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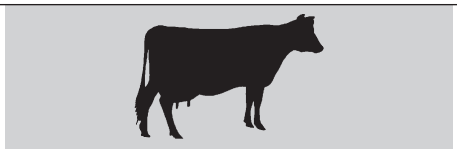

Case Study: Effect of strategic ration balancing on the efficiency of milk protein production and environmental impact of dairy cows in a commercial herd

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ABSTRACT

Three experiments were conducted with the objective of evaluation of supplementing rumen-protected Lys, rumen-protected Met, and RUP on productive performance, dietary N utilization, ammonia emission, and economic profitability. In Exp. 1 and 2, multiparous cows were fed (1) a control diet that represented the current herd diet (~17.5% CP) or (2) a reformulated diet (15.9–17.6% CP) supplemented with rumen-protected Lys, rumen-protected Met, and RUP. In Exp. 3, primiparous cows were fed (1) a control diet that represented the current herd diet (17.7% CP) or (2) a reformulated diet (16.7% CP) supplemented with rumen-protected Lys, rumen-protected Met, and RUP. The DMI was numerically similar between control and reformulated diets. Compared with the control diets, the yields of milk, milk protein, lactose, and solids nonfat were greater for the reformulated diet in Exp. 1, less in Exp. 2, and similar in Exp. 3. The yield of milk fat was greater for the reformulated diet in Exp. 1 and similar in Exp. 2 and 3. When the cows were fed the reformulated diet, the excreted manure N was numerically reduced by 4.8% to 14.7%, and milk N efficiency was increased by 6% to 10.3%. The ammonia emission from manure in cows fed the reformulated diet was numerically less in Exp. 1 and 2 and similar with control in Exp. 3. When cows were fed the reformulated diets, the income over feed cost was consistently greater than control only in Exp. 3. In conclusion, cows fed lower CP diets at a commercial farm could maintain milk production, improve the milk N efficiency, and reduce the manure N excretion and ammonia emission when the diets were reformulated and supplemented with rumen-protected Lys, rumen-protected Met, and RUP.

Key words: Met, Lys, ammonia emission, commercial farm

INTRODUCTION

It is common for less than 30% of dietary N to be captured in milk (Castillot et al., 2000; Jonker et al., 2002), and the N not captured in milk can potentially be lost to the atmosphere via ammonia emission (Hutchings et al., 2001; Webb, 2001), which is of concern from an environmental perspective (Hristov et al., 2011). NRC (2003) reported that about 50% of ammonia emission in the United States was contributed from livestock manure.

The content of urinary N is a major factor influencing the production and volatilization rate of ammonia (Mon-

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teny and Erisman, 1998; Sommer and Hutchings, 2001). Fecal N and urinary N excretions are linearly and exponentially reduced corresponding to decreased N intake in dairy cows (Kebreab et al., 2002). However, reducing dietary CP can correspond with decreased milk or milk protein yields, mainly due to a deficient supply of RUP and limited AA (Cabrita et al., 2011; Lee et al., 2011).

Several studies have demonstrated that when diets low in CP are supplemented with an RUP source, as well as rumen-protected Lys (**RPLys**) and rumen-protected Met (**RPMet**), urinary N can be minimized and productive performance can be maintained (Xu et al., 1998; Socha et al., 2005; Lee et al., 2012). Although feeding low CP diets with RPLys and RPMet has been verified in published research, the strategy has been slow to be adopted at commercial farms. This prompted us to focus on studies under commercial farm conditions and evaluate the strategy of reducing dietary CP by reformulating with RUP source, RPLys, and RPMet.

The objectives of the study were to verify whether feeding more balanced AA diets containing a high quality RUP source, RPLys, and RPMet can successfully improve the feed N utilization efficiency for milk protein synthesis and decrease ammonia emission from dairy manure without compromising the income over feed costs of primiparous and multiparous cows at a commercial farm.

MATERIALS AND METHODS

Animals used in Exp. 1, 2 and 3 were cared for and handled according to the guidelines of the Washington State University Animal Care and Use Committee. Experiments 1, 2, and 3 were conducted at a commercial farm located in Monroe, Washington.

Exp. 1

A total of 226 multiparous, lactating Holstein cows were used in a switchback trial conducted from January to March 2013. Cows were randomly assigned to 1 and 2 groups with average parity of 3.0 and 2.8 and DIM of 112 ± 80 and 107 ± 68 at the start of the experiment. There were 2 periods, and each period was 3 wk in duration. Week 1 was for adjustment to diets, and wk 2 and 3 were for data collection.

The control diet (**CON1**; Table 1) was the current herd diet at the commercial farm. The treatment diet (**LM1+**) was formulated using Agricultural Modeling and Training Systems Cattle Professional (**AMTS**, Version 3. 4.7.1, AMTS LLC, New York, NY) and intended to reduce the feed cost and dietary CP concentration. The contents of alfalfa hay, canola meal, and soybean meal were partially replaced by wheat straw and corn silage in the LM1+ diet and also supplemented (on a DM basis) with 2.93% Prolak (H. J. Baker & Bro. Inc., Westport, CT), 0.22% USA-Lys (Kemin Industries Inc., Des Moines, IA), and 0.07% Smartamine M (Adisseo USA Inc., Alpharetta, GA). The amount of Prolak, USA-Lys, and Smartamine M selected were intended to supply sufficient Lys, Met, and metabolizable protein (**MP**) to cows fed a low CP diet containing a high content of corn-base ingredients (Rulquin et al., 1993; NRC, 2001). The diets were fed as a TMR to be fed once daily and have 10% orts. Amounts of diets offered and orts were recorded daily for the individual groups. Cows were housed in a free-stall barn and milked 3 times a day.

Samples of each TMR were collected once every 2 d and dried in an oven at 65°C for 48 h to analyze for DM. Dried samples were ground through a Wiley mill (Thomas Scientific, Swedesboro, NJ) with a 1-mm screen and composited each week by treatment for chemical composition. Composites were analyzed by Cumberland Valley Analytical Services (Hagerstown, MD; details at http://www.foragelab.com/Resources/Lab-Procedures) for CP, NDF, ADF, ether extract, soluble CP, RDP, and minerals.

Cows in the herd were milked 3 times per day (milking parlor was active 24 h per day). Milk samples from individual cows were collected from 3 consecutive milking on 1 d during each of the last 2 wk of each period and shipped to the Dairy Herd Improvement Association (Burlington, WA) for analysis of milk fat, true protein, lactose, solids nonfat (**SNF**), and SCC. Milk urea N (**MUN**) was analyzed by the Dairy Herd Improvement Association in Chino Hills, California.

During the last 2 wk of each period, fecal and urine samples were randomly collected from at least 5 cows in each group and then composited by group and week. Composited fecal and urinary samples in each week of each group were around 4.5 and 3.5 kg, respectively. A portion of the composited samples were sent to Cumberland Valley Analytical Services for analyses of total N, total ammonium N (**TAN**), urea N, and total solids. Additional feces (about 3.5 kg) and urine (about 2.5 kg) were composited immediately and frozen at −20°C until they were used for simulated ammonia emission measurements.

Blood samples (10 mL per cow) were collected from the coccygeal vein or artery of 5 cows in each group by venipuncture into heparinized tubes in the last week of each period. Blood samples were mixed with 10% 500 μL of sulfosalicylic acid and 500 μ*M* norvaline solution and centrifuged at 16,000 × *g* for 3 min at 24°C. Plasma was then frozen at −20°C and sent to North Dakota State University (Fargo) Animal Science nutrition laboratory for analysis of plasma AA concentrations. Amino acid concentration was determined using the Water Ultra Performance Liquid Chromatograph MassTrak AA analysis solution developed by Waters Corporation (ACQUITY Ultra Performance LC, Milford, MA).

Exp. 2

A total of 311 multiparous, lactating Holstein cows were used in a switchback trial conducted from May to July 2013. The cows were assigned to 2 groups averaging parity of 3.2