

Effects of supplemental fat and roughage level on intake, growth performance, and health of newly received feedlot calves

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INTRODUCTION

Bovine respiratory disease (BRD) is a major cause of clinical disease and death in the feedlot industry (Blakebrough-Hall et al., 2020), with clinical symptoms observed in up to 60% of newly received calves (Snowder et al., 2006). According to Richeson et al. (2019), the receiving period is defined as the first 4 to 8 wk in which receiving cattle adjust to the feedlot environment, especially to the new nutritional management. Insufficient dry matter intake (DMI) during this period, usually below 2% of body weight (BW; Hutcheson and Cole, 1986), associated with the stress of marketing, commingling, and transportation, results in inadequate nutrient intake, especially energy, and amplifies the negative effects of stress on inflammation and immune function (Duff and Galyean, 2007).

Feeding newly received calves with high concentrate diets is an alternative to increase energy intake and growth performance; however, it also increases morbidity (total number of calves treated for BRD; Lofgreen et al., 1981, 1975; Rivera et al., 2005). Therefore, increasing dietary roughage level could be an alternative to reduce

BRD morbidity in lightweight, highly stressed receiving calves, although economic analyses suggest that the benefits of including higher amounts of roughage in the receiving diets would not offset the loss in profit resulting from less average daily gain (ADG; Rivera et al., 2005).

Including fat in feedlot diets is also an alternative to increase intake of energy (Zinn and Jorquera, 2007). Since energy is the first limiting element for newly arrived feedlot cattle (Duff and Galyean, 2007; Richeson et al. 2019) and activation of the immune system is an energy-dependent process (Batistel et al., 2018), increasing fat content in receiving diets could overcome the negative effects of low energy intake and improve immune function. However, information about sources and level of fat in receiving diets are scarce and variable (Cole and Hutcheson, 1987; Fluharty and Loerch, 1997; Zinn and Jorquera, 2007) and deserve further investigation, especially in low-starch feedlot diets.

Based on this rationale, it was hypothesized that increasing fat content in diets containing greater amount of roughage would be an alternative to increase energy intake and growth performance and reduce the negative effects of stress on the immune function of newly received calves. Thus, the objective of this study was to evaluate the effects of dietary fat and roughage level on

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intake, growth performance, and health of newly received feedlot calves.

MATERIALS AND METHODS

This study was conducted at the Clayton Livestock Research Center, Clayton, NM. All procedures involving live animals were approved by the New Mexico State University, Institutional Animal Care and Use Committee (protocol number # 2020-001).

Animals and Treatments

A total of 72 crossbreed male calves (British and British \times Continental; initial shrunk BW = 200 ± 13 kg) were sourced from commercial auctions and transported approximately 1,300 km into one commercial trailer from Delhi, LA, to the Clayton Livestock Research Center in Clayton, NM (16 h on truck). Upon arrival, calves were processed before access to feed or water (off-truck shrunk BW). All calves were individually weighed, given a unique ID and pen tag, dewormed, vaccinated against respiratory disease and clostridiosis, and received a growth-promoting implant. Once processed, calves were blocked by shrunk BW and assigned to 24 soil-surfaced pens (5×10 m; 3 calves/pen and 6 pens/treatment) equipped with water fountains and 3 m of feed bunk space.

The experiment was a randomized complete block design with a 2×2 factorial arrangement of treatments, consisting of two roughage levels (wheat hay at 30% [R30] or 60% [R60]; dry matter [DM] basis) combined with 2 levels of supplemental fat (yellow grease at 0% [−FAT; no additional fat] or 3.5% [+FAT]; DM basis). Diets were formulated to meet or exceed the nutrient requirements of calves as specified by [NASEM \(2016\)](#) and to contain equivalent concentration of crude protein ([Table 1](#)).

Management and Sampling

Calves were fed the receiving diets once daily at 0700 h. Feed ingredients were mixed using a feed wagon (Roto-Mix 414-14, Dodge City, KS), weighed into 165-kg capacity plastic containers using a digital platform scale, and delivered manually to each pen. To prevent contamination, −FAT diets were mixed prior +FAT diets, and the feed wagon was cleaned between loads.

The amount of feed offered to each pen was adjusted based on the DMI of the previous day and bunks were managed for a maximum of 5% orts.

Table 1. Ingredient and chemical composition of diets (DM basis)

Item	Roughage level, % of DM			
	30		60	
	−Fat	+Fat	−Fat	+Fat
Ingredient, % of DM				
Wheat hay	30.0	30.0	60.0	60.0
Corn grain, steam flaked	46.3	42.8	17.3	13.8
Wet corn gluten feed ¹	18.0	18.0	18.0	18.0
Soybean meal	3.00	3.00	2.00	2.00
Urea	0.20	0.20	0.20	0.20
Fat—yellow grease	—	3.50	—	3.50
Mineral and vitamin supplement ²	2.50	2.50	2.50	2.50
Analysed composition, %				
Dry matter	80.5	80.9	82.0	82.5
Crude protein	15.5	15.2	15.6	15.3
Ether extract	2.70	5.60	2.42	5.32
Neutral detergent fiber	27.4	27.0	41.8	41.4
IVNDFD ³	65.0	52.8	58.0	52.6
Total digestible nutrients ⁴	74.5	77.8	66.8	70.1
ME, Mcal/kg ⁴	2.76	2.88	2.47	2.59
NE _m , Mcal/kg ⁴	1.83	1.93	1.59	1.69
NE _g , Mcal/kg ⁴	1.21	1.28	0.99	1.01

¹Sweet Bran (Cargill, Inc., Dalhart, TX).

²Formulated to meet or exceed mineral and vitamins requirements for receiving calves according to [NASEM \(2016\)](#).

³In vitro neutral detergent fiber digestibility (IVNDFD) was determined after 48-h incubation using a modified version of the [Tilly and Terry's \(1963\)](#) procedure.

⁴Total digestible nutrients (TDN), metabolizable energy (ME), net energy for maintenance, and gain (NE_m and NE_g, respectively) were calculated based on tabular values from [NASEM \(2016\)](#).

Orts were removed daily, weight, and sampled for DM determination and DMI calculation.

The study was 58 d in length. Individual shrunk BW was collected again on d 58 (after 16 h of feed and water deprivation) of the study for average daily gain (ADG) calculation. Throughout the study, one trained person conducted animal health evaluations implementing a four-point scale method based on depression, anorexia, respiratory, and temperature (“DART”) as described by [Step et al. \(2008\)](#) and [Wilson et al. \(2015\)](#). Briefly, calves were pulled from their pens for further assessment when showing depression, respiratory distress, or abnormal appetites. Any calf identified with a severity score of 1 or 2 and with a rectal temperature of 40 °C or greater received an antimicrobial according to label instructions. If a calf was identified with a severity score of 1 or 2 and with a rectal temperature of less than 40 °C, no antimicrobial treatment was administered. Any calf with severe clinical signs (severity score = 3 or 4) received an

antimicrobial according to label instructions regardless of rectal temperature. Initial medical treatment for a sick animal was an injection of florfenicol antibiotic with flunixin meglumine (Resflor Gold, Merck Animal Health, Madison, NJ). If a second medical treatment was warranted, the calf received an injection of ceftiofur crystalline free acid (Excede, Zoetis, Florham Park, NJ), and a calf's third medical treatment (if warranted) was an injection of oxytetracycline (Bio-Mycin 200, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO). After each medical treatment, the calf received an ear tag to demonstrate that it has been treated, and were assigned to 5-d moratorium before they can receive a subsequent medical treatment.

Statistical Analysis

Quantitative data were analyzed using the MIXED procedure of SAS (version 9.4, SAS Inst. Inc., Cary, NC), whereas binary data were analyzed using the GLIMMIX procedure of SAS. All data were analyzed as a randomized complete block design with a 2×2 factorial arrangement of treatments. Pen was the experimental unit and the Satterthwaite approximation method was used to determine the correct denominator degrees of freedom for the test of fixed effects. The statistical model included the fixed effects of roughage level, fat, and roughage level \times fat interaction. Pen (roughage level \times fat), calf (pen), and BW block were considered random variables for BW and

ADG analyses. Results are reported as least square means. Significance was set at $P \leq 0.05$ and tendencies at $P > 0.05$ and ≤ 0.10 .

RESULTS AND DISCUSSION

Effects of roughage level \times supplemental fat interaction were not detected for any variable analyzed ($P \geq 0.31$), and therefore, the effects of roughage level and supplemental are reported separately.

Effects of Roughage Level

Dietary roughage level did not affect DMI ($P = 0.85$; Table 2). Calves fed R30 tended to have greater ADG and final BW than calves fed R60 ($P \leq 0.08$; Table 2). Feed efficiency was greater for calves fed R30 than calves fed diets R60 ($P = 0.01$; Table 2). Lofgreen et al. (1975) reported that newly received calves fed diets containing 28% roughage had greater DMI and ADG compared with calves fed 80% or 45% roughage. According to Rivera et al. (2005), the optimal dietary strategy for starting lightweight, newly received calves on feed would likely be to feed a 50% to 75% concentrate diet.

Dietary roughage level did not affect morbidity and mortality ($P \geq 0.11$) during the experiment (Table 2), despite the numerical increase in the number of calves fed R30 that required a third treatment for BRD (11.1% vs. 2.38% for R30 and R60, respectively). The number of antimicrobial treatments for BRD was also numerically greater

Table 2. Growth performance, morbidity, and mortality of newly received feedlot calves fed diets containing different roughage levels (wheat hay; 30% or 60%; DM basis) and supplemental fat (yellow grease; 0 [–FAT] or 3.5% [+FAT]; DM basis)

	Roughage level		Supplemental fat		SEM ¹	P-value		
Item	30%	60%	–FAT	+FAT		Roughage	Fat	Roughage × Fat
Growth performance								
Initial body weight, kg	200	199	200	200	6.00	—	—	—
Final body weight, kg	285	269	270	284	11.2	0.08	0.13	0.94
Dry matter intake, kg/d	6.00	5.92	5.87	6.04	0.297	0.85	0.64	0.94
Average daily gain, kg	1.47	1.20	1.21	1.46	0.144	0.07	0.09	0.91
Feed efficiency ²	0.249	0.204	0.207	0.246	0.016	0.01	0.03	0.80
Cattle treated for respiratory disease ³ , %								
First treatment	50.0	47.2	44.4	52.8	9.61	0.82	0.49	0.82
Second treatment	19.4	11.1	8.33	22.2	6.50	0.32	0.10	0.32
Third treatment	11.1	2.78	5.56	8.33	6.10	0.14	0.62	0.62
Number of antimicrobial treatments required	1.75	1.34	1.51	1.58	0.272	0.11	0.78	0.30
Mortality, %, (n)	8.33 (3)	2.78 (1)	5.56 (2)	5.56 (2)	3.87	0.31	1.00	0.31

¹Highest pooled SEM was reported.

²Gain-to-feed ratio (kg/kg).

³Calves were observed daily for BRD signs according to the four-point scale method based on depression, anorexia, respiratory, and temperature (“DART” system) as described by Step et al. (2008) and Wilson et al. (2015).

for calves fed R30 than R60 (1.75 vs. 1.34, respectively). Contrary, Reuter et al. (2008) observed that cattle fed 70% roughage diets had lower rectal temperature and greater peak proinflammatory cytokines than those fed diets containing 30% roughage, suggesting that dietary energy content may alter the immune response.

Effects of Supplemental Fat

Supplemental fat did not affect DMI ($P = 0.64$), but tended ($P = 0.09$) to increase ADG compared with the -FAT diet (Table 2). Contrary, Zinn and Jorquera (2007) recommended that receiving diets should not contain more than 2% supplemental fat, especially due to some negative effects related to diet palatability. According to the survey conducted by Samuelson et al. (2016), 18.2% of the nutritionists recommended that their clients use either yellow grease (9.09%) or fat blends (9.09%) in receiving diets, and the maximum total fat concentration was 3.75% of diet DM. Feed efficiency was greater for calves fed +FAT than -FAT ($P = 0.03$; Table 2). According to Fluharty and Loerch (1997) including 4% fat (animal-vegetal blend) in high-protein diets (15.3% to 22.9% crude protein; DM basis) may improve the efficiency of feed utilization during the receiving period. These authors also observed a numerical decrease in morbidity for calves fed diets containing 4% fat (animal-vegetal blend).

Feeding the +FAT diet tended ($P = 0.10$) to increase the number of retreatments (calves that received a second treatment) against BRD compared with -FAT (Table 2), although the total number of antimicrobial treatments required to treat sick calves ($P = 0.778$) and the mortality rate ($P = 1.0$) were not affected by supplemental fat (Table 2).

IMPLICATIONS

In summary, feeding 30% roughage diets or adding 3.5% of yellow grease as supplemental fat increased feed efficiency during the feedlot receiving period. Adding 3.5% yellow grease (DM basis) as supplemental fat had some impact on morbidity rate, and roughage level did not affect the number of antimicrobial treatments for BRD, despite the numerical increase in the percentage of retreatments.

Conflict of interest statement. The authors declare no conflict of interest.

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