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Effect of corn silage storage system on silage nutritional quality and feedlot performance of young bulls

O desempenho de novilhos terminados em confinamento depende da qualidade bromatológica da silagem de milho armazenada em diferentes tipos de silo

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Highlights

Multivariate statistical model can be used to evaluate the quality of natural rubber.
Near-infrared spectroscopy (NIRS) enabled rapid, nondestructive analysis of DRC.
NIRS DRC analysis can support quality-based payment systems for natural rubber latex.
Portable and benchtop NIRS devices showed similar performance predicting rubber DRC.

Abstract

This study evaluated the effects of corn silage storage system (trench silo or silo bag) on silage nutritional quality, apparent diet digestibility, performance, ingestive behavior, and carcass characteristics of feedlot-finished young bulls. Experimental diets contained 40% corn silage and 60% concentrate. Thirty-two Angus × Nellore crossbred young bulls from the same herd (11 months old; 350 kg initial body weight) were assigned to a randomized block design with two treatments and eight replicates, with each replicate consisting of one pen housing two animals. Compared with trench silos, corn silage

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stored in silo bags increased average daily gain (1.757 vs. 1.592 kg day^{-1}), carcass gain both on a daily basis (1.164 vs 1.087 kg day^{-1}) and over the total feedlot period (103.6 vs. 96.7 kg), slaughter body weight (537.9 vs. 520.1 kg), and hot carcass weight (294.3 vs. 286.3 kg), while improving feed efficiency, expressed as dry matter (DM) intake per unit of weight gain (5.85 vs. 6.27 kg kg^{-1}). Greater apparent DM digestibility in silage stored in silo bags than in trench silos (74.06 vs. 71.64%) likely contributed to the improved performance of feedlot-finished young bulls.
Key words: Feed efficiency. Apparent dry matter digestibility. Weight gain. Carcass gain. Silo bag. Trench silo.

Resumo

O presente estudo teve como objetivo avaliar o efeito do tipo de silo de armazenamento (trincheira ou bag) de silagem de milho, sobre o desempenho produtivo, o comportamento ingestivo, a digestibilidade aparente da ração e as características de carcaça de bovinos de corte terminados em confinamento. As dietas foram constituídas por 40% de silagem de milho e 60% de concentrado. O delineamento experimental foi o de blocos casualizados, constituído de dois tratamentos e oito repetições, onde cada repetição foi representada por uma baia com dois animais. No experimento, foram utilizados 32 novilhos inteiros, ½ sangue Angus Nelore, provenientes do mesmo rebanho, com idade média de 11 meses e peso vivo médio inicial de 350 kg. A confecção da silagem de milho em silos do tipo bag promoveu maior ganho diário de peso (1,757 contra 1,592 kg dia^{-1}), maior ganho médio de carcaça expresso em kg dia^{-1} (1,164 contra 1,087), e em kg equivalente ao período total de confinamento (103,6 contra 96,7 kg), maior peso vivo de abate (537,9 contra 520,1 kg), maior peso de carcaça quente (294,3 contra 286,3 kg) e melhor capacidade de transformação da matéria seca ingerida em ganho de peso (5,85 contra 6,27 kg kg^{-1}), devido as condições de armazenamento proporcionarem maior digestibilidade aparente da MS (74,06 contra 71,64%) se comparada à silagem armazenada em silo trincheira, ambas utilizadas na terminação de novilhos em confinamento. Portanto, a silagem proveniente do armazenamento em silo bag utilizada na alimentação de novilhos confinados promoveu melhor desempenho animal.
Palavras-chave: Conversão alimentar. Digestibilidade aparente da MS. Ganho de peso e de carcaça. Silo bag. Silo trincheira.

Introduction

Corn silage quality depends on the storage system used and the anaerobic conditions achieved during ensiling. Poor fermentation conditions alter temperature and pH, favoring microbial activity and resulting in losses of soluble carbohydrates and reduced dry matter (DM) and neutral detergent fiber digestibility (Ortiz et al., 2021; Neumann et al., 2017). Under farm conditions, failures in storage management can compromise silage nutritional value. To reduce silage deterioration, oxygen exposure should be minimized throughout the ensiling process, from harvest to feed-out (Borreani et al., 2018).

Each storage system presents advantages and limitations related to construction costs and preservation efficiency, directly influencing producers' management decisions (Barboza et al., 2020). Compared with silo bags, trench silos expose ensiled material to greater air contact and temperature fluctuations during filling, increasing nutrient losses and silage deterioration (Neumann et al., 2017). Silage nutritional quality largely depends on the rapid establishment of anaerobic conditions during silo filling, which may affect animal performance (Velho et al., 2008).

However, perforations in the plastic film may compromise the effectiveness of silo bags as a barrier to gas exchange. In addition, this storage system requires greater investment in specialized equipment for silage production (Taher et al., 2019; Bartosik et al., 2023; Borreani et al., 2018).

Given the structural, operational, and environmental differences among storage systems, silo type plays a key role in silage aerobic stability and nutrient preservation, directly affecting fermentation efficiency and feed nutritional quality (Neumann et al., 2017). Therefore, understanding how storage systems influence silage nutritional value and animal performance is essential for optimizing feeding management under practical production conditions.

This study evaluated the effects of corn silage storage system on feedlot performance, ingestive behavior, apparent diet digestibility, and carcass characteristics of young bulls.

Material and Methods

The experiment was conducted at the Animal Production Center (NUPRAN) of the Midwestern State University of Paraná (UNICENTRO), CEDETEG campus, in Guarapuava, Paraná, Brazil. Laboratory procedures were performed at the Laboratory of Feed Analysis and Ruminant Nutrition, whereas the animal trial was carried out at the Beef Cattle Feedlot Research and Extension Unit. Both facilities are affiliated with the Master's Program in Veterinary Sciences of the Agricultural and Environmental Sciences Sector. The experimental site is located at 25°23′02″ S and 51°29′43″ W.

This study evaluated the effects of corn silage storage systems on silage quality and the performance, ingestive behavior, apparent diet digestibility, and carcass characteristics of feedlot-finished young bulls. Treatments consisted of corn silage storage in trench silos (T1) or silo bags (T2).

Corn hybrid P2501 (Pioneer®) was grown under a no-till system. Sowing was performed with 0.45 m row spacing and a depth of 0.04 m to achieve a final population of 85,000 plants ha^{-1}. Corn was harvested at the R4 stage (dough stage), 122 days after emergence, using a JF® C-120 AT S2 precision forage harvester adjusted to obtain particle sizes ranging from 8 to 12 mm.

Silage from both treatments was produced from the same corn hybrid and stored in eight silos: four trench silos (15 m long × 1.2 m wide × 1.2 m high) and four silo bags (15 m long × 1.2 m diameter). Silos were opened simultaneously 150 days after ensiling. During feed-out, a 0.15 m layer of silage was removed daily for 105 days.

Trench silos were compacted by tractor and sealed with double-sided polyethylene film (200 μm thick; Carga Pesada®). Silo bags were filled using a Silomaster bagging machine (JF Máquinas Agrícolas®) and sealed with double-sided polyethylene film (220 μm thick; Extraplast®).

Ensiling conditions resulted in a silage density ranging from 200 to 250 kg DM m^{-3}, associated with the average corn dry matter content at harvest (33.38%).

Thirty-two Angus × Nellore crossbred young bulls from the same herd (11 months old; 350 kg initial body weight) were assigned to a randomized block design with two treatments and eight replicates, with each replicate consisting of one pen housing two animals.

Sixteen individual pens were used for housing the animals during the feedlot trial. Each pen measured 2.5 m in width and 6.0 m in length, providing a total area of 15 m², and contained a concrete feed bunk measuring 2.30 × 0.60 × 0.35 m and a metallic drinking trough equipped with an automatic float-control system.

The trial extended over 105 days. The initial 16 days were allocated to the adaptation of the animals to the housing conditions and experimental diet. The subsequent 89 days constituted the evaluation phase and were organized into three experimental periods, comprising two consecutive 28-day periods and a final 33-day period.

Animals were fed ad libitum twice daily at 06:30 and 17:30 h. Diets were supplied as a total mixed ration (TMR) containing 40% corn silage and 60% concentrate on a dry matter basis. Voluntary intake was recorded daily by weighing feed offered and feed refusals from the previous day. Feed allowance was adjusted to maintain refusals at 5% of the total DM offered.

The concentrate used in the experiment (Table 1) was obtained from the feed mill of Cooperativa Agrária (Guarapuava, Paraná, Brazil). Its formulation included soybean meal, corn, wheat bran, soybean hulls, malt rootlets, calcitic limestone, dicalcium phosphate, feed-grade urea, sodium chloride, and a vitamin-mineral premix, and it was supplied in pelleted form.

Table 1
Chemical composition of the concentrate used in the experimental diets (% DM)

Variable	Concentrate
Dry matter, %	90.40
Ash, % DM	6.36
Crude protein, % DM	20.20
Ether extract, % DM	2.05
Neutral detergent fiber, % DM	31.47
Acid detergent fiber, % DM	13.08
Lignin, % DM	4.73
Total digestible nutrients, % DM	78.68
Calcium, % DM	1.67
Phosphorus, % DM	0.58

Samples of corn silage from each storage system and concentrate were dried in a forced-air oven at 55 °C for 72 h to determine partial DM content. Pre-dried samples were then ground in a Wiley mill fitted with a 1 mm screen and subjected to chemical analyses. The chemical composition of silages and experimental diets is presented in Table 2.

Table 2
Chemical composition of corn silages and experimental diets (% DM)

Variable	Corn silage	
	Trench silo	Silo bag
Dry matter, %	29.03	28.96
Ash, % DM	2.98	2.73
Crude protein, % DM	7.48	7.60
Ether extract, % DM	2.47	2.80
Neutral detergent fiber, % DM	48.25	45.10
Acid detergent fiber, % DM	27.50	25.72
Lignin, % DM	3.91	3.46
Total digestible nutrients, % DM	68.59	69.84
Variable	Experimental diets	
	Trench silo	Silo bag
Dry matter, %	65.85	65.82
Ash, % DM	5.01	4.91
Crude protein, % DM	15.11	15.16
Ether extract, % DM	2.22	2.35
Neutral detergent fiber, % DM	38.18	36.92
Acid detergent fiber, % DM	18.85	18.14
Lignin, % DM	4.40	4.22
Total digestible nutrients, % DM	74.64	75.14

[1] Premix guaranteed levels per kg of concentrate: 16,000 IU vitamin A, 2,000 IU vitamin D_3, 25 IU vitamin E, 0.36 g S, 0.74 g Mg, 3.6 g Na, 0.52 mg Co, 22.01 mg Cu, 1.07 mg I, 72.80 mg Mn, 0.64 mg Se, and 95.20 mg Zn.

Total dry matter was determined in an oven at 105 °C for 4 h. Crude protein (CP) was analyzed according to D. J. Silva and Queiroz (2009), whereas ether extract (EE) and ash were determined according to AOAC (1995) procedures. Neutral detergent fiber (NDF) was analyzed according to Van Soest et al. (1991), while acid detergent fiber (ADF) and lignin (LIG) were determined according to Goering and Van Soest (1970). Non-fibrous carbohydrates (NFC), hemicellulose, and cellulose were estimated according to D. J. Silva and Queiroz (2009). Total digestible nutrients (TDN, %) were calculated using the equation proposed by Bolsen et al. (1996).

Feed refusal quality was evaluated daily by visual assessment of the proportion of silage and concentrate remaining in the refusals, according to Cristo et al. (2025).

Refusals were scored on a scale from 1 to 6 as follows: 1 – 60% silage and 40% concentrate; 2 – 50% silage and 50% concentrate; 3 – 40% silage and 60% concentrate; 4 – 30% silage and 70% concentrate; 5 – 20% silage and 80% concentrate; and 6 – 10% silage and 90% concentrate, on a DM basis.

Fecal score was assessed daily in each pen by visual observation according to the methodology adapted from Looper et al. (2001) and Ferreira et al. (2013). Scores ranged from 1 to 5 as follows: 1 – liquid feces with no defined consistency; 2 – loose feces with slight surface ridging; 3 – pasty feces with two to four concentric rings and a height of 1.0 to 1.5 cm; 4 – soft feces forming piles 5.0 to 7.5 cm high; and 5 – firm feces forming piles greater than 7.6 cm high.

Ingestive behavior was evaluated at the end of the first and third experimental periods through continuous observations conducted over 72 h. Evaluations were performed by seven observers per shift working on a 6 h rotation schedule, with behavioral activities recorded at 3 min intervals.

Behavioral activities, including idle behavior, rumination, water intake, and feed intake, were expressed in h day^{-1}. Feeding, drinking, urination, and defecation frequencies were expressed as occurrences day^{-1}. Artificial lighting was provided during nighttime observations throughout the experimental period.

Apparent diet digestibility was evaluated during the same periods. Daily feed intake and refusals were recorded, and composite diet samples were collected from each treatment once daily throughout the evaluation period and stored frozen at -15 °C. After the collection period, samples were thawed and homogenized. Simultaneously, total fecal collection was performed in each pen, encompassing all feces excreted during the evaluation period, which were weighed daily. Proportional composite samples were subsequently obtained for pH determination (Silva & Queiroz, 2009) and fecal scoring (Looper et al., 2001; Ferreira et al., 2013).

During the apparent digestibility assay, homogeneous fecal samples were collected every 6 h and refrigerated. After three consecutive days, samples were pooled and homogenized to obtain composite samples for laboratory analyses. The amount collected at each interval was proportional to total fecal output.

Diet and fecal samples were dried in a forced-air oven at 55 °C for 72 h to determine partial DM content and subsequently corrected to total DM at 105 °C. Dry matter content of feed refusals and feces was determined using the same procedures applied to diet samples.

Apparent DM digestibility was calculated as follows: [(g nutrient intake − g nutrient excreted) ÷ g nutrient intake] × 100.

Performance variables were evaluated across the three experimental periods after 10 h of solid-feed withdrawal to obtain individual body weights. Variables included average daily gain (ADG, kg day^{-1}), dry matter intake (DMI, kg day^{-1}), dry matter intake as a percentage of body weight (DMI as % BW), and feed efficiency (FE, kg kg^{-1}).

ADG was calculated as the difference between final and initial body weight divided by the number of evaluation days (ADG = [FBW – IBW]/28 and/or 33). DMI was determined as the difference between feed offered and refusals from the previous day. Dry matter intake as a percentage of body weight was calculated as DMI divided by average body weight and multiplied by 100 (DMI (% BW) =

DMI/BW × 100). Feed efficiency was calculated as the ratio of DMI to ADG (FE = DMI/ADG). Variables were evaluated separately for each experimental period (0–28, 0–56, and 0–89 days), with comparisons performed only between storage systems within each period.

At the end of the feedlot period, animals underwent 10 h of solid-feed withdrawal before final weighing. Animals were then fed and weighed before transport to the slaughterhouse to obtain shrunk body weight (SBW). After slaughter, carcasses were weighed to determine hot carcass weight, and subcutaneous fat thickness was measured according to Muller (1987). Carcass dressing percentage was calculated as the ratio of hot carcass weight to shrunk body weight.

Carcass performance was evaluated by calculating carcass gain during the feedlot period (CG, kg) as the difference between hot carcass weight at slaughter and initial body weight, assuming a theoretical carcass dressing percentage of 50%. Average daily carcass gain (ACG, kg day^{-1}) was calculated from CG and the duration of the feedlot period (89 days). Carcass conversion efficiency (CCE, kg DM kg carcass^{-1}) and the proportion of weight gain converted into carcass, expressed as the ACG:ADG ratio, were also determined. All calculations were based on hot carcass weight.

Carcass traits were evaluated according to Muller (1987). Carcass length was measured as the distance between the medial cranial borders of the pubic bone and first rib. Forelimb length corresponded to the distance between the olecranon tuberosity and radiocarpal joint, whereas forelimb circumference was measured at the midpoint of the limb using a measuring tape. Thigh thickness was determined with calipers positioned perpendicular to carcass length at the greatest distance between the split surface of the carcass and the lateral thigh muscles. Subcutaneous fat thickness was measured over the *Longissimus dorsi* muscle between the 12th and 13th ribs using a millimeter-graduated caliper.

At slaughter, non-carcass components were characterized by recording the weights of the head, tongue, tail, hide, and feet (external components), as well as the heart, kidneys, liver, lungs, spleen, and the full and empty rumen-reticulum, abomasum, omasum, and intestines (vital organs).

The pen was considered the experimental unit for all analyses. Measurements obtained from the two animals within each pen were averaged to generate a single representative value. Data were analyzed according to the following statistical model:

$Y_{ij} = \mu + \alpha_i + \varepsilon_{ij}$, where Y_{ij} = dependent variable; μ = overall mean; α_i = effect of dietary treatment i (1 = trench silo; 2 = silo bag); and ε_{ij} = residual random error. Data were subjected to analysis of variance, and means were compared at the 5% significance level using SAS (Statistical Analysis System Institute [SAS Institute], 1993).

All experimental procedures were approved by the Animal Ethics Committee (CEUA/UNICENTRO; Official Letter No. 005/2020).

Results and Discussion

Table 3 shows that time spent on feed intake, water intake, rumination, and idle behavior was not affected ($P>0.05$) by corn silage storage system, regardless of feedlot phase.

Table 3
Ingestive behavior expressed as time (h day^{-1}) and activity frequency (events day^{-1}) in feedlot-finished young bulls fed corn silage stored in different silo systems according to feedlot phase

Silo system	Feedlot phases		Mean
	Initial phase	Final phase	
Ingestive behavior (h day^{-1}):			
		Feed intake	
Trench silo	3.14	2.72	2.93 A
Silo bag	2.76	2.73	2.74 A
Mean	2.95 a	2.72 a	
		Water intake	
Trench silo	0.35	0.21	0.28 A
Silo bag	0.32	0.24	0.28 A
Mean	0.33 a	0.22 a	
		Rumination	
Trench silo	6.80	6.17	6.48 A
Silo bag	6.56	6.44	6.50 A
Mean	6.68 a	6.31 a	
		Idle behavior	
Trench silo	13.72	14.91	14.31 A
Silo bag	14.38	14.62	14.50 A
Mean	14.05 a	14.76 a	
Ingestive behavior (events day^{-1}):			
		Feeding	
Trench silo	22.4	20.5	21.5 A
Silo bag	20.7	18.4	19.6 A
Mean	21.6 a	19.5 a	
		Drinking	
Trench silo	9.2	7.8	8.5 A
Silo bag	9.1	7.9	8.5 A
Mean	9.2 a	7.9 a	
		Defecation	
Trench silo	11.9	9.2	10.5 A
Silo bag	9.7	9.4	9.5 A
Mean	10.8 a	9.3 a	
		Urination	
Trench silo	7.9	7.7	7.8 A
Silo bag	8.0	7.9	8.0 A
Mean	7.9 a	7.8 a	

Means followed by different lowercase letters within rows or uppercase letters within columns differ according to the F-test at the 5% significance level.

The similar physical characteristics of the experimental diets likely contributed to the absence of treatment effects on feeding behavior, whether expressed in h day^{-1} or events day^{-1}. Dry matter intake also remained unchanged (Table 3).

Feeding, drinking, urination, and defecation frequencies were also unaffected ($P>0.05$) by storage system or evaluation period.

As shown in Table 4, fecal output (kg day^{-1}), fecal DM content, and fecal pH were not affected by silage storage system. Apparent DM digestibility, however, was higher ($P<0.05$) in animals fed silage stored in silo bags than in trench silos (74.06% vs. 71.64%).

Table 4

Fecal output (kg day^{-1}, fresh or dry matter basis), fecal dry matter content, fecal pH, and apparent DM digestibility of diets for feedlot-finished young bulls fed corn silage stored in different silo systems according to feedlot phase

Silo system	Feedlot phases		Mean
	Initial phase	Final phase	
	Fecal output, kg fresh matter day-1		
Trench silo	16.13	15.80	15.96 A
Silo bag	16.76	15.70	16.23 A
Mean	16.44 a	15.75 a	
	Fecal dry matter, %		
Trench silo	17.80	17.31	17.55 A
Silo bag	16.92	16.58	16.75 A
Mean	17.36 a	16.94 a	
	Fecal output, kg DM day-1		
Trench silo	2.87	2.72	2.79 A
Silo bag	2.83	2.59	2.71 A
Mean	2.85 a	2.66 a	
	Fecal pH		
Trench silo	7.37	7.58	7.47 A
Silo bag	7.30	7.69	7.50 A
Mean	7.34 a	7.63 a	
	Apparent DM digestibility, %		
Trench silo	70.60	72.69	71.64 B
Silo bag	73.26	74.86	74.06 A
Mean	71.93 a	73.77 a	

Means followed by different lowercase letters within rows or uppercase letters within columns differ according to the F-test at the 5% significance level.

Greater aerobic exposure during trench silo filling may reduce silage nutritional quality by promoting losses of soluble carbohydrates, impairing fermentation efficiency and decreasing DM and fiber digestibility (Ribeiro et al., 2014; Neumann et al., 2021). These effects are consistent with the greater aerobic instability previously reported for trench silos (Bartosik et al., 2023).

Almeida et al. (2023) also reported that reduced oxygen exposure during silage storage improves apparent DM digestibility, lowers fungal count (CFU g^{-1}), and better preserves DM, supporting the present findings.

Table 5 presents average daily gain (ADG), dry matter intake (DMI), and feed efficiency (FE). Corn silage storage system did not affect ($P>0.05$) performance during the initial feedlot phase (0–28 days). During the subsequent periods, however, animals fed silage stored in silo bags showed higher ($P<0.05$) ADG and improved FE compared with those fed silage from trench silos. Although DMI did not differ between treatments, the superior performance observed with silage stored in silo bags indicates more efficient nutrient utilization, resulting in greater weight gain per unit of DM consumed. This response suggests that a greater proportion of consumed nutrients was converted into body tissue rather than being excreted in the feces (Neumann et al., 2017).

Table 5

Average daily gain (ADG), dry matter intake (DMI) expressed in kg day^{-1} or percentage of body weight (BW), feed efficiency (FE), feed refusal score, and fecal score of feedlot-finished young bulls fed corn silage stored in different silo systems

Parameter	Silo system		Mean	P-value	SEM
	Trench silo	Silo bag			
ADG, kg day^{-1}					
0–28 days	1.652 a	1.656 a	1.654	0.9791	0.078
0–56 days	1.628 b	1.802 a	1.715	0.0568	0.038
0–89 days	1.592 b	1.757 a	1.675	0.0500	0.035
DMI, kg day^{-1}					
0–28 days	9.48 a	9.73 a	9.61	0.4568	0.16
0–56 days	9.77 a	10.18 a	9.98	0.2449	0.16
0–89 days	9.86 a	10.25 a	10.06	0.3214	0.18
DMI, % BW					
0–28 days	2.23 a	2.27 a	2.25	0.4446	0.03
0–56 days	2.18 a	2.24 a	2.21	0.3309	0.03
0–89 days	2.10 a	2.13 a	2.11	0.5224	0.03
FE (DMI:ADG), kg kg^{-1}					
0–28 days	5.82 a	6.01 a	5.92	0.7504	0.28
0–56 days	6.07 a	5.68 b	5.88	0.1299	0.11
0–89 days	6.27 a	5.85 b	6.06	0.1157	0.12
Feed refusal score					
0–28 days	3.14 a	3.14 a	3.14	0.9657	0.07
0–56 days	3.17 a	3.12 a	3.15	0.6504	0.06
0–89 days	3.30 a	3.24 a	3.27	0.4817	0.05
Fecal score					
0–28 days	3.08 a	3.09 a	3.08	0.7551	0.02
0–56 days	3.06 a	3.04 a	3.05	0.5072	0.01
0–89 days	3.05 a	3.04 a	3.05	0.5680	0.01

Means within rows followed by different lowercase letters differ according to the F-test at the 5% significance level.
SEM: standard error of the mean.

Magalhães and Sousa (2020) also reported better grain preservation in silo bags, with more stable moisture content, bulk density, and electrical conductivity. By limiting oxygen exposure, silo bags reduce deterioration and promote lactic acid fermentation (Taher et al., 2019; Santos et al., 2023).

The lower ADG and FE observed with trench silos may be associated with the longer filling time required for this storage system. Prolonged exposure during the initial aerobic phase after harvest promotes the conversion of nutrients and energy into water, carbon dioxide, heat, and free ammonia, thereby reducing silage nutritional value and impairing animal performance (Bartosik et al., 2023).

Feed refusal and fecal scores were not affected (P>0.05) by silage storage system and remained stable throughout the experimental period (Table 5). These findings indicate the absence of selective feeding behavior or clinically detectable gastrointestinal disturbances.

Fecal characteristics provide important information about digestive processes associated with feed utilization, since gastrointestinal disorders in cattle are closely related to diet composition (G. M. Moreira et al., 2019). Although increasing dietary energy density improves productivity and enhances the expression of genetic potential, it may also increase the risk of acidosis (Silvestre & Millen, 2021).

Table 6 shows that silage stored in silo bags increased (P<0.05) carcass gain both over the total feedlot period (103.6 vs. 96.7 kg) and on a daily basis (1.164 vs. 1.087 kg day^{-1}) compared with trench silos. However, carcass conversion efficiency and the proportion of weight gain converted into carcass were not affected (P>0.05) by silage storage system.

Table 6

Average daily carcass gain (ACG, kg day^{-1}), total carcass gain during the feedlot period (CG, kg), carcass conversion efficiency (CCE), proportion of weight gain converted into carcass (ACG:ADG, %), and carcass traits of feedlot-finished young bulls fed corn silage stored in different silo systems

Parameter	Silo system		Mean	P-value	SEM
	Trench silo	Silo bag			
Carcass performance:					
CG, kg	96.7 b	103.6 a	100.1	0.0453	0.17
ACG, kg day^{-1}	1.087 b	1.164 a	1.125	0.0437	0.03
ACG:ADG, %	69.4 a	66.3 a	67.8	0.2365	1.20
CCE, kg DM kg carcass^{-1}	9.11 a	8.88 a	9.00	0.5324	0.17
Carcass traits:					
Slaughter body weight (kg)	520.1 b	537.9 a	529.0	0.0589	4.60
Hot carcass weight (kg)	286.3 b	294.3 a	290.3	0.3083	3.69
Carcass dressing percentage (%)	55.1 a	54.7 a	54.9	0.5819	0.33
Fat thickness (mm)	5.25 a	5.19 a	5.22	0.8850	0.21
Carcass length (cm)	129.94 a	130.16 a	130.05	0.7876	0.39
Thigh thickness (cm)	18.66 a	18.50 a	18.58	0.8329	0.36
Forelimb length (cm)	38.78 a	38.66 a	38.72	0.9241	0.63
Forelimb circumference (cm)	42.50 a	42.38 a	42.44	0.9225	0.62

Means within rows followed by different lowercase letters differ according to the F-test at the 5% significance level.
SEM: standard error of the mean.

The reduced aerobic exposure associated with silo bags likely improved silage quality (Bartosik et al., 2023), resulting in higher daily carcass gain and increased carcass deposition throughout the feedlot period.

Lower nutrient losses during storage may also have increased silage energy concentration, allowing greater carcass gain despite similar DM intake between treatments (Miranda et al., 2023).

As shown in Table 6, slaughter body weight and hot carcass weight were higher (P<0.05) in animals fed silage from silo bags (537.9 and 294.3 kg, respectively) than in those fed silage from trench silos (520.1 and 286.3 kg, respectively). Carcass dressing percentage, fat thickness, carcass length, thigh thickness, forelimb length, and forelimb circumference were unaffected (P>0.05) by storage system, with mean values of 54.9%, 5.22 mm, 130.05 cm, 18.58 cm, 38.72 cm, and 42.44 cm, respectively.

Table 7
Non-carcass components expressed as a percentage of body weight in feedlot-finished young bulls fed corn silage stored in different silo systems

Parameter	Silo system		Mean	P-value	SEM
	Trench silo	Silo bag			
Vital organs:					
Heart	0.30 a	0.32 a	0.31	0.2989	0.01
Liver	0.99 a	1.00 a	1.00	0.8739	0.03
Lungs	0.91 a	0.93 a	0.92	0.7033	0.02
Kidneys	0.21 a	0.20 a	0.21	0.7799	0.00
Spleen	0.34 a	0.34 a	0.34	0.8218	0.01
Full abomasum	0.44 a	0.40 a	0.42	0.3452	0.02
Empty abomasum	0.39 a	0.33 a	0.36	0.1978	0.02
Full rumen-reticulum	7.69 a	7.61 a	7.65	0.4878	0.06
Empty rumen-reticulum	2.76 a	2.73 a	2.75	0.7839	0.04
Full intestines	4.23 a	4.16 a	4.20	0.8309	0.15
External components:					
Head	2.18 a	2.19 a	2.19	0.9024	0.03
Tongue	0.17 a	0.17 a	0.17	0.2753	0.00
Hide	9.35 a	9.30 a	9.32	0.9187	0.21
Tail	0.26 a	0.24 a	0.25	0.3159	0.01
Feet	2.17 a	2.06 a	2.12	0.5969	0.09
Testicles	0.31 a	0.29 a	0.30	0.5421	0.01

Means within rows followed by different lowercase letters differ according to the F-test at the 5% significance level. SEM: standard error of the mean.

The greater slaughter body weight and hot carcass weight observed in animals fed silage from silo bags are consistent with the daily and total carcass gain reported in Table 6.

Average carcass dressing percentage was 54.9% regardless of treatment, reflecting the carcass traits of Angus × Nellore crossbred young bulls. Fat thickness also exceeded the minimum slaughterhouse requirement (>5 mm), which is important for preventing cold shortening (Philippe et al., 2020).

Carcass dressing percentage, carcass length, thigh thickness, forelimb length, and forelimb circumference appear to be more strongly influenced by animal genetics than by silage storage system, since tissue deposition occurs relatively uniformly throughout the carcass. The greater muscular development observed in young bulls is associated with higher androgen concentrations (P. S. A. Moreira et al., 2015). Although androgenic hormones generally reduce adipose tissue deposition, the early maturity of the animals used in this study allowed adequate fat deposition to meet market requirements (Miranda et al., 2023; F. A. S. Silva et al., 2023).

Non-carcass components were also unaffected (P>0.05) by silage storage system (Table 7), consistent with the quantitative carcass traits.

Weights of non-carcass components are influenced by genetic background, sex, feeding system, and other factors (Vaz et al., 2015). Because the animals used in this study were homogeneous for these characteristics, visceral organ weights remained unchanged between treatments.

Evaluation of non-carcass components is important for the meat industry because these tissues have commercial value after inspection and help explain relationships between nutritional management and carcass traits (Vaz et al., 2015; Souza et al., 2015).

Conclusion

Corn silage stored in silo bags improved apparent DM digestibility and animal performance, increasing average daily gain, carcass gain, slaughter body weight, hot carcass weight, and feed efficiency in feedlot-finished young bulls.

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