.23$) or by KP ($P = 0.22$). Additionally, growth efficiency was not impacted by harvest time ($P = 0.23$) or KP ($P = 0.22$). No Harvest time × KP interaction was detected ($P \geq 0.26$) for any parameters related to the efficiency of dietary NE utilization. The main effect of Harvest time and KP did not appreciable influence observed dietary NE ($P \geq 0.21$) or the ratio of observed-to-expected dietary NE ($P \geq 0.29$).

Carcass Traits

There was no interaction between harvest time and KP ($P \geq 0.18$) for hot carcass weight, dressing percentage, 12th rib fat thickness, ribeye area, marbling, calculated YG, retail yield, estimated EBF, or final BW at 28% EBF (Table 3). Harvest time did not influence ($P \geq 0.17$) hot carcass weight, dressing percentage, 12th rib fat thickness, ribeye area, marbling, calculated YG, retail yield, or estimated EBF. No interaction between harvest time and KP was noted ($P \geq 0.32$) for the distribution of USDA yield grades. Harvest time ($P \geq 0.18$) nor KP ($P \geq 0.18$) affected the distribution of USDA yield grades. Steers from ML/KP- had the fewer ($P = 0.05$) USDA Prime carcasses compared to ML/KP+, BL/KP-, and BL/KP+.

Implications

Harvest time and kernel processing of corn silage have minimal effects on animal growth performance and only moderately affect carcass traits in finishing steers. Delayed harvest enhanced the comparative NE value of corn silage by 6% above current feed standards and kernel processing decreased comparative NE value of corn silage by 9% compared to current feeding standards. These data indicate that corn silage harvest can be delayed without detriment to growth performance and kernel processing does not enhance the apparent feeding value of corn silage when corn silage is fed as the sole roughage component of a feedlot finishing diet (i.e. 20% inclusion DM basis).

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Tables

Table 1. Diet formulation and composition.[1]

	d 57 - 84				d 85 - 112			
Item	**ML/KP-**	**ML/KP+**	**BL/KP-**	**BL/KP+**	**ML/KP-**	**ML/KP+**	**BL/KP-**	**BL/KP+**
Dry-rolled corn, %	55.51	55.31	56.44	55.81	54.59	54.59	54.48	55.14
Liquid supplement, %	3.90	3.89	3.97	3.92	3.97	3.97	3.97	4.01
RH, %	0.00	0.00	0.00	0.00	1.81	1.81	1.80	1.83
Modified DGS, %	20.54	20.48	20.90	20.67	19.89	19.89	19.86	20.07
Corn Silage, %	20.05	20.32	18.70	19.60	19.74	19.74	19.89	18.95
Dry Matter, %	65.64	66.70	68.38	67.96	64.45	65.39	67.64	66.52
Crude Protein, %	12.10	12.08	12.22	12.14	12.40	12.39	12.47	12.46
NEm, Mcal/cwt	93.26	93.20	93.57	93.37	93.33	93.30	93.51	93.50
NEg, Mcal/cwt	63.29	63.24	63.55	63.38	63.37	63.34	63.52	63.51

[1]All values except Dm on a DM basis.

ML = silage harvested at ½ to 2/3 milk line, BL = silage harvested at black line, KP- = No kernel processing, and KP+ = kernel processing.

Table 2. Cumulative growth performance responses.

	Treatment					*P* – value		
Item	ML/KP-	ML/KP+	BL/KP-	BL/KP+	SEM	Harvest time	Kernel processing	Interaction
Pens, n	6	6	6	6	-	-	-	-
Steers, n	48	48	48	48	-	-	-	-
Initial body weight (BW)[2], lbs	982	983	984	983	1.7	0.53	0.95	0.35
Final BW[3], lbs	1586	1560	1574	1561	18.4	0.66	0.14	0.63
Average daily gain (ADG), lbs	5.40	5.15	5.27	5.16	0.159	0.60	0.12	0.55
Dry matter intake (DMI), lbs	31.63	31.58	31.58	30.83	0.447	0.23	0.22	0.28
ADG/DMI (G:F)	0.171	0.163	0.167	0.168	-	-	-	-
F:G[4]	5.85	6.13	5.99	5.95	-	-	-	-
Observed dietary net energy (NE), Mcal/cwt								
Maintenance	95.7	93.0	95.3	95.3	1.61	0.43	0.21	0.26
Gain	65.3	62.6	64.9	64.9	1.41	0.43	0.21	0.26
Observed-to-expected NE[5]								
Maintenance	1.02	0.99	1.02	1.02	0.017	0.55	0.29	0.35
Gain	1.03	0.99	1.02	1.02	0.022	0.57	0.30	0.37

[1]ML = silage harvested at ½ to 2/3 milk line, BL = silage harvested at black line, KP- = No kernel processing, and KP+ = kernel processing.

[2]Average of d -3 and d 1 BW; a 4% pencil shrink was applied to account for gastrointestinal tract fill.

[3]Final BW = HCW/0.625.

[4]F:G = 1/G:F

[5]Dietary NEm and NEg (Mcal/kg) was 2.06 and 1.40 for ML/KP-, BL/KP-, and BL/KP+; dietary NEm and NEg (Mcal/kg) was 2.05 and 1.39 for ML/KP+.

Table 3. Carcass trait responses.[1]

Item	ML/KP-	ML/KP+	BL/KP-	BL/KP+	SEM	*P* - value		
						Harvest time	Kernel processing	Interaction
Pens, n	6	6	6	6	-	-	-	-
Steers, n	48	48	48	48	-	-	-	-
Hot carcass weight, lbs	992	975	984	975	11.5	0.66	0.14	0.63
Dressing, %	62.27	62.06	62.03	62.44	0.497	0.84	0.78	0.40
Rib fat, in	0.62	0.61	0.66	0.62	0.031	0.22	0.25	0.43
Ribeye area, in^2	14.82	14.77	14.61	14.99	0.220	0.99	0.30	0.18
Marbling[2]	543	540	566	563	23.0	0.17	0.84	0.98
Calculated yield grade (YG)	3.56	3.50	3.71	3.45	0.125	0.55	0.08	0.28
Retail Yield, %	48.90	49.05	48.60	49.14	0.257	0.57	0.07	0.28
Estimated empty body fatness (EBF), %	32.62	32.38	33.38	32.59	0.530	0.21	0.18	0.48
Final BW at 28% EBF, lbs	1381	1365	1343	1358	16.7	0.07	0.99	0.20
USDA YG distribution								
YG 1, %	0.0	0.0	0.0	0.0	-	-	-	-
YG 2, %	25.0	22.9	16.7	27.1	6.15	0.74	0.51	0.32
YG 3, %	58.3	68.8	58.3	56.3	7.37	0.41	0.58	0.41
YG 4, %	16.7	8.3	22.9	16.7	5.21	0.18	0.18	0.84
YG 5, %	0.0	0.0	2.1	0.0	1.04	0.33	0.33	0.33
USDA Quality Grade distribution								
Select, %	2.1	0.0	0.0	4.5	1.76	0.51	0.51	0.08
Low Choice, %	26.2	41.1	29.8	23.5	6.47	0.29	0.51	0.12
Average Choice, %	48.2	35.7	28.0	33.9	6.27	0.09	0.61	0.16
High Choice, %	23.5	10.4	29.5	27.7	5.77	0.06	0.21	0.34
Prime, %	0.0[b]	12.8[a]	12.7[a]	10.4[a]	3.40	0.14	0.14	0.04

[1]ML = silage harvested at ½ to 2/3 milk line, BL = silage harvested at black line, KP- = No kernel processing, and KP+ = kernel processing.

[2] 400 = small 00 = USDA Low Choice.

[a, b] Means within a row lacking a common superscript differ ($P \leq 0.05$).

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