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Protein supplementation for growing cattle fed a corn silage–based diet[1]

T. L. Felix,*[2] PAS, S. C. Loerch,† PAS, and F. L. Fluharty,† PAS
*Department of Animal Sciences, University of Illinois at Urbana-Champaign, Urbana 61801; and
†Department of Animal Sciences, The Ohio State University, Wooster 44691

ABSTRACT

The objectives were to determine effects of protein supplementation in corn silage–based diets on growing cattle performance and economics of gain. In Exp. 1, steers (n = 144; initial BW = 269 ± 60 kg) were blocked by BW. The 6 pens within each block were randomly assigned to 1 of 3 protein supplements: 1) urea, 2) soybean meal, or 3) dried distillers grains with solubles (DDGS). The diets contained 79% corn silage and 21% CP, vitamin, and mineral supplement (DM basis). Protein supplements were formulated to achieve 11.5% total dietary protein (DM basis) and were fed for 84 d. In Exp. 2, steers (n = 34, initial BW = 198 ± 28 kg) and heifers (n = 19, initial BW = 194 ± 42 kg) were blocked by sex and allotted to 9 pens (3 pens of heifers and 6 pens of steers). Pens within block were randomly assigned to 1 of 3 protein supplements: 1) 11% CP, 2) 12% CP, or 3) 13% CP. Urea was used to increase protein concentrations by treatment, and diets contained 90% corn silage and 10% corn-based supplement containing urea, vitamins, and minerals (DM basis). In Exp. 1, cattle fed DDGS and soybean meal had greater ($P < 0.01$) ADG, DMI, G:F, and final BW than those fed urea-based protein supplements with corn-silage diets. Ingredient price differences resulted in cattle fed DDGS having the least ($P < 0.01$) cost per kilograms of BW gain. In Exp. 2, increasing dietary urea concentration tended to linearly decrease ($P = 0.08$) ADG and G:F. Cattle fed 11 or 12% CP had the least cost per kilograms of BW gain. Cattle fed soybean meal or DDGS with corn silage had comparable growth performance, and using DDGS as a protein supplement to corn silage–based diets provided the most economical return.

Key words: corn silage, protein, growing cattle, beef

INTRODUCTION

High corn prices can provide an economic incentive to develop and use least-cost growing programs before placing cattle on more-expensive, grain-based finishing diets. Corn silage–based growing diets result in a relatively inexpensive cost of gain, but they necessitate protein supplementation to meet protein requirements (Guyer, 1978). Growing cattle (BW = 200 to 400 kg) require absorption of true metabolizable protein (**MP**) to meet their protein needs (NRC, 2000). Urea provides NPN and is typically a less costly nitrogen source than plant protein sources, such as soybean meal (**SBM**) or dried distillers grains with solubles (**DDGS**). However, urea may not provide enough MP to meet the requirements of growing cattle (Sewell and Wheaton, 2013). Surprisingly, there is a paucity of information regarding level or source of protein needed to optimize the performance of growing calves on a corn silage–based diet; therefore, 2 experiments were performed. The objectives of these experiments were to determine effects of protein supplementation in corn silage–based diets on cattle performance and economics of gain.

MATERIALS AND METHODS

All animal procedures in Exp. 1 were approved by the Agricultural Animal Care and Use Committee at The Ohio State University. All animal procedures in Exp. 2 were approved by the Institute of Animal Care and Use Committee at the University of Illinois. Furthermore, all animal procedures followed guidelines recommended in the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching (FASS, 2010).

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[2] Corresponding author: tfelix@illinois.edu

Exp. 1

Animals and Diets. A total of 144 Angus-sired crossbred steers (initial BW = 269 ± 60 kg) were used in an 84-d experiment to examine source of supplemental protein in corn silage–based growing diets. Steers originated from 3 Ohio State University branch research stations. They were preconditioned (vaccination and weaning) for 5 wk before feedlot arrival. Upon arrival, they were fed a diet consisting of 65% corn silage; 20% soybean hulls; and 25% protein, vitamin, and mineral supplement to meet or exceed NRC (2000) requirements of growing cattle. Following this 21-d receiving period, steers were blocked by BW into 4 blocks (largest, large, medium, and small) and allotted to 24 pens with 6 pens per block. Pens within each block were randomly assigned to 1 of 3 dietary supplemental protein treatments: 1) urea, 2) SBM, or 3) DDGS. The diets contained 79% corn silage and 21% of a protein and mineral supplement containing the respective protein source (DM basis). Corn silage was harvested at 33 to 35% DM over a 2-d period and was stored in an upright concrete silo with a top unloader. Protein supplements were formulated to achieve 11.5% CP (DM basis; Table 1). Diets were formulated to meet or exceed cattle nutrient requirements according to NRC (2000). Diets were also formulated to be isonitrogenous and to provide the same amount of NE_g. Steers were fed for ad libitum intakes once daily at 0900 h, and refusals were recorded daily. Cattle were weighed on 2 consecutive days, to reduce variation associated with gut fill, at the start and end of the experiment to determine initial and final BW, respectively. Throughout the experiment, interim BW were collected every 2 wk. All BW measurements were made at 0800 h before feeding. Steers were implanted on d 1 with Component E-S (Elanco Animal Health, Greenfield, IN). Individual feed ingredients were collected every 2 wk, and 50 g was dried for 3 d at 55°C. The 50 g of individual feed ingredients was then composited by feed type for the course of the experiment and ground, using a Wiley mill (1-mm screen; Thomas Scientific, Swedesboro, NJ), for further nutrient analysis. The composited samples of each ingredient were analyzed for ADF and NDF (using Ankom Technology Method 5 and 6, respectively; Ankom Technology, Fairport, NY), CP (macro Kjeldahl N × 6.25), and fat (using Ankom Technology Method 2). All samples were analyzed for DM (24 h at 100°C).

Table 1. Composition of diets fed to cattle in Exp. 1 on a DM basis

	Protein source		
Item	Urea	DDGS[1]	SBM[2]
Ingredient, %			
Corn silage[3]	79	79	79
Supplement			
Ground corn	17.406	0.688	9.633
DDGS		18.250	
SBM			9.200
Urea	1.427		
Limestone	0.600	0.995	0.600
Dicalcium phosphate	0.500		0.500
Trace mineral salt[4]	0.375	0.375	0.375
Vitamin A	0.007	0.007	0.007
Vitamin D	0.007	0.007	0.007
Vitamin E	0.022	0.022	0.022
Selenium	0.038	0.038	0.038
Rumensin 90[5]	0.017	0.017	0.017
Animal-vegetable fat	0.600	0.600	0.600
Analyzed composition, %			
NDF	29.21	32.15	29.44
ADF	18.16	19.51	18.48
CP	10.83	10.84	10.63
Fat	2.17	3.14	2.07
Calculated			
NE_m,[6] Mcal/kg	1.92	2.05	2.04
NE_g,[6] Mcal/kg	1.27	1.39	1.38
DIP,[7] % CP	73.17	67.88	70.76

[1]Dried distillers grains with solubles.

[2]Soybean meal.

[3]Corn silage composition (DM basis): 34.9% NDF, 22.2% ADF, 6.8% CP, and 1.5% fat.

[4]Trace mineral salt included 95% NaCl; 0.35% Zn, as ZnO; 0.28% Mn, as MnO_2; 0.175% Fe, as $FeCO_3$; 0.040% Cu, as Cu_2O; 0.007% I, as $Ca_5(IO_6)_2$; 0.007% Co, as $CoCO_3$.

[5]Rumensin 90 (200 g of monensin/kg, Elanco, Greenfield, IN).

[6]Calculated using the iterative equation for medium-framed steers (NRC, 1996).

[7]Degradable intake protein: calculated using published tabular values for corn silage [International Feed Number (IFN) 3-28-250], ground corn (IFN 04-02-931), DDGS (IFN 5-28-844), SBM (IFN 5-04-612), and urea (NRC, 2000).

Statistical Analysis. The design of Exp. 1 was a randomized complete block. Data were analyzed using the MIXED procedures of SAS (SAS Institute Inc., Cary, NC). The model was $Y_{ijk} = \mu + b_i + T_j + e_{ijk}$, where μ represents the overall mean, b_i represents the random effect of BW block, T_j represents the fixed effect of dietary treatment, and e_{ijk} represents the experimental error; pen was the experimental unit. The PDIFF statement of SAS was used to separate treatment means. Significance