J. Dairy Sci. 96:7210–7222
http://dx.doi.org/10.3168/jds.2013-6906

Evaluation of rumen-protected lysine supplementation to lactating dairy cows consuming increasing amounts of distillers dried grains with solubles

H. A. Paz,* M. J. de Veth,† R. S. Ordway,† and P. J. Kononoff*[1]
*Department of Animal Science, University of Nebraska-Lincoln, Lincoln 68583
†Balchem Corporation, New Hampton, NY 10958

ABSTRACT

Twenty multiparous Holstein cows were used in four 5 × 5 Latin squares to determine the effects of feeding increasing amounts of distillers dried grains with solubles (DDGS) in diets with or without the supplementation (60 g/d) of a rumen-protected Lys (RPL) product (AminoShure-L, 38% L-Lys; Balchem Encapsulates, New Hampton, NY) on milk yield and composition and plasma concentration of AA. Dietary treatments were (1) control (CON; no DDGS), (2) 10% DDGS (10DG), (3) 20% DDGS (20DG), (4) 10% DDGS plus RPL (10DGRPL), and (5) 20% DDGS plus RPL (20DGRPL). Diets were formulated using the Cornell-Penn-Miner Dairy model (CPM v3.0; http://cahpwww.vet.upenn.edu/node/77) to provide a predicted decreasing supply of Lys (117, 99, and 91% of requirements) for the CON, 10DG, and 20DG diets, respectively. Addition of RPL to the 10DG and 20DG diets (unsupplemented diets) resulted in 2 additional treatments, 10DGRPL and 20DGRPL diets, respectively. The 10DGRPL and 20DGRPL diets met 110 and 100% of the Lys requirements, respectively. Periods lasted 21 d, with the last 3 d for data collection. Compared with cows fed the CON diet, cows fed diets with DDGS had a similar dry matter intake (DMI; 25.4 ± 0.88 kg/d), milk yield (30.7 ± 1.67 kg/d), and composition, except for protein percentage, which was higher (3.15 vs. 3.21 ± 0.05%) and resulted in higher (0.94 vs. 1.00 ± 0.05 kg/d) protein yield by cows fed diets containing 20% DDGS. Unexpectedly, despite diets being formulated based on predicted DMI of 23.3 kg/d and milk yield of 38.5 kg/d, cows had a greater DMI and lower milk yield across all treatments, which resulted in diets that were predicted by CPM Dairy to supply sufficient amounts of Lys (140, 118, and 104% of requirement for the CON, 10DG, and 20DG diet, respectively) and consequently, supplementation with RPL did not have an effect on milk production or composition. Plasma concentration of Lys decreased (11.8%) as DDGS inclusion increased. For other essential AA, plasma concentrations of cows fed diets with DDGS were lower for Arg, His, and Val and greater for Leu and Met compared with cows fed the CON diet. Supplementation with RPL failed to decrease the plasma concentration of other essential AA, which provides support that Lys was not limiting.
Key words: dairy cow, distillers dried grains with solubles, rumen-protected lysine

INTRODUCTION

An increase in the availability and quality of distillers dried grains with solubles (**DDGS**) generated from the corn ethanol industry has promoted the development of research oriented toward finding the most effective ways to utilize this coproduct for milk production. This feed ingredient is characterized by a high concentration of CP (30% of DM) and energy (2.26 Mcal of NE_L/kg; Schingoethe et al., 2009), but low Lys concentration (1.86% of RUP; Kelzer et al., 2010). Despite low levels of metabolizable Lys coming from DDGS, only a few studies (Owen and Larson, 1991; Kleinschmit et al., 2006; Mjoun et al., 2010b) have reported negative effects on milk protein when feeding DDGS. One potential reason for this is that in studies where milk protein did not change (Janicek et al., 2008; Zhang et al., 2010), the diets fed were high in CP concentration (>18.0% of DM) and as a consequence, even if the dietary Lys concentration (% of CP) was low, the total amount of Lys supplied to the cows met or exceeded the requirement. The feeding of high-CP diets may be problematic because of the excessive amount of N excreted by the cow into the environment (Frank and Swensson, 2002). As a result, a current need exists to evaluate the effect of feeding DDGS in diets not containing excessive amounts of CP.

Supplementation of rumen-protected AA has proven to be an effective route to supply limiting AA in dairy diets (NRC, 2001). However, information about supplementation of individual rumen-protected essential AA (**EAA**) is limited, except for Met (Patton, 2010). Lysine is cited as the most-limiting AA in diets that

Received April 8, 2013.
Accepted July 20, 2013.
[1]Corresponding author: pkononoff2@unl.edu

rely on corn-based ingredients (NRC, 2001); thus high inclusion of DDGS has not been favored in the field (Schwab, 2010). Supplementation of rumen-protected Lys (**RPL**) could be beneficial if Lys is limiting in diets with DDGS. The objective of this study was to evaluate the effects of feeding increasing amounts of DDGS in diets with or without the supplementation of an RPL product on milk yield and composition and plasma concentration of AA.

MATERIALS AND METHODS

Animals and Experimental Treatments

Twenty multiparous Holstein cows averaging 62 ± 28 DIM were assigned to one of four 5 × 5 Latin squares. Cows were blocked by milk yield and DIM and then treatments were randomly assigned to cows. Experimental periods lasted 21 d, with 18 d for diet adaptation and 3 d for data collection. During the entire experiment, cows were housed in a tie-stall barn, fed once daily at 0900 h for ad libitum consumption to ensure at least 5% orts, and had continuous access to water. Additionally, cows were milked twice daily at 0700 h and 1900 h. Animal care and experimental procedures were approved by the University of Nebraska-Lincoln Animal Care and Use Committee.

Diets comprised 53.3% forage and 46.7% concentrate (Table 1). Forages and cottonseed were premixed in a mixer wagon (Roto-Mix 312; Roto-Mix Inc., Dodge City, KS). In addition to the premixed forages and cottonseed, the specific concentrate of each diet was added into the Calan Data Ranger (American Calan Inc., Northwood, NH) to prepare the TMR. Diets were formulated using the Cornell-Penn-Miner (**CPM**) Dairy model (Boston et al., 2000) to be isoenergetic (2.59 Mcal of ME/kg) and isonitrogenous (16.4% CP, DM basis) but were expected to provide a decreasing supply of MP-Lys. The latter was achieved by using DDGS to replace supplements higher in Lys. Dietary treatments were (1) control (**CON**; no DDGS), (2) 10% DDGS (**10DG**), (3) 20% DDGS (**20DG**), (4) 10% DDGS plus RPL (**10DGRPL**), and (5) 20% DDGS plus RPL (**20DGRPL**). Based on the CPM Dairy predictions, the CON diet was formulated to meet or exceed the requirements of a lactating dairy cow weighing 680 kg, with a BCS of 3.00, consuming 23.3 kg of feed daily, and producing 38.5 kg of milk daily with a composition of 3.0 and 3.5% of true protein and fat, respectively. In the CON diet, Lys was predicted to supply 6.86% of the MP and meet 117% of the MP-Lys requirements of the animals. Two more treatments containing increasing amounts of DDGS were formulated and Lys was predicted to supply 6.38 and 5.88% of the MP and meet 99 and 91% of the MP-Lys requirements of the animals (10DG and 20DG diets, respectively) and these 2 diets will be referred as unsupplemented diets. Two additional treatments (10DGRPL and 20DGRPL diets) were achieved by supplementing the 10DG and 20DG diets with an RPL product (AminoShure-L, L-Lysine 38%; Balchem Encapsulates, New Hampton, NY) once daily at 60 g/d via top dressing evenly over the TMR. Supplemented RPL was estimated to provide 14.6 g of MP-Lys; consequently, the 10DGRPL and 20DGRPL diets met 110 and 100% of the MP-Lys requirements of the animals. To ensure that all diets provided sufficient Met to avoid Met limiting potential milk protein responses by Lys supplementation, MetaSmart dry (Adisseo Inc., Antony, France) was added at a rate of 29 g/d per cow.

Experimental Measures and Sample Analysis

Feed intake, orts, and milk production were recorded daily during the entire experiment. Dry matter concentrations of corn and alfalfa silages were determined weekly (microwave oven; Oetzel et al., 1993) and their respective inclusion in the diet was adjusted to account for DM variation. During the sampling period, forages, cottonseed, DDGS, concentrates, and TMR of the unsupplemented diets were sampled daily, refrigerated (4°C), and composited at the end of each period. Composite samples of forages, cottonseed, DDGS, and concentrates were divided into 2 subsamples. One subsample from each composite was dried for 48 h at 55°C in a forced-air oven, subsequently ground with a Wiley Mill (1-mm screen; Arthur H. Thomas Co., Philadelphia, PA), and then reground with a Cyclotec 1093 mill (Tecator 1093; Foss Tecator AB, Höganäs, Sweden) to ensure uniform particle size. Ground samples were sent to the Experimental Station Chemical Laboratories, University of Missouri-Columbia and analyzed for AA (method 982.30 E; AOAC International, 2006) using a Hitachi L-8800 AA analyzer (Hitachi Co., Tokyo, Japan). The other subsample from each composite was sent to Cumberland Valley Analytical Services Inc. (Hagerstown, MD) for standard analysis, which included DM, N (Leco FP-528 Nitrogen Combustion Analyzer; Leco Corp., St. Joseph, MI), unavailable protein (haylages only), adjusted protein, soluble protein, degradable protein (calculated for forages only), ADF (method 973.18; AOAC International, 2000), NDF (Van Soest et al., 1991), ether extract (method 2003.05; AOAC International, 2006), ash (method 942.05; AOAC International, 2000), NFC, Ca, P, Mg, K, Na, Fe, Mn, Zn, Cu, and pH analysis (ensiled silages; Mettler DL12 Titrator; Mettler-Toledo Inc., Columbus, OH). Two subsamples from the TMR composites were taken. One