J. Dairy Sci. 94:416–425
doi:10.3168/jds.2010-3656

Effect of rumen-undegradable protein supplementation and fresh forage composition on nitrogen utilization of dairy ewes[1]

C. Mikolayunas,*[2] D. L. Thomas,* L. E. Armentano,† and Y. M. Berger‡
*Department of Animal Sciences, and
†Department of Dairy Science, University of Wisconsin–Madison, Madison 53706
‡Spooner Agricultural Research Station, University of Wisconsin-Madison, Spooner 54801

ABSTRACT

Previous trials with dairy ewes fed stored feeds indicate a positive effect of rumen-undegradable protein (RUP) supplementation on milk yield. However, dairy sheep production in the United States is primarily based on grazing mixed grass-legume pastures, which contain a high proportion of rumen-degradable protein. Two trials were conducted to evaluate the effects of high-RUP protein supplementation and fresh forage composition on milk yield and N utilization of lactating dairy ewes fed in confinement or on pasture. In a cut-and-carry trial, 16 multiparous dairy ewes in mid-lactation were randomly assigned to 8 pens of 2 ewes each. Pens were randomly assigned 1 of 2 protein supplementation treatments, receiving either 0.0 or 0.3 kg of a high-RUP protein supplement (Soy Pass, LignoTech USA Inc., Rothschild, WI) per day. Within supplementation treatment, pens were randomly assigned to 1 of 4 forage treatments, which were applied in a 4 × 4 Latin square design for 10-d periods. Forage treatments included the following percentages of orchardgrass:alfalfa dry matter: 25:75, 50:50, 75:25, and 100:0. No interactions were observed between supplement and forage treatments. Supplementation with a high-RUP source tended to increase milk yield by 9%. Milk yield, milk protein yield, milk urea N, and urinary urea N excretion increased linearly with increased percentage of alfalfa. Milk N efficiency was greatest on the 100% orchardgrass diet. In a grazing trial, 12 multiparous dairy ewes in mid lactation were randomly assigned to 3 groups of 4 ewes each. Within group, 2 ewes were randomly assigned to receive either 0.0 or 0.3 kg of a high-RUP protein supplement (SoyPlus, West Central Cooperative, Ralston, IA) per day. Grazing treatments were arranged in a 3 × 3 Latin square design and applied to groups for 10-d periods. Ewes grazed paddocks that contained the following percentages of surface area of pure stands of orchardgrass:alfalfa: 50:50, 75:25, and 100:0. There were no interactions between supplement and forage treatments. Milk yield, milk protein yield, and milk urea N increased linearly with increased percentage of alfalfa in the paddock. In conclusion, supplementing with high-RUP protein tended to increase milk yield and increasing the proportion of alfalfa in the diet increased dry matter intake, milk yield, and protein yield of lactating dairy ewes fed or grazing fresh forage.
Key words: dairy sheep, forage, protein degradability

INTRODUCTION

Most dairy sheep producers in North America use improved pastures as the primary source of forage and provide a supplemental concentrate in the milking parlor. Although temperate grass or mixed grass-legume pastures may be high in CP, fresh forage protein is highly degradable (>70%; Hongerholt and Muller, 1998; Bargo et al., 2003). Intake of RDP in excess of microbial utilization contributes to preduodenal N losses, increases animal energy requirements (Cannas et al., 2004), and reduces embryo survival in sheep (Berardinelli et al., 2001; Fahey et al., 2001). In addition, the excretion of urea N contributes to environmental pollutants such as atmospheric NH_3 and nitrates in ground water (Tamminga, 1992). Therefore, balancing rations for protein degradability may improve animal performance and reduce the environmental impact of livestock production.

Although microbial protein is the primary protein source for ruminants, increasing dietary RUP can increase the flow of AA above microbial AA supply. Specific requirements are not reported for RUP in lactating ewe diets, but the NRC (2007) indicates that increasing dietary RUP from 3.4 to 9.3% of DM decreases dietary CP requirements from 17 to 15.5% of DM, indicating increased efficiency of N utilization from RUP. In trials with stored feeds, RUP supplementation increased milk yield by 13 to 27% in nondairy ewes (Robinson et al.,

Received July 27, 2010.
Accepted September 14, 2010.
[1]This research was supported by the University of Wisconsin–Madison Agricultural Experiment Station through USDA Hatch (project No. WIS01190).
[2]Corresponding author: mikolayunas@wisc.edu

1979; Loerch et al., 1985). In dairy ewes, supplementing RUP from expeller soybean meal increased milk yield by 14% in low- and high-milk-yielding ewes (Mikolayunas-Sandrock et al., 2009). Few trials have evaluated the effect of RUP supplementation to lactating ewes on pasture. Penning et al. (1988) reported a 23% increase in milk yield and a 15% increase in lamb growth when dams were supplemented with fish meal compared with supplementation with barley or no supplement. In early lactation dairy cows, Schor and Gagliostro (2001) reported a 17% increase in milk yield and a 14% increase in milk protein yield in cows fed blood meal compared with soybean meal. Therefore, RUP supplementation may be beneficial to high-producing dairy ewes.

In addition, the inclusion of legumes in pastures increases animal performance in dairy cattle (Stiles et al., 1968), beef cattle (Yarrow and Penning, 2001), and growing sheep (Fraser et al., 2004). Dairy cattle have higher DMI on legume-based pastures compared with grass-based pastures due to lower NDF and higher digestibility of legumes compared with grasses (Kristensen et al., 2005). In grazing dairy ewes, legumes increased pasture protein availability, pasture protein intake, and DMI on pasture (Molle et al., 2008). Therefore, 2 experiments were conducted to evaluate the effect of RUP supplementation and fresh forage composition on milk production and N utilization of dairy ewes. The first experiment was conducted as a cut-and-carry trial, and the second experiment was a pasture-based grazing trial.

MATERIALS AND METHODS

Ewes and Treatments

Two trials were conducted at the University of Wisconsin–Madison, Spooner Agricultural Research Station, and all procedures were approved by the Animal Care and Use Committee of the College of Agricultural and Life Sciences.

Cut-and-Carry Trial. In May 2008, 16 third-lactation dairy ewes in mid lactation (104 DIM; SD = 8) with similar milk production (2.37 kg/d; SD = 0.22) were randomly assigned to 8 pens of 2 ewes each. Pens were randomly assigned to 1 of 2 supplementation treatments, with 4 pens receiving 0.0 and 4 pens receiving 0.3 kg of a high-RUP protein supplement per day (Soy Pass, Borregaard LignoTech, LignoTech USA Inc., Rothschild, WI), fed in 2 equal feedings in the milking parlor. Within each supplementation treatment, pens were assigned to 1 of 4 forage treatments. Dietary forage treatments were applied to pens for 10-d periods in a 4 × 4 Latin Square and balanced for carryover effects. All ewes were milked twice per day (0530 and 1700 h) and had access to water and a free-choice mineral–salt mixture. All ewes received 0.8 kg of DM/d of an equal mixture of whole corn and soyhulls, fed twice daily in the milking parlor.

Forage treatments were composed of the following proportions of DM from orchardgrass (*Dactylis glomerata* L.) and alfalfa (*Medicago sativa*): 25% orchardgrass and 75% alfalfa (25 diet), 50% orchardgrass and 50% alfalfa (50 diet), 75% orchardgrass and 25% alfalfa (75 diet), and 100% orchardgrass (100 diet). All pens were fed the 50 diet for a 5-d adaptation period before the trial began. Forages were clipped daily at 0600 h at a height of 5 cm above the soil surface using a walk-behind sickle-bar mower (Jari Products Inc., Minneapolis, MN). Clipped forages were fed to ewes at 0800 h and stored at 7°C until feeding again at 1100 and 1800 h. Multiple feedings were designed to mimic the multiple meals consumed by ewes grazing pasture. Forage DM was determined on d 2 and 7 of each experimental period by drying forages in a 37°C forced-air oven until they reached a constant weight. As-fed forage amounts were calculated based on these DM determinations. Pens were fed forage ad libitum to allow 5% refusals. Forages were clipped to maintain similar stages of maturity.

Grazing Trial. In June 2009, 12 third-lactation dairy ewes in mid lactation (126 DIM; SD = 6) with similar milk production (2.32 kg/d; SD = 0.16) were randomly assigned to 3 groups of 4 ewes each. Groups were assigned to 1 of 3 dietary forage treatments, which were balanced for carryover effects and applied to ewes for 10-d periods in a 3 × 3 Latin square.

Forage treatments were paddocks containing the following proportions of surface area from pure stands of orchardgrass and alfalfa: 50% orchardgrass and 50% alfalfa (50 diet), 75% orchardgrass and 25% alfalfa (75 diet), and 100% orchardgrass (100 diet). Forages were planted in monoculture strips, clipped to a height of 7.5 cm, and allowed 20 d of regrowth before the start of each grazing period. No plot was grazed more than once and the maximum age of forage regrowth was 30-d. Paddocks were created using a combination of portable electric and wooden fencing. Ewes were given fresh forage daily and paddock size was based on the residual from the previous day.

Within each group, 2 ewes were randomly assigned to one of 2 supplementation treatments, receiving either 0 or 0.3 kg of SoyPlus/d, a source of RUP (West Central Cooperative, Ralston, IA), fed in 2 equal feedings in the milking parlor. All ewes were milked twice daily (0700 and 1900 h) and had access to water and a free-choice mineral–salt mixture. All ewes received 0.8 kg of DM/d of whole corn, which was fed in equal portions at each milking. All ewes were dosed twice daily with a gelatin